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Łukasz Tomczyk
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Digital Literacy for Teachers

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Łukasz Tomczyk · Laura Fedeli
Editors

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Editors
Łukasz Tomczyk
Institute of Pedagogy
Jagiellonian University
Kraków, Poland

Laura Fedeli
University of Macerata
Macerata, Italy

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Chapter 1
Introduction—On the Need for Research on the Digital Literacy of Current and Future Teachers

Łukasz Tomczyk and Laura Fedeli

The development of the information society forces a reflection on how the next generation of teachers are prepared for work in the school and non-formal education system. Current models for the education of pedagogical staff all over the world require the challenges posed by the convergence of analogue and digital media to be met, as well as for the continuous and intensive process of digitization to be taken into account, especially when that process is accelerated by circumstances beyond the control of the teachers themselves (e.g. pandemic situation, the accelerated development of e-services, the creation of new educational policies, and the informatization of the state, to name just a few). Facing these challenges requires an attempt to organise the existing knowledge on digital competences among current and future teaching staff. The aim of the study is to show the multidimensionality of the concept of digital competence among future generations of teachers. The individual chapters are based on a systematic review of research findings (from the last two decades) in order to outline the trends that relate to changes in the measurement and level of digital competence.

The digitisation of education has now become a priority in many countries as never before. Effective digitisation requires not only knowledge of how ICT can be used in education, but also skills in handling new technologies. Currently, before our very eyes, there is an incredible "leap" in the process of retrofitting schools with new media, as well as the spread of e-learning. These processes mean that the focus is increasingly shifting from the technical layer to soft areas, i.e. the skills of educational stakeholders. Teachers have become the cornerstone in the process of the effective implementation of ICT (Tomczyk & Fedeli, 2021). Simply equipping schools without

Ł. Tomczyk (✉)
Jagiellonian University, Stefana Batorego 12, 30-322 Kraków, Poland
e-mail: tomczyk_lukasz@prokonto.pl

L. Fedeli
University of Macerata, P.le Bertelli1, 62100 Macerata, Italy
e-mail: laura.fedeli@unimc.it

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developing the teachers' skills is insufficient. Therefore, it is necessary to take stock of what has been done so far in the area of the digitization of education from a global perspective. Such an ambitious goal is outlined in this publication.

Reflection on the level of the digital competence of stakeholders among future generations of teachers has been evident in the literature for more than two decades. In this book, authors from twenty-five countries have undertaken the complex task of showing the level of preparation of new teaching staff for the teaching profession in the information society. Authors from North America, South America, Asia, and Europe set out to accomplish the very complex task of summarising the existing research on digital literacy among those who will soon be transforming the school environment. Using a systematic analysis of documents, the results of quantitative and qualitative research, and references to global and regional strategic documents related to the digitization of education, the authors have sought to bring home to their readers the complexity of conditions for the digitization of education in individual countries and regions. The whole study consists of twenty-five chapters. In the first text Jacek Pyżalski and Natalia Walter from the Adam Mickiewicz University in Poznań, Poland, introduce readers to the notion of digital competence through the prism of changes that have taken place over the last several months. This text is crucial for understanding the instability of the theoretical concept and the operationalisation of the notion of digital competence, which has been transformed due to the pandemic situation. The second chapter, by Nazmi Xhomara from Albania, is not only a review of research but also an empirical reference to the earlier text. Xhomara makes it clear that digital competences nowadays should be strongly combined with e-learning. In chapter three, Vladimir Costas-Jauregui, Sonia Manzur, and Violeta Costas-Jauregui provide a critical-constructive analysis of the digitisation of schooling in Bolivia. In chapter four, the authors from Bosnia and Herzegovina—Elma Selmanagić Lizde, Amina Đipa, Izela Habul Šabanović, Jasmina Bećirović Karabegović—attempt a constructive-critical review of the literature in relation to vocational preparation in an increasingly digitalised reality. Due to the geographical breadth involved, the authors from Brazil had a very difficult task ahead of them. Maria Amelia Eliseo, Cibelle Albuquerque de la Higuera Amato, and Ismar Frango Silveira present the directions of research on digital competence and how this skill is shaped in the largest country in Latin American. The sixth chapter, by Plamen Zlatkova and Ivanka Kirilova, is an attempt to show the level of digital competence of teachers and future teachers against the background of national strategies in Bulgaria with reference to strategic documents of the European Union, as well as the challenges presented in the pandemic period. In the next chapter, Helen J. DeWaard from Canada highlights the role that the institutions responsible for the professional preparation of future teachers should adopt and are adopting in an ICT-based society. The chapter by Juan Silva, Roberto Canales, and José Garrido highlights the variety of ways in which ICT literacy is assessed by pedagogical students in Chile. In the ninth chapter, two authors, Jiafeng Gu and Rui Ding, use a systematic document analysis to present the complexity of the concept of digital competence in China. The next text, by Milan Kubiatko, is a typical analysis of found documents relating to Czech research on the digital competence of future teachers in the Czechia. In the eleventh chapter, Darwin Munoz, Rita

Licelot Cruz, Leipzig Guzmán, and Laura Reyes Alardo introduce readers to the ways in which digital competence is understood and measured in the Dominican Republic. Another chapter, by Magali Arteaga and Esteban Valdiviezo, covers not only general analyses related to the digital competence of teachers, but also research findings related to foreign language educators. These Ecuadorian authors thus highlight the fact that digital competences may differ somewhat in their definition and means of measurement not only in different professional groups but also in different teaching specialisations. Laura Fedeli, using an analysis of previous research articles published in Italy, makes it clear that in her country there is a multiplicity of methodological approaches related to the measurement of digital competences, but that this topic, despite its relevance, has not translated into a large number of studies. In the fourteenth chapter Hasan Saliu and Arberore Bicaj present the concept of digital competence through the lens of academic programmes of preparation for the teaching profession. The voices of the authors from Kosovo shift the focus of discussion not only to how digital competences are defined and measured, but above all to the methodology of their formation. Ramunė Kasperė and Vilmantė Liubinienė in their chapter pose a reasonable question—is Lithuania ready for the effective digitization of education? They answer this question similarly to the authors of the previous chapter by referring to the professional education of teachers and to the surveys conducted among all the actors who are focused on the school sector. A classic systematic document analysis is carried out by the authors from Mexico—Claudia Blanca González Calleros, Josefina Guerrero García, Yadira Navarro Range, Juan Manuel González Calleros and Cesar Alberto Collazos Ordoñez. This is a chapter that allows for an in-depth understanding to be reached of the role of higher education in the process of shaping the digital competences of future teachers through institutions assigned to higher education. In the seventeenth chapter, Nils Christian Tveiterås and Siri Sollied Madsen from Norway, in reviewing the research from their own country, have sought to show not only the level of preparation of teachers to use ICT in the process of education and subject didactics, but also to draw attention to the fact that the digitisation of education extends beyond the simple matter of the software tools in use and requires systemic thinking about the use of cyberspace resources. In the next chapter, Vivencio O. Ballano, Nicolas T. Mallari, and Raul Roland R. Sebastian from the Philippines stress that the understanding of digital competence should be firmly rooted not only in the historical background of the development of the information society, but above all in the real challenges of today (related to the COVID pandemic, among others). In the nineteenth chapter, Łukasz Tomczyk shows how research tools measuring digital competences among future pedagogical staff in Poland are shaped in different ways. On the one hand, this diversity contributes to an increase in the number of indicators defining digital competences, while on the other hand it introduces methodological inconsistencies. In the subsequent text, Gabriela Neagu from Romania makes it clear that research on digital competences is linked to pedagogical practice. Thus, the research process is not only a way to describe the level of preparation of future teachers, but also allows for the improvement of existing professional education programmes. The twenty-first chapter, by Olga Fedotova, Alla Belousova, and Mariya Vyshkvyrkina in Russia, clearly emphasises that digital competence is one of the most important areas of research exploration in the field of media pedagogy within their country. These researchers repeatedly underline that the formation of digital competences cannot be separated from the school reality. Alena Hašková and Ján Záhorec from Slovakia, who like some of the aforementioned researchers employ a systematic literature review, show how the measurement and level of digital competence has been changing in one of the Visegrad countries. The Slovak researchers also note that the difficulties that have occurred most recently (at the stage of crisis e-learning) are the result of the earlier education of pedagogical staff in the area assigned to media pedagogy. The twenty-third chapter, by Antonio-José Moreno-Guerrero, José-Antonio Marín-Marin, Jesús López-Belmonte, and Prathamesh Churi in Spain, presents the results of an analysis of almost three hundred articles dedicated to the indicated topic, which were affiliated by authors from the Iberian Peninsula. Another text, compiled by Larysa Lukianova from Ukraine, is a review of promotion studies (e.g. doctoral dissertations) devoted to the topic of the digitization of education in Ukraine. Larysa Lukianova developed her chapter using the technique of the triangulation of different types of expert sources, which is a unique technique compared to the other chapters, which were prepared using the most popular scientific databases (EBSCO, CEOOL, Google Scholar, Scopus, Web of Science). The last chapter, by Mariana Porta, Regina Motz, and Daniel De Queiroz Lopes in Uruguay, emphasises the importance of the theoretical framework used in the measurement of digital competence, which types of research tools are used, and the systemic conditions of the development of digital competence in Uruguay.

All twenty-five chapters constitute extended and in-depth studies on the characteristics and means of measuring digital competence. Regardless of the methodology adopted (qualitative or quantitative), it is currently difficult to provide a clear and complete definition of digital competence (Tomczyk, 2021b). The richness of approaches and the diversity of measurement methods is not a characteristic of a single country but is present in all twenty-five texts. Looking at the research results of the last several years through the prism of the richness of views, clashing paradigms, and the multiplicity of indicators, one can observe how dynamically media pedagogy is developing all over the world. On the one hand, the wealth of theories, tools, and research directions is a resource, while on the other hand that very same wealth does not allow for longitudinal research or the development of a common theoretical framework or tools. Therefore, the present publication should be regarded as an attempt at in-depth and systematic reflection, something that is particularly necessary at the current (strategic) stage of the development of the information society and the digitization of education (Stosic, 2015).

The creation of this book was inspired by a number of events and discussions, as well as the challenges that the authors and editors of the publication have faced of late. The first of these was the research on media pedagogy paradigms conducted by Jacek Pyżalski (2012, 2017, 2019). It was through Prof. Jacek Pyżalski that one of the editors of this publication attempted to systematically organise and understand the current research directions on the digitalization of education and the competences of future and current pedagogical staff (Tomczyk, 2021a). Using Pyżalski's paradigm of risks and opportunities of media pedagogy (Pyżalski, 2012), an attempt was made to perform a longitudinal analysis of the phenomenon of digital competences, as well as of the opportunities and limitations associated with the digitization of didactics and the process of education. Therefore, at this point I would like to express my great thanks to Professor Jacek Pyżalski not only for his inspiration, but also for his support in conducting the research and guiding me towards innovative solutions, fostering the discovery of truth by means of the available theories and tools in the intensely developing media pedagogy.

We would like to extend our sincere thanks to the reviewers from Italy (Prof. Gigliola Paviotti, Prof. Valentina Pennazio), Slovakia (Prof. Miriam Niklova), Poland (Prof. Nataliia Demeshkant, Prof. Katarzyna Potyrała), Romania (Prof. Sebastian Toc, Prof. Alexandru-Mihai Carțiș), and Spain (Prof. Francisco David Guillen-Gamez) for their help in the quality control of the texts. Thanks to the involvement of eight reviewers, we were able to significantly increase the quality of the study. The insight of external experts allowed the authors as well as the editors to eliminate shortcomings and thus increase the readability of the texts.

Separate thanks are due to the Polish National Agency for Academic Exchange. This monograph, which we are thus presenting to our readers, is mainly the result of the project "Teachers of the future in the information society-between risk and opportunity paradigm" (Bekker programme Grant number: PPN/BEK/2020/1/00176). Without institutional support, it would be difficult to find adequate time and organisational resources to foster this type of comparative research.

The present publication may prove to be particularly valuable for researchers educating future generations of teachers in the use of new media. Taking into account the content of the monograph, the book seems to be particularly valuable for people trying to measure the stage of development of the information society, as well as for specialists conducting research in the field of comparative pedagogy (including the transfer of the most effective solutions in the field of media pedagogy).

The main benefit for readers familiarising themselves with individual chapters is access to a systematic analysis of research results from the last two decades concerning the preparation of teachers for the use of new media in selected Asian, North and South American, and European countries. The publication is in line with the needs of the academic community and is intended to be of use in the modernisation of academic courses such as media in education, information technology, and pedagogical innovations.

Considering the multifaceted analysis undertaken by authors from twenty-five countries, the book contains research results of use for the development of several disciplines, namely: (1) general pedagogy in terms of showing how to measure and perceive digital skills, which are one of the main key competences; (2) media pedagogy as an intensely developing sub-discipline, which includes issues of improving the skills of implementing new media in the process of learning, teaching, and upbringing; (3) comparative pedagogy, in which comparing the achievements of learners contributes to the development of the whole discipline; (4) higher education pedagogy, where research results are used to improve curricula, in this case teacher education; (5) pedagogical diagnostics, which focuses on the development and standardisation of new measurement tools, including those measuring key competences; (6) media sociology, which shows the changes occurring in society due to the intensive implementation of information solutions; and (7) educational policy, where research results are used to define new directions for education, teacher training, and lifelong learning.

Considering the multi-sectoral nature of this study, we hope that the book will also contribute to the global reflection on universal processes in education. We wish the readers a pleasant reading, and we thank the authors and reviewers for their fruitful cooperation.

Łukasz Tomczyk.
Laura Fedeli.

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Chapter 2
Lessons Learned from COVID-19 Emergency Remote Education. Adaptation to Crisis Distance Education of Teachers by Developing New or Modified Digital Competences

Natalia Walter and Jacek Pyżalski

Abstract Emergency remote education caused by the COVID-19 pandemic brought numerous challenges to both educational systems and educational professionals. All teachers, including those reluctant to use ICT in their classrooms, had to implement it under specific social and psychological circumstances. That situation brought a variety of challenges and demanded from teachers appropriate skills to carry out effective educational activities. All of this put a new light on the problems connected with e-education such as digital inequalities, digital well-being, or development of digital skills by students and teachers. The text analyses in a coherent way the commonly accepted European Framework for the Digital Competence of Educators (DigCompEdu) in the context of its usefulness for the specific situation during school closure. We refer to the research data pointing out which teacher competences are significantly more important or which should be defined in a different way or adjusted based on the pandemic experience. The text confirms the adequacy of the European Framework for the Digital Competence of Educators (DigCompEdu) but brings attention to important details that may be important for its implementation after the COVID-19 period.

Keywords e-Education · Remote education · COVID-19 pandemic · Emergency remote education · Digital inequalities · e-Learning · Digital teacher competences

2.1 Introduction

It is often said that the Internet has not brought new social (also educational) phenomena but reinforced and sometimes made more visible the old ones. We acknowledge, based on the research conducted during the pandemic, that the same

N. Walter (✉) · J. Pyżalski
Adam Mickiewicz University, Wieniawskiego 1, 61-712 Poznań, Poland
e-mail: Natalia.Walter@amu.edu.pl

J. Pyżalski
e-mail: pyzalski@amu.edu.pl

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can be said about the period of remote education during school closure due to the COVID-19 pandemic. From the perspective we use in this text, we observe that remote education during the COVID-19 pandemic has not brought demand for entirely new digital competences of teachers. It has rather confirmed and sometimes modified widely acknowledged models and lists of competences elaborated before the pandemic, such as the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker, 2017). The modification means here bringing new dimensions or a new understanding of initially defined competences as well as underlining the importance of certain aspects that, although discussed before, have not been properly addressed.

The period of remote education during the COVID-19 pandemic is commonly defined as the crisis or emergency remote education in the scientific literature (Bozkurt & Sharma, 2020; Murphy, 2021; Pyżalski, 2020). Those terms clearly underline the unique characteristics and difficulties experienced by educational institutions and professionals. Educational systems around the world have not been sufficiently prepared to change from traditional to remote education. Many unexpected pitfalls and challenges emerged during the process of providing education mediated by digital tools (Doucet et al., 2020). Many of them transcended obvious issues like teachers' technical competence and covered other issues such as the need to build online relationships vital for education (mainly peer and teacher-student relationships), the need to protect and maintain well-being and mental health of students and teachers, as well as digital well-being related to an extensive use of information and communication technologies. On the other hand, the closer look reveals not only the problems but also the educational potential of technology in education. Such a salutogenic approach is visible not only in purely didactic aspects but also in areas connected to relationships, social support, and psychological needs of students. Additionally, the remote crisis education period sheds light on groups of students that need specific attention when participating in online education. This attention should be focused on both vulnerable groups and those groups for which this period was clearly beneficial.

We believe that the analysis of how institutions and stakeholders adapted to the new scenario created by the COVID-19 pandemic may be beneficial to improving the concepts of teacher digital competence and the curricula of high schools that are aimed at supporting the development of digital skills for emerging teachers.

Before undertaking the main topic—teacher digital competences needed for good quality education, we analyze contemporary concept of digital competences. It is understood in our rationale as the aim that teachers want to achieve in the area of digital competences in students. In other words, teachers aim at supporting their students in achieving the wide set of digital competences needed for successful social, occupational, and educational life in the digital age (Brolpito, 2018).

Then we move to the main topic—teacher digital competences. We analyze selected groups of competences from European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker, 2017), presenting what research data and experiences from the crisis remote education period may add to this model. Based on this we provide reflection and set forth suggestions for modifying or extending

DigCompEdu conceptualization. For a better understanding, we start from a cohesive summary of DigCompEdu framework presenting its main conceptual aspects.

2.2 Digital Competency Frameworks

As stated above we start our analysis with presentation of man conceptual issues on general digital skills and competences framework.

Acquisition of relevant competences that are a valid combination of knowledge, understanding, evaluation, and efficient use of new information technologies is also an essential issue from an educational perspective. A person possessing these competences is able to categorize and assess information, deal with excess information, and make analyses and comparisons. Researchers suggest different definitions and classifications of digital skills and competences (DSC). The emerging EU classification identifies three main DSC categories for citizens: (1) Digital competences: also referred to as digital literacy, which includes a set of basic digital skills, including information and data literacy, online communication and collaboration, digital content creation, security, and problem solving. Digital competences relate to the ability to apply these digital skills (knowledge and attitudes) in a certain, critical, and responsible manner in a specific context (e.g., education). Digital competence has been one of the eight key competences in the EU within lifelong learning since 2006; (2) occupational-specific digital skills: a set of specific digital skills for those involved in tasks, including the use and maintenance of digital tools. (3) Digital skills for ICT professionals: a set of advanced and highly specialized digital skills for those involved in ICT professions, for example, programmers (Brolpito, 2018).

While competence can be understood as the ability to use knowledge, skills, and personal, social, and/or methodological abilities in various work or study-related situations and in professional and personal development, skills are the abilities necessary to apply knowledge and use know-how to complete tasks and solve problems. According to UNESCO (2018b), digital skills can be defined as a range of "abilities to use digital devices, communication applications, and networks to access and manage information. They enable people to create and share digital content, communicate and collaborate, and solve problems for effective and creative self-fulfillment in life, learning, work, and social activities at large". Helsper and Eynon (2013) identified four broad categories of skills: technical, social, critical, and creative skills. The concept of digital skills by van Laar et al. (2018) includes: technical, information management, communication, collaboration, creativity, critical thinking, and problem solving.

The European Union in 2013 referred to digital literacy as digital competence (DigComp) and included it in its standard of eight key competences for lifelong learning: "Digital competence can be broadly defined as the confident, critical, and creative use of ICT [Information and Communications Technologies] to achieve goals related to work, employment, learning, leisure, inclusion, and/or participation in society. Digital competence is a key transversal competence that enables us to acquire other key competences (e.g., language, mathematics, learning-to-learn, and cultural awareness). It is related to many of the skills of the twenty-first century that should be acquired by all citizens to ensure their active participation in society and the economy (Ferrari, 2013). This EU report offered a self-assessment tool to evaluate digital literacy competences in five areas (information retrieval, evaluation, and management; communication; content creation; safety in the digital environment; and problem solving) with three proficiency levels. A, foundation level; B, intermediate level; C, advanced level (Ferrari, 2013). DigComp 2.0 and 2.1 are another complemented and extended version of the Digital Competence Framework for citizens. Based on the conceptual model published in DigComp, they identify the key components of digital competence in five areas: (1) Information and data literacy: To articulate information, one needs to locate and retrieve digital data, information, and content. To evaluate the relevance of the source and its content. To store, manage, and organize digital data, information, and content; (2) Communication and collaboration: To interact, communicate, and collaborate through digital technologies while being aware of cultural and generational diversity. Participate in society through public and private digital services and participatory citizenship. Manage one's digital identity and reputation; (3) Digital content creation: Create and edit digital content to improve and integrate information and content into an existing body of knowledge while understanding how copyright and licenses are to be applied. Know how to give understandable instructions for a computer system; (4) Safety: Protect devices, content, personal data, and privacy in digital environments. Protect physical and psychological health, and be aware of digital technologies for social well-being and social inclusion. To be aware of the environmental impact of digital technologies and their use, and (5) Problem solving: Identify needs and problems, and resolve conceptual problems and problem situations in digital environments. To use digital tools to innovate processes and products. To keep up-to-date with the digital evolution (Carretero et al., 2017; Vuorikari et al., 2016).

Among the models and classification of digital competences and skills, there are those that explicitly include aspects of emotional intelligence. To illustrate this, let us consider a concept proposed by Park (2016) during the World Economic Forum in 2016. It presented eight digital competences that we should provide contemporary children with: digital identity, digital usage, security, protection, digital emotional intelligence, communication, digital literacy, and digital rights. They all make up the so-called DQ (digital intelligence quotient, by analogy to the intelligence quotient), which are social, emotional, and cognitive skills that enable people to face challenges and adapt to the requirements of digital life.

The Eurydice report (2012) shows that national strategies on digital competence have been defined and are available in almost all European countries. At the time of the preparation of the report, digital competences were taught through the application of the cross-curricular approach at the basic level in all EU countries (except for two) and in all countries at the secondary school level, in addition to other approaches used in a dozen other countries, such as integrating ICT with other subjects or teaching IT as an independent subject. The key element of success is to provide teachers with adequate digital competence: the OECD (2014) TALIS 2013 study shows that 18%

of teachers consider it essential to develop their ICT skills they use during class, while 16% think the same for the competences in the workplace.

The main document that is also a basis of our analysis is European Digital Competence Framework for Teachers (DigCompEdu), which is a descriptive framework mandating teachers to possess digital competences required for successful education of their students in the digital age. DigCompEdu is targeted at teachers at all levels of education, from early childhood up to higher and adult education, including general and vocational education, special education and the context of non-formal learning. DigCompEdu describes in detail 22 competences organized into six areas. What is particularly important is that it is not focused on technical skills. Instead, this framework aims to determine how digital technologies can be used to improve and innovate in education and training. The areas are as follows: Area (1) focused on the professional environment; Area (2) related to acquiring, creating, and sharing digital resources; (3) on the management and coordination of the use of digital tools in teaching and learning; (4) on digital tools and strategies to improve evaluation; (5) on the use of digital tools to strengthen the position of students and (6) on facilitating the digital competences of students (Redecker, 2017). A digitally competent teacher is one who has knowledge and skills in areas such as: (1) focused on the professional environment; (2) related to the acquisition, creation, and sharing of digital resources; (3) concerning the management and coordination of the use of digital tools in teaching and learning; (4) on digital tools and strategies to improve assessment; (5) using digital tools to empower learners, and (6) improving learners' digital competences (Redecker, 2017).

Based on the DigCompEdu typology, we will look at teaching competences that have changed or become particularly relevant in the context of the crisis e-learning experience during the COVID-19 pandemic.

2.3 Professional Environment

DigCompEdu (Redecker, 2017) defines competences related to the professional environment of educators primarily through the lens of communication. This communication is on the one hand connected to communication with the main actors, learners, and parents. However, it is also the area of horizontal communication with other teachers (from the same organization) as a basis for collaboration. This extends also to other educators (e.g., those present in online communities) who can be partners for sharing and exchanging professional communication and reflect and assess educational practices. Competence in this area should also be a basis for continuous professional development with the help of digital resources (Redecker, 2017). This should be a central issue, since teachers' collaboration is regarded as a dimension of school quality and is a prerequisite for teacher and school development (Huber, 2018). This was in many cases negatively affected during the remote emergency education period (Huber & Helm, 2020).

As communication is a basis for important educational relationships, we observed changes in this respect during the period of remote education when mediated communication was only possible or at least the main mode of contact. This was caused primarily by the limited social presence frequently discussed in the literature during the remote education of COVID-19 (Carrillo & Flores, 2020). What is interesting is that those changes were not the same in the whole population. For example, in Polish teachers, about one-third indicated that the quality of relations and communication with teachers in their schools decreased. At the same time, 20% experienced such a decrease in relations with parents/guardians of students. The same is interesting from the perspective of parents—18% communicated with teachers less frequently than before the pandemic, while 23% were doing this more often (Ptaszek et al., 2020). Analyzing this result, one may conclude that mediated communication may both improve and spoil the quality of communication. Surely, the actual situation and the outcomes depend on the competences of the involved parties. This confirms that competences concerning digital communication based on a deep understanding of its characteristics and psychological processes involved are vital for contemporary teachers. It is particularly true in situations where digital communication becomes a main platform for communication with the main actors in education.

It should be noted that during the COVID-19 pandemic, the role of online communities and support groups became more important than before. They have been used not only to exchange experience and pedagogical ideas and methods, but also to support other teachers on issues concerning their health and well-being (impacted negatively by new stressors brought about by remote education) (Baker et al., 2021; Klapproth et al., 2020). This means that teachers' digital competences should include being able to provide and receive digitally social support effectively in not only their own institutions but also in wider online communities. This means on one hand knowledge of possibilities in this respect, but more importantly the communication competences needed for such activities.

A professional environment also means providing an organization of work that is supportive of the health of the teacher. The forced remote education period has shown that, although not included in DigCompEdu, the aspect of digital well-being in the context of work environment should be involved in the typology of teacher digital competence.

Although digital well-being has been explored mainly among students during the remote education period, there were also studies showing that problems in this area were also experienced by teachers, sometimes to greater extent than in young people. A large-scale study conducted in Poland confirmed that more than 85% of teachers declared that they were often or very often ready to receive calls and notifications or that they were often or very often tired of sitting at the computer screen. Three-quarters felt tired and overloaded with the information present in the media. Additionally, the majority of teachers indicated many health complaints that they attributed to the extensive use of ICT. It is worth underlining that most of those indicators were higher in teachers compared to their students (Ptaszek et al., 2020).

Based on this evidence, one can claim that the digital well-being of teachers using digital media should be a part of the support system in their work environment. From this perspective, taking care of digital well-being and the ability to take care of it should be on the list of digital teacher competences. As such, it could be understood both as an individual competence but also as the competence of educational institution headmasters who should organize the work of teachers that promotes healthy ICT use (Oberle et al., 2020; Sultana et al., 2021). We should also not forget about role modeling in this respect with the question of whether teachers who do not use technology in a healthy way themselves may effectively affect positive use by their students.

Another issue related to teacher mental health related to occupational factors is work-life balance. Although acknowledged widely and explored in the literature before the pandemic (e.g., Schonfeld & Chang, 2017) it was brought to a new dimension during remote emergency education. This was mainly caused by the fact that the entire work of teachers moved to their places of residence and substantially modified family environments. Being all time in the same physical setting makes setting boundaries between private and professional time extremely difficult. This was also connected to permanent attempts at digital communication with students and their parents/guardians. This is clearly seen in the research results. For example, high percentages of Polish teachers during remote education in crisis. complained openly about the problems of fulfilling family duties due to remote education. Furthermore, 60% had often or very often wished to be completely unavailable to online communication and almost 70% felt irritated due to the constant use of digital devices (Ptaszek et al., 2020). Furthermore, 90% of teachers indicated that they needed more time to prepare their lessons and 70% had to learn how to use new digital tools (e.g., e-learning platforms) (Ptaszek et al., 2020). From this perspective, it is important to possess competences that may be generally defined as those that support building and maintaining digital well-being. Among them, important could be planning time online. This can cover such issues as controlling and limiting professional communication and time spent on other professional activities and planning reasonable breaks from the digital mode of work. It should also include setting and implementing certain rules concerning activities and situations (like family time) when digital media are completely not used. All of this requires that educators have the ability to analyze and reflect on the way teachers use digital technologies from the perspective of their potential negative influence on mental health.

2.4 Digital Resources

The pandemic has forced teachers, despite the lack of this preparation, to implement technology in education in a way never known. Almost all education research during the COVID-19 pandemic highlights a significant increase in the use of digital solutions by teachers at all levels of education. Tools that comprehensively support distance education, that is, LMS platforms, were used most frequently. Open educational resources have become popular, especially regarding the use of reading materials (when schools and public libraries were closed), films, and recorded lectures.

In the case of younger children, interactive tasks were used, both ready-made and created by the teachers themselves (Walter, 2020).

The pandemic has clearly shown that every modern teacher must raise the level of digital competence understood in this way, but at the same time it has opened up enormous opportunities for self-development through access to online teaching support groups, enabling the sharing of experience; online courses and training (both institutional and non-institutional); open educational resources in the form of methodological instruction, guides, and electronic books. This widespread use of the Internet for self-education (also in the context of functioning in online communities of other learners) has been confirmed in many studies, e.g., qualitative studies on the functioning of Polish English teachers teaching preschool and younger school-age children.

Teachers provided various types of support, especially informative and emotional support, during the pandemic. Many teaching groups have been established or developed on social networks. They have provided many educators with the feeling that they are not alone in this difficult situation. The pandemic and the distance education it enforced have shown teachers that it is worth cooperating with each other. It enabled contact between people from different parts of the world and exchange of experiences. Many inspiring teacher projects were created, such as the Polish idea "Invite me to your lesson", which was based on the fact that some teachers invited others to their lessons. Among the benefits, it is noted that lessons are often more interesting when the material is provided by an unknown person or someone who is a specialist in the field, and the teachers themselves can learn from each other by observing the lessons given by invited guests and interacting with each other, long-term cooperation with them (Przybysz-Gardyza, 2020). When we described the competency framework, we mentioned the concept of Park (2016), because in the pandemic, issues related to digital emotional intelligence turned out to be particularly important. Many teaching initiatives resulted from altruistic premises.

In addition, many didactic materials, lesson plans, and other solutions were developed. Tools and applications that support student activation were also popularized. Teachers also had opportunities for self-development and access to numerous resources that facilitate remote improvement of skills. It was especially appreciated by educators living in small towns, far from large professional development centres.

The most desirable competences in the field of developing digital resources for teachers were not only content selection, but most of all creating their own resources and sharing them with others.

2.5 Assessment

Formative and summative assessment is a crucial part of education. According to DigCompEdu, teachers should master their skills to enhance the diversity and suitability of assessment formats and approaches and to analyze evidence on learners' activities and progress through digital tools. Important in this respect is also the provision of assessment feedback to students and their parents/guardians (by digital technologies) (Redecker, 2017). Since remote assessment methodology became during crisis and remote education the only possible assessment, it brought a few important aspects to consider and analyse (Daniel, 2020).

The first important issue was the competence of teachers to decide which aspects included in the curriculum should be assessed. As mediated assessment is difficult and in many cases time-consuming, it is necessary to define priories and reduce the scope of assessment. Another issue was of ethical nature and is also related to teacher-student communication. The challenge of online assessment is connected to wider potential opportunities to cheat during digital assessment processes. Therefore, the competences of teachers may on the one hand mean using technologies and processes that minimalize cheating, but, on the other hand, the communication with students that is based on trust. This may cause conflicts, but it remains a challenge, since there is a substantial risk that online assessments will be less accurate and valid than traditional ones.

Another reason for focusing on the competence of teachers to provide honest and accurate testing is the fact that employers and universities use educational credentials to sort applicants. In situations where teachers fail to provide fair digital assessment procedures mentioned, it would be extremely unfair.

2.6 Teaching and Learning

The use of information and communication technologies in education requires detailed planning of their inclusion in didactics. Empirical evidence on the effects of using ICT for educational purposes and improving student performance is still scarce, and the results are mixed (Bulman & Fairlie, 2016). The impact of technology on student achievement and interventions to improve teachers' communication with students and families, and students with their peers have been extensively explored. Overall, evidence shows little, if any, impact of increased access to educational hardware and software in schools on increasing learning efficiency (Escueta et al., 2017), and the improvements are comparable to other types of offline interventions, such as student feedback and peer learning (Higgins et al., 2012). There are, however, some benefits that do not relate strictly to cognitive performance but to the emotional and social functioning of students, which may translate into the so-called educational success. The use of technology can provide an innovative and stimulating learning environment, facilitate individualized learning, and increase student motivation (Blossfeld et al., 2018; Süss et al., 2013). Therefore, based on the results of previous research, the planning of didactic classes should take into account both the quantity and quality of the media, as well as the selection appropriate to the age and perceptual abilities of the students. However, such an approach requires the prior factual, methodical, and technical preparation of teachers.

The pandemic was also highlighted by the fact that it has been known for a long time that, in addition to these frequently mentioned IT (technical) competences, teachers working remotely should be characterized by competences in the field of pedagogy (including didactics) and the psychology of learning and e-learning (Walter, 2013). The simultaneous in-depth knowledge of online learning methods and the knowledge of how to adapt them to the content, objectives, effects, and methods of assessment and evaluation creates a new quality that has become a key issue during the crisis distant education. Of course, the teacher now also has to use the tools to create comprehensive online training courses efficiently, including managing any e-learning platform. However, these are not strictly IT competences, but rather related to knowledge and skills in the field of new information technologies in the field of education.

It turns out that even though teachers quickly acquired the technical competency to use remote education tools, the quality of the classes and their attractiveness to students were worse. More than half of the students surveyed in Poland indicated that remote lessons are less interesting than before the pandemic, and about a quarter was unable to understand what the teacher was saying and did not keep up with the pace of online classes (Ptaszek et al., 2020). Therefore, it is clear where the emphasis should be placed regarding the professional preparation of teachers in the area of using ICT in education and media education.

Initially, teachers struggled with the difficulties resulting from the lack of technical (operational) skills, but it soon turned out that modern e-learning solutions are so friendly and functional that mastering them does not require much effort. After several months of remote education, according to the research of Plebańska et al. (2021), teachers gained a sense of an increase in the level of their digital competence, but at the same time declared a strong need for support regarding effective methods of activating students during classes and motivating them to learn. We come to the heart of the problem here—digital competences are not only technical skills, but also social, critical, and creative skills, including the possibility of online collaboration, communication, or problem solving (Helsper & Eynon, 2013; van Laar et al., 2018).

Finally, referring to the recent experience of the pandemic, it should be clearly indicated that without the possibility of using mediated communication during school closure, maintaining essential relationships for education (with the teacher and with peers) would be completely impossible.

2.7 Empowering Learners

DigCompEdu (Redecker, 2017) underlines the need to tailor digital education to the needs of different groups of learners, particularly young people with special needs. Although the competences in this area are essential, it must be said that they have not been treated seriously enough before the pandemic (Plichta 2011, 2017).

Awareness of digital inequalities and the ability to offer internet safety and positive internet use programs are not commonly perceived as digital competences required by teachers. The general public focuses more on technical skills regarding particular digital learning tools.

However, since the proportion of young people in school populations who, for different reasons, experience digital inequalities is high and still growing, one cannot effectively support young people without this kind of competence. This was significantly demonstrated during pandemic experiences in crisis education that made digital inequalities and their consequences more visible and extended the scope of vulnerable students who need special attention and attention, accompanied by teacher competence.

Official documents such as DigComp for educators state that empowering vulnerable learners is important and means “ensuring accessibility to learning resources and activities for all learners, including those with special needs” (Redecker, 2017, p. 22). This may be encouraged by potential negative outcomes that are higher in those groups, for instance, the possibility of digital exclusion and experiencing online risks. They reinforce traditional inequalities already negatively influencing the lives of young people with special needs and may be magnified by those brought by the Internet and ICT usage also within the educational context (e.g., Aesaert et al., 2015; Alfredsson Ågren et al., 2020; Alper et al., 2016; Borgström et al., 2019).

Some scholars (Alper & Goggin, 2017) tend to see digital inequalities as negatively affecting child rights. From this perspective, the rights of the online environment are endangered, and the measures that empower them in this context should be implemented. From this perspective, the empowerment of young people with special needs is at the center since it is recognized that “children with special needs have no supportive space to access and learn how to navigate the digital environment without adults” (Council of Europe, 2017, p. 26). This, of course, means far beyond the problems of inaccessible technology. This educational technology is often not designed to fulfill the needs of young people with a wide range of sensory, mobility, and learning abilities. Still, the knowledge and competences of teachers play a significant role here since teachers decide which technologies and how are implemented in the school environment, which is crucial in the time of forced remote education.

The significance of these competences was strongly confirmed during the remote education period. Research conducted in different groups of young people with special needs (e.g., those with mental disabilities or the deaf) has shown that these young people were particularly negatively affected and that the quality of remote education provided to them was far from sufficient (Domagała-Zyśk, 2020). This was mostly due to the use of technologies that were not tailored to the educational needs of children in those groups, as well as the frequent lack of educational support in their families. In some cases, the reason for this was the lack of digital equipment. For example, parents interviewed by Wolstencroft et al. (2021) reported that in some cases their families had difficulty accessing basic hardware and software. Furthermore, even having digital equipment was not sufficient to overcome the inequalities as the digital skills of the parents were very low.

There is also a positive side and great potential for teacher digital competences in the field of empowerment of learners. During the COVID-19 pandemic in Poland, we identified about 5% of students who, in the circumstances of remote learning, have shown tremendous progress and benefited in many ways (Ptaszek et al., 2020). There were, e.g., students with a high level of social anxiety who started speaking in public (through computer-mediated communication tools) or some young people who felt safe and for the first time asked for teacher support (since they could have done it in private, e.g., in a chat, without being noticed by their peers). We consider the ability of teachers to recognize such students and mechanisms and methodology to support students from those groups as crucial competences of contemporary teachers. That means that when talking about competences important to support specifically different groups, we should not only focus on vulnerable groups but also on those who may benefit the most.

2.8 Facilitating Learners' Digital Competence

However, research evidence shows a significant deficit in digital skills among European children and adolescents (European Commission, 2018; 2012; European Training Foundation, 2018). The percentage of young people in Europe with a good level of computer skills (measured by Eurostat as being able to perform five or six tasks from the list of six selected computer-related activities) remained stable at around 45% (European Commission, 2016). This is a serious problem in the context of the constantly growing demand for jobs requiring ICT skills. Studies also show that simple access to ICT alone is insufficient to guarantee positive results (van Dijk & van Deursen, 2014). In addition, the support for access to and use of information and communication technologies must also take into account the pre-existing inequalities (in terms of gender, socioeconomic status, ethnicity, disability, and other factors), so that disadvantaged people do not lag behind. It is essential to pay attention to the development and testing of softer non-technical skills that enable young people to interact safely in a civil way on social media, including the ability to use critical information, and to understand the attitude of an online source of content. Children and young people should learn new skills such as problem solving, implementing creative activities, improving communication skills, and developing competences in information management (van Laar et al., 2018).

The pandemic situation after school closure definitely confirmed the situation described above. First, the students turned out to be much less digitally competent and prepared for remote education than everyone expected (Ptaszek et al., 2020). Regarding trends in the use of the Internet, they remained unchanged in the context of the time before the pandemic (Pyżalski, 2019; Tanaś et al., 2016). It was most often used to watch content (e.g., series, playing games, and communicating with teachers and family) or listening to podcasts and audiobooks is very rare, both before and during school closings, but of course, not always doing certain things online does not have to be skilled enough, because sometimes we do not do the things we can do. The context we are discussing is, however, that in many situations the lack of action and lack of skills should be treated as two sides of one coin, especially since most of the skills discussed here are acquired in practice (Table 2.1).

Table 2.1 Suggestions based on COVID-19 emergency remote education research and experiences

Group of competences from DigCompEdu	Suggestions based on COVID-19 emergency remote education research and experiences
Professional environment	– More focus on online support communities for teachers and competences connected to communication within those structures – Further recognition of competences needed for high quality digital communication among main educational actors (teachers, learner, students) – Addition of competences aim at maintaining digital well-being and usage of ICT in a way that is supportive for health – Addition of competences allowing successfully implementation of work-life balance (in the context of digital technologies use and its specificity)
Digital resources	– Particular emphasis on the role of open educational resources – The need to develop the ability to create and share your own resources, also in the form of videos – Collaboration with teachers from all over the world through mutual participation in online lessons – Developing empathy for online collaboration
Assessment	– Addition of ethical dimensions into discussion of digital assessment competences (concerning accuracy and fairness of assessment provided exclusively by digital methodology
Teaching and learning	– In addition to IT (technical) competences, teachers working remotely should be characterized by competences in the field of pedagogy (including didactics) and the psychology of learning and e-learning
Empowering learners	– The need for competences that help to identify groups that are particularly vulnerable or particularly beneficial when it comes to use of digital educational methods – More focus not only on specific groups of learners but also on their families (holistic approach required)
Facilitating learners' digital competences	– Children and young people should learn new skills such as problem solving, implementing creative activities, improving communication skills, and developing competences in information management during school activities and during online classes – The possibility of using private student devices, i.e., smartphones, should be taken into account (BYOD)

2.9 Conclusions

The main question that arises is whether experiences and conclusions from crisis remote education may be extrapolated to the "normal" times. To be more specific—to what extent what we experienced may help us to improve digital education that is additional not the only possible mode of education.

Firstly, we stand on the position that analysis we provided in the chapter may help to improve digital education in a case when a crisis situation happens again. Leaning from difficult experiences of emergency COVID-19 education may mean the next time education we provide will fulfill students' needs better and the teachers will avoid most of the mistakes we can make while providing it.

For better clarity and consistency, we decided that we provide there a table showing the list of groups of digital teacher competences from DigCompEdu (Redecker, 2017) with the shorten version of modifications and suggestions based on COVID-19 educational research.

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Chapter 3
Digital Competencies of Pre-service Teacher Students: Albanian Context

Nazmi Xhomara

Abstract The chapter is dedicated to the digital competencies of pre-service teacher students in Albania. Therefore, the level of knowledge and skills of the future generation of teachers. The chapter is composed of two main parts; the first one is about the situation of digital competencies, and the second one is an empirical study focused on Moodle and Microsoft teams' competencies of pre-service teacher students or future teachers. The chapter aims to explore the important policies and results of several policy documents of main Albanian and international institutions focusing on the digital competencies of pre-service teacher students. The chapter also aims to investigate Moodle and Microsoft Teams' key competencies and academic progress through Moodle and Microsoft Team's use. This chapter comprises five sections including (1) Introduction, (2) Theoretical framework and review of literature, (3) Methods, (4) Findings, and (5) Discussion. The introduction begins with the (a) Pre-University Education Strategy, and (b) Albania's Curriculum and Assessment Frameworks. This is followed by (c) School autonomy, (d) Primary and secondary education, and (e) Tertiary education. The theoretical framework and literature review contains (a) Demand for quality teachers (Digital Agenda 2021–2025; Digital Skills in the field of education), (b) ICT use and e-Learning, (c) Digital skills in Albania, and (d) Digital skills during Covid-19 pandemic, (e) Literature review. The empirical study including (a) Methodology, (b) Results (Descriptive analysis, Inferential analysis), and (c) Discussion.

Keywords Digital competence · Pre-service teachers · Moodle competence · Microsoft teams' competence · Academic progress

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N. Xhomara (✉)
Department of Mathematics and Statistics, Faculty of Information Technology and Innovation, Luarasi University, Tirana, Albania
e-mail: nazmixhomara@hotmail.com

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3.1 Introduction

3.1.1 Rationale

The chapter entitled “Digital competencies of pre-service teacher students: Albanian Context" is referred to the important policies and results of several policy documents of main Albanian and international institutions focusing on the digital competencies of pre-service teachers’ students. The study also employs the author’s research because of the lack of Measurement and Comparing Digital Competence study in the country.

According to UIS (2020), “Albania is a South-East European country with about 2.8 million people, where about 49% of enrollment in basic education in 2016–2017 was in rural areas. Albania’s current curriculum framework defines the goals, general principles, educational levels, crosscutting key competencies, and subject areas of the pre-tertiary education system. School life expectancy from primary through tertiary education has changed from 10.6 schoolyears in 2000 to 14.8 in 2017, similar to that of neighboring countries, though lower than the average in the EU (17.1 years) and the OECD (17.2 years)” (UIS, 2020).

As SPHERE (2021) pointed out, “Albania has 15 public and 25 non-public universities, and 139,043 students (y. 2018–2019), the most of which are enrolled in public universities (113.277, or 81%). The ICT has been part of curricula in Albania, accompanied by the preparation of the necessary human resources to use it, hence increasing the quality of education. A significant part of the population, main people around 15–25 years old, owns intermediate digital skills, thanks to the knowledge they receive in the education system”.

3.1.2 Albanian Education System

3.1.2.1 The Pre-University Education Strategy

The Albanian Ministry of Education according to MoESY (2016), “steered the preparation of Albania’s current Pre-University Education Development Strategy 2014–2020, which was adopted in 2016. It delineates a vision of the future education and an action with adequate activities, assigned responsibilities, as well as deadlines for implementing change. However, implementation has been relatively weak, in part because individual agencies develop their work plans, which undermines sector-wide planning. In addition, indicators and targets found in the strategy are not aligned with each other, which diminishes the strategy’s ability to drive system improvement.

The Pre-University Education Development Strategy for 2014–2020 delineates main principles for education reform”:

(1) "Qualitative and Inclusive Education: Give students the right to quality in education, equal opportunities to all, as well as the right to be different.
(2) Uniform Education System: In a short time, learning conditions in schools should be comparable to the regional and European educational institutions.
(3) Education for Life: Build the premises for students to learn new knowledge and skills to respond to the country's development and challenges in the labor market.
(4) Quality Assurance of Standards Achievement: The provision of pre-university education is based on western standards and high-quality evaluations.
(5) Decentralization: Creates premises for effective management of a decentralized education system by strengthening the autonomy of schools.
(6) Accountability and Transparency: Improve the legal framework, processes, and procedures needed for accountability and transparency.
(7) Community Support: Arrange financial support from different sources of society to all pre-university education institutions".

According to MoESY (2016), "the strategy also sets the policy priorities for education. For each priority, the strategy sets forth expected results and main activities that will be undertaken. The main priorities are":

(1) "Improving the leadership, and management skills of primary and secondary school resources.
(2) Quality and inclusive learning.
(3) Quality assurance based on western education standards.
(4) Modern teacher training and professional development" (MoESY, 2016).

3.1.2.2 Curriculum and Assessment Frameworks

According to UNESCO (2017), "Albania's current curriculum framework, published in 2014, defines the goals, general principles, educational levels, crosscutting key competencies, and subject areas of the pre-tertiary education system. It sets out a constructivist and student-centered teaching and learning approach and describes the methods teachers should be using in their classrooms, such as formative assessment and portfolio. It sets forth the key competencies for lifelong learning that all students are expected to achieve by the end of upper secondary education, informed by the EU's 2006 Recommendation on Key Competences for Lifelong Learning" (UNESCO, 2017).

According to OECD (2016), "with approval from their local education institutions, schools can draft their curriculum based on the curriculum framework and standards approved by the ministry. Schools in Albania have much greater flexibility in making decisions about curriculum than schools in other Western Balkans countries. Data from "OECD Program for International Student Assessment (PISA) 2015" show that about 79% of the responsibility for curriculum lies at the school level (either teacher, principals, or school boards), a percentage similar to the OECD on average (73%)

and much higher than in Montenegro (34%), North Macedonia (41%) and Croatia (44%)" (OECD, 2016).

UNESCO (2017), pointed out that "Albania's assessment framework builds on the curriculum framework. The framework defines policies and practices such as portfolio assessment, formative assessment, and continuous assessment, though these definitions sometimes lack clarity and concreteness. However, the implementation of many of the processes and activities described in the framework is left to schools, regional directorates, and local education offices, with little additional support or concrete guidance at the national level" (UNESCO, 2017).

3.1.2.3 School Autonomy

As part of its broader decentralization efforts, Albania has taken steps to increase school autonomy, which is one of the general principles of the National Education Law (MoESY, 2012). MoESY (2012) emphasized that "school-level governance in Albania involves school directors along with their substitutes as well as the school boards. According to Albanian law, each school must also have its teacher, parent, and student councils that help shape policies at the school level. For example, schools now play an important role in hiring and dismissing teachers and selecting textbooks. However, the ministry, regional directorates, and local education offices continue to make all decisions related to financial resources, and schools receive no discretionary funding.

At the same time, MoESY (2012) showed that "the ability of schools to reflect on their policies and practices is important for making effective use of school resources, lack of discretionary financial resources notwithstanding. However, the capacity for school planning and self-evaluation remains weak in Albanian schools. Despite guidelines and methodological documents developed by the ministry and the defunct State Education Inspectorate, not all schools understand the legal obligation of conducting self-evaluations, and many view this task as a formal bureaucratic exercise" (MoESY, 2012).

3.1.2.4 Primary and Secondary Education

According to UIS (2020), "the school life expectancy from primary through tertiary education has increased from 10.6 schoolyears in 2000 to 14.8 in 2017, similar to that of neighboring countries like Serbia (14.7 years) and Montenegro (15.0 years), though lower than the average in the EU (17.1 schoolyears) and the OECD (17.2 schoolyears)" (UIS, 2020). As MoESY, reported "about 49% of enrollment in basic education in 2016–2017 was in rural areas, as compared to 54% in 2006–2007". According to OECD (2018), "in rural areas public basic education there are about 17 students per class, as compared to about 21 students per class on average across all Albanian public basic education. However, about 27% of classrooms in Albania had over 30 students in 2015–2016, and overcrowding is of particular concern in urban centers (UNESCO, 2017). Some teachers have reported class sizes of over 40 students, beyond the legal limit. In OECD countries, the average class size is about 21 and 23 for primary and lower secondary schools respectively" (OECD, 2018).

As MoESY, indicated, "the student-to-teacher ratio in public basic education is smaller in rural areas, about 11, as compared to a national average of about 14". Meantime, according to OECD (2018), "at the high secondary education, the student per teacher ratio in public schools is also lower in rural areas (about 13) than on average in Albania (about 14). In OECD countries, the ratio of students to teaching staff is 15 across all primary schools, 13 in public lower secondary schools, and 13 overall" (OECD, 2018).

As UNESCO (2017), indicated, "several features of the basic school system in Albania stand out when compared with school networks in most OECD and EU countries. These include the relatively large number of students enrolled in multi-shift schools (12%) and multi-grade classrooms (10%)" (UNESCO, 2017). At the same time, "recent national data indicate that about 22 000 students attend a multi-grade classroom, which is a concern in terms of equity. Multi-grade classrooms have lower levels of reading and writing skills and have faced particular challenges in implementing the competency-based curriculum" (UNESCO, 2017). According to AQAPUE (2014, 2018), "the Ministry of Education defines the percentage of learning time during each curriculum stage, which spans multiple grade levels, and the percentage of instructional time per week that should be dedicated to each subject area. Lessons are mandated to be 45 min long" (AQAPUE, 2014, 2018).

3.1.2.5 Tertiary Education

Albania has 15 public and 25 non-public universities, and a total of 139,043 students (y. 2018–2019), most of them enrolled in public universities (113.277, or 81%) (SPHERE, 2021). According to OECD (2020), "Albania has made significant progress in developing a multi-party democracy and open market economy, evolving from one of the poorest countries in Europe into an increasingly competitive, upper-middle-income economy. As part of this process, Albania has embarked on significant education reforms such as the decentralization of school governance and the introduction of a competency-based curriculum. This has contributed to improvement across key education indicators. However, the majority of Albanian students continues to end universities without mastering basic skills and competencies. Equity is also a concern, with continued disparities in educational opportunities and outcomes according to ethnic background and geographical region" (OECD, 2020).

According to Bekteshi (2015), "there were only 14,000 university students in Albania up until 1990, meantime, capacities were limited. Admissions at universities were limited and controlled, and not all secondary school students who wanted to attend them were accepted. The plural democratic system after 1990 also brought the increase in capacities and admissions as well as the opening of new universities. The great quantitative changes happened in 2005 when admission capacities went up to

52,000, and 175,000 students in 2014. There were also qualitative changes during this period, the most important of them was the participation of Albania in the Bologna Process in 2003. Bologna participation was accompanied by the restructuring and upgrading of the study programs, as well as adaptation of the university curricula to the Bologna system, and the concept of ECTS" (European Credits Transfer System) (Bekteshi, 2015).

However, as UIS (2020), indicated, "after a consistent increase since 1991, the gross enrollment ratio in tertiary education has fallen from 66% in 2014 to 55% in 2018. This is in part due to the closure of private universities awarding a high volume of reportedly low-quality degrees, as well as migration outflows are driven by the pursuit of education and career opportunities abroad" (UIS, 2020).

As Council of Ministers of Albania, as well as MoESY, "in 2016, a new higher education law provided greater flexibility on the use of the State Matura examination as the basis for entry into higher education programs. While students must still achieve a minimum score based on a formula weighting set by the Council of Ministers, universities are allowed to develop their publicly available criteria, set quotas, and conduct their ranking of applicants" (Albanian Academic Network, 2020). As Bekteshi (2015), showed, "the use of additional criteria by universities has thus far been limited, and there are mixed views among universities as to whether adding criteria will make schools less competitive in enrolling students or, by setting higher expectations, increase the quality of candidates" (Bekteshi, 2015).

3.2 Theoretical Framework and Literature Review

3.2.1 Demand for Quality Teachers

According to MoESY, "Albania has engaged in several important efforts to improve the quality of teaching. These include raising entry requirements and moving toward the standardization of curriculum content for certain initial teacher education programs, updating teaching standards, implementing a state exam for new entrants to the teaching profession, and setting up professional learning networks. In addition, the percentage of teachers that have attained some level of higher education has increased from two-thirds of teachers in 2006–2007 to 91% in 2016–2017". OECD, pointed out that, "however, data from the OECD Teacher and Learning International Survey (TALIS) indicate that this percentage is below the average across participating countries and economies in the OECD (98%) and the EU" (98%). Meantime, Echazarra and Radinger (2019), emphasized that, "moreover, there remain concerns about the quality of teachers, particularly in rural and disadvantaged areas. As reported by principals in the PISA 2015 survey, the gap in the quality and quantity of teaching staff between rural and urban schools is particularly large in Albania, and Albania is one of only ten countries and economies where the quality of teaching staff is of greater concern among rural school principals than among city school principals"

(Echazarra & Radinger, 2019). At the same time, according to UNESCO (2017), "economically disadvantaged areas of Albania also have greater difficulty finding quality teachers, in part due to migration into urban areas" (UNESCO, 2017).

3.2.2 ICT Use and e-Learning

According to Bekteshi (2015), "part of the strategies of the Albanian government for higher education is the strategies for the development and mass use of ICT and e-Learning as very important means of support to the teaching and learning process in universities. The need for the mass use of ICT in Albanian universities is immediate, and some of the following are stimulating factors". First, "the assessment criterion of a university is its competitiveness toward the other universities, for which the assessing or leading boards should obtain academic, pedagogic, and administrative information. Second, the ever-increasing amount or numbers of data and information, the complexity of the problems accompanying higher education, and the number of students and lecturers require the use of an information system for their full management. Third, the increase of transparency of actions related to the administration of data on students, academic staff, lecture times, literature, taxes and financial obligations of the students, etc. Fourth, the increase of teaching and reading quality, as well as the improvement of student administration quality-from the moment they enroll at university, attendance of academic programs, gradual assessment, up to the completion of their academic programs. Fifth, having all the data in one central database, and the understanding and easy use of the information system by the users: students, lecturers, and administration staff" (Bekteshi, 2015).

As Bekteshi (2015, point out, "many public and private universities in Albania consider the e-Learning platform as an indispensable addition to their normal infrastructure. E-Learning is being used by Albanian universities as an indispensable factor characterized by the elimination of the time and geographic barriers between students and lecturers, increases the interaction between them, and affects the quality of teaching and learning process in universities. The ICT has been included in curricula in Albania, accompanied by the preparation of the necessary human capital to use it, thus increasing the possibilities to read and increase the quality of education. Initiatives coming by both the government and universities consist in information services, professors' capacity building, infrastructure, content development, and organizational structures" (Bekteshi, 2015).

3.2.3 Digital Skills in Albania

Demand for digital skills in Albania nowadays is getting much more attention by key stakeholders, as well as by the entire society. Demand for digital skills in Albania is related to both digital skills as a key competence and specialized digital skills related to specific occupations. The current demand for digital skills in Albania is linked to the changes that the economy is undergoing and the desire of society to move closer to digitalization. In an increasingly digital world, Albania, as a middle-income country, has high demands for digital skills development but few opportunities to acquire these skills. The majority of society owns basic digital skills and technical competence, such as using electronic products, software programs, social media, and making easy online transactions such as searching on the internet and sending and receiving emails. A significant part of the population, main people around 15–25 years old, owns intermediate digital skills, thanks to the knowledge they receive in the education system. On the other hand, only people who have completed university studies and people who work in the growing digital sector itself possess more advanced skills (Haxhi, 2021).

3.2.3.1 Digital Agenda 2021–2025

The Albanian Government has designed a digital agenda that includes the period 2021–2025. The main guidelines of the Albanian Government Digital Agenda 2021–2025 include further development of the information society and promotion of the economy, culture, and digital tourism, through further development of e-Government, promoting and enabling the digital economy, culture, and tourism, as well as improving cybersecurity and trusted services. Digital Agenda 2021–2025 include also the development of national electronic communications infrastructure and regulations in the field of audiovisual media, enabling and developing basic and advanced digital skills to broadly involve the population in ICT services and increase ICT professionals, and policy development and piloting, testing and experimentation in new ICT Fields (Haxhi, 2021).

3.2.3.2 Digital Skills in the Field of Education

Digital Skills in the field of education, including steps for the future in pandemic circumstances, are shown in the shape of short-term objectives, as well as medium-term objectives. Short-term objectives in the field of education in Albanian, as shown below represent three main directions. First is the identification and promotion of good e-learning practices that include effective or appropriate online platforms for interactive learning to take place. Second is the increasing the capacity of online teaching through. The second direction includes (a) training teachers for the use of online platforms or adoption with the distance learning methods of teaching or adaptation of the curriculum for online teaching equipment with digital tablets of pre-university students, (b) preparing or designing user-friendly guides for teachers and students and make it easier for students to use online learning platforms, (c) equipping pre-university students with digital tablets or internet sticks, especially those in distant areas where there is no internet coverage, as well as (d) adaptation of legislation regarding digital skills, that is foreseen also in the new Strategy for

Education. Third, is the regional cooperation, which includes (a) digitalization of the Higher Education system- implementation of blockchain technology for automatic recognition of qualifications, and (b) regional digital competition on digital smart solutions (Haxhi, 2021).

Meanwhile, medium-term objectives as shown below represent five other main directions. First is an investment in digital infrastructure for supporting e-learning, to ensure high speed and very high connectivity to make possible the quality learning, as well as increasing e-skills mainly for micro-businesses that operating in remote areas of Albania. Second is the investments in digital skills for the digital economy, through increasing the digital skills of small and medium-sized enterprises, thereupon, the focus can be on e-commerce, as functional e-commerce practices, support to increase the digital skills of businesses, assistance for the legal framework for the provision of online services, and design a guide to educate the public on how to stay safe when shopping online. The third is to design and approve a comprehensive digital skills strategy. Fourth is the establishment of a Regional Digital Transformation Academy related to the development of digital skills for the labor force or small and medium-sized enterprises and the digital economy. Fifth is the support to introduce Micro-Credentials—a new flexible and alternative pathway of learning in Higher Education (Haxhi, 2021).

3.2.4 Digital Skills During Covid-19 Pandemic

According to SPHERE (2021), "like many other countries in the world, Albania today is facing until now the Covid-19 pandemic situation. Considering and analyzing the Covid-19 situation, the Ministry of Education suggested to universities to consider online learning and teaching as an alternative. MASR proposed to each university to set up a working group of lecturers that piloted and tested different platforms that could be used by each institution. Academic senates, after having evaluated the situation, decided to switch to online learning and teaching as fast as possible. There were some difficulties during the preparatory phase, such as IT infrastructure preparation, student database development, and the preliminary assessment of how to prepare didactic materials. However, they were quickly overcome. In a relatively short period and with great motivation, the academic staff, the governing bodies, and the administrative staff of the Albanian Universities created online platforms for the students using Google Classroom, Moodle, Zoom, Google Meet, Microsoft Teams, etc. Through those platforms, didactic materials were made available for all study programs at the bachelor's and master's levels" (SPHERE, 2021).

As SPHERE (2021) emphasized, "regarding other elements of teaching, universities were working to solve the issues they have encountered for other academic activities such as laboratories, professional practices, or other activities that need physical participation. The percentage of online students during a usual day of the week is about 85%. At this moment, all academic activities are performed online except fieldwork and professional practices. Laboratory classes are recorded by the lecturer in 'Screen Rec' and then shared with students. The second part of lab classes is organized based on discussions, questions, and answers. In some subjects, virtual labs have been executed by staff and students. This process has entailed some difficulties during the first week, such as missing digital equipment or faulty internet connection. The universities assisted the staff and students by making available manuals and video tutorials for the use of digital platforms" (SPHERE, 2021).

As SPHERE (2021) showed, "it is hoped that online teaching will continue to improve: The quality of the group assignments given to students should be improved to encourage the cooperation of students outside the classroom. The discussion that promotes the development of critical thinking should also be stimulated. Students should be guided between the interactive learning of projects, case studies, and learning through inquiry and research-based learning, connecting these different means in the pursuit of completing student learning outcomes. Students should be motivated to give thoughtful answers to the questions that arise from observing online laboratory sessions to enable a deeper understanding of processes. Performing online exams through different platforms have been proposed as an alternative to the traditional examination ways".

"Universities have identified cases where students have faced difficulties (mainly internet access and performance, home conditions, etc.) and staff is working to guarantee the due support. Being aware of the situation of the Covid-19 crisis, but also in compliance with academic standards of teaching, universities' governing bodies are monitoring the development of the teaching process over the respective online platforms. The main purpose of this monitoring process is to guarantee access to all students and make the improvements needed to the relevant infrastructure" (SPHERE, 2021). According to SPHERE (2021), "the implementation of digital teaching in Albania following the Covid-19 situation shows that academic staff has been adapting quickly to this new mode of teaching, although some shortcomings need to be addressed. This new experience for universities has led the academic staff to face not only barriers but also to identify the need for better digital skills and competencies by introducing new methodologies and technologies in teaching and learning. This experience is expected to affect a large number of universities, and encourage increasing, in the future, not only investments in the area of ICT in teaching and learning but also to strengthen the professional development of staff through training related to digital technology and teaching methods" (SPHERE, 2021).

3.2.5 Literature Review

Many authors have done a lot of research on digital skills and competencies of future education and teachers themselves. "Shrinking budgets, innovations in technology, and staff changes each cause organizations to ask traditionals and can enhance managers to use new ways of thinking to support workflow and to answer evolving university initiatives. To manage the knowledge has also emerged as one such way of thinking about management challenges" (Shropshire et al., 2019). At the same time, Shehata et al. (2020) in their study indicate that "the academic staff level of preparedness for online teaching and learning was evaluated as medium to high and effective leadership support was reported by 70% of them. Academic staff reported diverse views about the proper role of education units, and 64.1% of the participants identified knowledge and skills teaching challenges, meanwhile, 76.3% of them reported the absence of alternative approaches for final assessment. In conclusion, lectures themselves moved faster than managers and relied on support existing outside the universities when the situation happened" (Shehata et al., 2020). Meanwhile, Neuwirth et al., 2020 showed that "the coronavirus (COVID-19) pandemic situation has required to faculty and students to adapt to an unprecedented challenge and rapidly transition from traditional face-to-face teaching to distance instruction formats through virtual learning. While most universities trained academic staff to ensure quality and maintenance of the curriculum through virtual teaching, less support has been given to training students, who face equal and in some cases even more challenges in adapting to this fast change in the delivery of the online curriculum. Less support has been developed for students to facilitate their involuntary transition to virtual teaching and maintenance of adequate online learning behaviors. Building a significant dialogue between academic staff, who are engaged in efforts to cope and adapt to the pandemic, may be useful in re-envisioning and re-designing future curriculum. This process may facilitate future procedures on creating best practices guidelines for asynchronous/synchronous virtual teaching post pandemic" (Neuwirth et al., 2020).

Jones et al. revealed that "due to the COVID-19 pandemic situation, worldwide universities have curtailed face-to-face teaching. At the same time, academic staff has to do the delivery of the practical experience required of students. Of course, practical skills and competences cannot be easily provided with the recording laboratory experiences and putting videos, quizzes, and data online for students to work with. Meanwhile, it is an effective way of putting students to work with real data, uncertainty, and equipment which they cannot access in direct way. Several short case studies are provided to inspire and support other educators in how they can use effective online experiments. Anecdotal evidence suggests that this approach is at least acceptable for students". "Universities and Colleges in the United States are using Open Sources software applications such as the Moodle and Sakai course management systems and the Kuali financial system to create integrated learning environments that serve both lectures and students' needs. Open Source is meant to be more flexible and less costly than commercial software, and support creating a balance between sound pedagogy and business efficiencies" (Williams & van Rooij, 2017). "The impact of the ongoing digital innovation has been profound and has been studied in many ways such as faculty interaction with the students, e-participation. However, the research of how the digital innovation has changed faculty interactions with students via information and communication technologies (ICTs) has been modest, and the theory constructing in research studies has been, for the most part, modest too. A major reason for this lack of progress is the inability to produce an operational definition of e-leadership that spans telework, team, and enterprise settings" (Wart et al., 2017).

Dalziel (2011) pointed out that "e-learning has considerable potential for education, but there is a need to move beyond individual, self-paced views of e-learning to appreciate its full potential. Learning Design provides a framework for describing and freely sharing effective teaching ideas, building on other Internet-based sharing approaches such as open-source software and open content. The Learning Activity Management System (LAMS) is a Learning Design system that allows lecturers to author and share learning designs, as well as run them with students and assess their progress" (Dalziel, 2011). Wireless sensor networks "according to Kim et al. (2011)" include a wide range of potential applications to increase the quality of instruction and academic progress in an all-over learning environment. Wireless sensor networks become an evolving technology that acts as the ultimate interface between the students and the context, enhancing the interactivity and improving the acquisition of students' contextual knowledge. The u-learning model is a web-based e-learning system utilizing various state-of-the-art features of wireless sensor networks that could enable students to acquire knowledge and skills through interaction between them and the all-over learning environment. It is based on the theory of connectivism which confirms that knowledge and the learning of knowledge and skills are distributive and are not located in any given place but rather consist of the network of connections that is formed from experiences and interactions between lecturers and students. The communication between devices and the embedded computer in the environment supports students to learn in an environment of their interest while they are moving, hence, attaching them to their learning environment" (Kim et al., 2011). "Computational thinking contains concepts that are essential to communication and information technology to solve different problems, to design and evaluate different systems, and to answer student reasoning and behavior. Computational thinking has important implications in information and communication technology, as well as in almost every other field. Hence, it is suggested that computational thinking should be taught in elementary schools and included in every university's curriculum" (Flórez et al., 2017).

Hollyhead et al. (2012) used grounded theory "to examine the function and application of both lecturer-led and student-led forums within a virtual learning environment of a university or college. Differences between academic staff are identified, including those relating to the type, frequency, and breadth of forum usage. The findings suggest that students' voluntary use of Social Network Sites as a complement to formal learning is socially embedded at the university and build a widely accepted integral part of the learning experience. This rapidly evolving usage of forums could present future challenges for lecturers, not least because of Social Network Site-hosted learning materials and patterns may be obscured from them" (Hollyhead et al., 2012). Joshi et al. (2016) indicated that "while effective knowledge and skills management has been acknowledged as the key driver for new knowledge and skills, the fact that academics still write about it and organizations are actively go after the concept means that effective knowledge and skills management is going to continue in future" (Joshi et al., 2016).

Wan and Nicholas (2010) in their research demonstrate that "online support for students with high ability is possible as well as practical. Online support requires a structured approach to move the students in a progressive way to more open-ended inquiry. Applying this approach decrease the extent of student drop-out and improves task completion when compared to more challenging open-ended tasks. Lecturers or universities seeking to provide this kind of support to overcome local isolation of students with high ability. It is suggested to design the structured engagement with topics and with other students, to remain closely involved in the initial stages of engagement and only gradually remove their scaffolding as students demonstrate the capacity to sustain independent interactions" (Wan & Nicholas, 2010). "For some schools, using iPads instead of computer labs can be a cost- and space-saving endeavor, and attitudes toward tablets did not change but confidences did, particularly in document design" (Watkins et al., 2019). Boling and Beatty (2010) reveal that "online discussion forums can provide an excellent medium where students analyze models of writing, engage in the writing process, and monitor, reflect upon, and discover expert strategies in context. They also show that both the quantity and quality of computer-mediated feedback increased over time, resulting in students learning not only from their teacher but from each other" (Boling & Beatty, 2010). MacLeod et al. (2018) found "a positive association between student-to-student connected classroom climate and the benefits of student integration, learning, and retention in face-to-face environments. They also provide empirical evidence of the relationships between key technological factors and connected classroom climate in cloud classrooms. Main technological variables examined were positively associated with connected classroom climate: advanced computer self-efficacy, software computer experience, internet computer experience, and computer importance" (MacLeod et al., 2018). Hence, as the above work pointed out, digital competence is very important to in-service teachers, because the future work of teaching is very challenging.

3.3 Methodology

The empirical study aims to investigate the relationships between Moodle and Microsoft Teams' key competencies and academic progress through Moodle and Microsoft Team's use. Therefore, the two main research questions are provided below. What is the perceived level of Moodle and Microsoft Teams digital literacy of pre-service teacher-student? Do Moodle and Microsoft Teams' key competencies predict academic progress through Moodle and Microsoft Teams use?

3.3.1 Defining Digital Competence

According to Julien (2018), "digital literacy, a term which emerged in the '90 s and was popularized by Gilster (1997); (McArthur et al., 2018), refers on the one hand, to a set of skills, attitudes, and knowledge needed to access digital information effectively, efficiently, and ethically'" (Julien, 2018, cited by Peled). "On the other hand, it stresses the digital tools available to communicate with others, to create meaning, and to evaluate digital content" (Neumann et al., 2017). As McArthur et al. (2018) pointed out, "some educational researchers identify digital literacy by categorizing its skills into information access, online participation, computer ability, search engine skills, and skills required to evaluate found information" (McArthur et al., 2018). "Others divide the digital skills into operational, mobile, navigation, social, and creative domains" (Peromingo & Pieterson, 2018, cited by Peled).

Therefore, the definition of Moodle and Microsoft Teams competencies employed for the empirical study is the confidential, critical and creative use of Moodle and Microsoft Teams to achieve a high level of academic performance, as well as to achieve life skills in work, inclusion, and contribution in society.

3.3.2 Method and Design

The quantitative approach was the method selected to be used in the study. The research design of the study employed a sample of 239 pre-service teacher students. Moodle and Microsoft Teams' key competencies were selected to be used as independent variables; meanwhile, academic progress through Moodle and Microsoft Teams use were selected as dependent variables. Moodle and Microsoft Teams' key competencies, as an independent variable have fore levels: 1 = never, 2 = sometimes, 3 = frequently, 4 = always. Meanwhile, academic progress through Moodle and Microsoft Teams, as dependent variables have also fore levels: 1 = low, 2 = medium, 3 = high, and 4 = very high.

3.3.3 Sample and Data Collection

A non-random sample of 239 pre-service teacher students was selected to be investigated in the research. The sample of respondents is composed of 144 females (60.3%), and 95 (39.7%) males. A structured questionnaire was used to gather the primary data from the students in the 2020–2021 academic year. The questionnaire is based on Self-Report Digital Literacies (SRDL) (Peled, 2021) and is modified, piloted, and validated by the author.

3.3.4 Hypothesis

Based on theoretical framework and literature review, the main hypothesis of the study is shown below.

H #: Moodle and Microsoft Teams' use predict academic progress through Moodle and Microsoft Teams' use by the pre-service teacher students.

The main hypothesis is split up into three specific hypotheses as follows.

H # 1: The variance in academic progress through Microsoft Teams' use is explained by lecture attendance through Microsoft Teams' use.

H # 2: The variance in academic progress through Microsoft Teams' use is explained by seminar attendance through Microsoft Teams' use.

H # 3: The variance in academic progress through Moodle's use is explained by Moodle's use.

3.3.5 *Analysis*

The frequency values, as well as, central tendency values were used to describe the Moodle and Microsoft Teams' key competencies and academic progress through Moodle and Microsoft Teams use. Pearson product-moment correlation coefficient was used to investigate the relationship between Moodle and Microsoft Teams' key competencies and academic progress through Moodle and Microsoft Teams use. Linear multivariate regression was used to investigate the ability of one control measure to predict academic progress through Moodle and Microsoft Teams used by Moodle and Microsoft Teams key competencies. Preliminary assumption testing was made to check for normality, linearity, outliers, homogeneity of variance–covariance matrices, and multicollinearity, with no violations noted (Table 3.1).

Table 3.1 Frequencies of Moodle lecture and Moodle exercises download competence

		Moodle lecture download competence		Moodle exercises download competence	
		Frequency	Percent	Frequency	Percent
Valid	Never	24	10	19	7.9
	Sometimes	27	11.3	38	15.9
	Frequently	103	43.1	93	38.9
	Always	84	35.1	88	36.8
	Total	238	99.6	238	99.6
Missing	System	1	0.4	1	0.4
Total		239	100	239	100

3.4 Results

3.4.1 Descriptive Results

3.4.1.1 Moodle Lecture Download Competence

Moodle Lecture Download competence frequencies indicate that 21.3% of the respondents claim that they never or sometimes download lectures from Moodle; meanwhile, 78.2% of them claim frequently or always. Central tendency values for the respondents (M = 3.352; SD = 0.0718), showed the same tendency for values as measured by frequencies. Hence, there are differences between the low levels of download lectures values (never or sometimes: 21.3%), and the high levels (frequently or always: 78.2%). Therefore, the most of students (78.2%) claim that they download lectures from Moodle most frequently or always during the academic year.

Moodle Exercises Download competence frequencies revealed that 23.8% of the respondents claim that they never or sometimes download exercises or other supporting material from Moodle; meanwhile, 85.7% of them claim frequently or always. Central tendency values for the respondents (M = 3.260; SD = 0.0810) mean the same tendency for values as measured by frequencies. Hence, there are differences between the low levels of exercises or other supported material values (never or sometimes: 23.8%), and the high levels (frequently or always: 85.7%). Therefore, the most of students (85.7%) claim that they download exercises or other supporting material from Moodle most frequently or always during the academic year (Table 3.2).

Table 3.2 Frequencies of Lecture attendance and Seminar attendance through Microsoft Teams

		Lecture attendance through Microsoft Teams		Seminar attendance through Microsoft Teams	
		Frequency	Percent	Frequency	Percent
Valid	Never	11	4.6	14	5.9
	Sometimes	21	8.8	28	11.7
	Frequently	51	21.3	75	31.4
	Always	155	64.9	121	50.6
	Total	238	99.6	238	99.6
Missing	System	1	0.4	1	0.4
Total		239	100	239	100

Table 3.3 Frequencies of Moodle use and Microsoft Teams use competence

		Moodle use competence		Microsoft Teams use competence	
		Frequency	Percent	Frequency	Percent
Valid	Never	11	4.6	11	7.1
	Sometimes	42	17.6	42	8.8
	Frequently	36	15.1	36	22.6
	Always	149	62.3	149	61.1
	Total	238	99.6	238	99.6
Missing	System	1	0.4	1	0.4
Total		239	100	239	100

3.4.1.2 Lecture and Seminar Attendance Through Microsoft Teams

Lecture attendance through Microsoft Teams frequencies revealed that 13.4% of the respondents claim that they never or sometimes attended lectures through Microsoft Teams; meanwhile, 86.2% of them claim frequently or always. Central tendency values for the respondents (M = 3.916; SD = 0.402), showed the same tendency for values as measured by frequencies. Hence, there are huge differences between the low levels of lecture attendance through Microsoft Teams values (never or sometimes: 13.4%), and the high levels (frequently or always: 86.2%). Therefore, the most of students (86.2%) claim that they attended lectures through Microsoft Teams most frequently or always during the academic year.

Seminar attendance through Microsoft Teams frequencies showed that 17.6% of the respondents claim that they never or sometimes attended seminars through Microsoft Teams; meanwhile, 82.4% of them claim frequently or always. Central tendency values for the respondents (M = 3.857; SD = 0.516), revealed the same tendency for values as measured by frequencies. Hence, there are considerable differences between the low levels of seminar attendance through Microsoft Teams values (never or sometimes: 13.4%), and the high levels (frequently or always: 82.4%). Therefore, the most of students (82.4%) claim that they attended seminars through Microsoft Teams most frequently or always during the academic year (Table 3.3).

3.4.1.3 Moodle and Microsoft Teams Easy Use Skill

Moodle use competence frequencies indicate that 22.2% of the respondents claim that they never or sometimes use Moodle; meanwhile, 77.4% of them claim frequently or always. Central tendency values for the respondents (M = 3.579; SD = 0.717) show the same tendency for values as measured by frequencies. Hence, there are differences between the low levels of using the Moodle easy values (never or sometimes: 22.2%), and the high levels (frequently or always: 77.4%). Therefore, most students (77.4%) claim that they use Moodle most frequently or always during the academic year.

Table 3.4 Frequencies of easy tests access in Moodle and Microsoft Teams skill

		Test access in Moodle competence		Test access in Microsoft Teams competence	
		Frequency	Percent	Frequency	Percent
Valid	Never	12	5	12	5
	Sometimes	21	8.8	27	11.3
	Frequently	73	30.5	72	30.1
	Always	132	55.2	127	53.1
	Total	238	99.6	238	99.6
Missing	System	1	0.4	1	0.4
Total		239	100	239	100

Microsoft Teams use competence frequencies reveal that 15.9% of the respondents claim that they never or sometimes use the Microsoft Teams; meanwhile, 83.7% of them claim frequently or always. Central tendency values for the respondents (M = 3.810; SD = 0.461) mean the same tendency for values as measured by frequencies. Hence, there are considerable differences between the low levels of using the Microsoft Teams easy values (never or sometimes: 15.9%), and the high levels (frequently or always: 77.4%). Therefore, the most of students (83.7%) claim that they use Microsoft Teams most frequently or always during the academic year (Table 3.4).

3.4.1.4 The Middle and Final Term-Test Took Online

Tests access in Moodle competence frequencies indicate that 13.8% of the respondents claim that they never or sometimes access the tests easily in the Moodle; meanwhile, 85.7% of them claim frequently or always. Central tendency values for the respondents (M = 3.567; SD = 0.650), revealed the same tendency for values as measured by frequencies. Hence, there are differences between the low levels of easy test access in Moodle values (never or sometimes: 13.8%), and the high levels (frequently or always: 85.7%). Therefore, most students (85.7%) claim that they access the tests easily in Moodle most frequently or always during the academic year.

Tests access in Microsoft Teams competence frequencies indicate that 16.3% of the respondents claim that they never or sometimes access the tests easily in the Microsoft Teams; meanwhile, 83.2% of them claim frequently or always. Central tendency values for the respondents (M = 3.680; SD = 0.550) show the same tendency for values as measured by frequencies. Hence, there are differences between the low levels of test access in Microsoft Teams values (never or sometimes: 16.3%), and the high levels (frequently or always: 83.2%). Therefore, the most of students (83.2%) claim that they access the tests in Microsoft Teams most frequently or always during the academic year (Table 3.5).

Table 3.5 Frequencies of Academic progress through Moodle and Microsoft Teams use frequencies

		Academic progress through Moodle use		Academic progress through Microsoft Teams use	
		Frequency	Percent	Frequency	Percent
Valid	Low	32	13.4	31	13.0
	Medium	47	19.7	30	12.6
	High	104	43.5	69	28.9
	Very high	55	23.0	108	45.2
	Total	238	99.6	238	99.6
Missing	System	1	0.4	1	0.4
Total		239	100.0	239	100.0

3.4.1.5 Academic Progress Through Moodle Use and Microsoft Teams Use

Academic progress through Moodle use frequencies indicates that 13.4% of the respondents achieved a low or medium level of academic progress through Moodle use; meanwhile, 86.2% of the high or very high level. Central tendency values for the respondents (M = 3.016; SD = 0.880) show the same tendency for values as measured by frequencies. Hence, there are differences between the low or medium levels of academic progress through Moodle use values (33.4%), and the high or very high levels (66.5%). Therefore, most students (66.5%) claim that they achieved high or very high levels of academic progress through Moodle use during the academic year.

Academic progress through Microsoft Teams use frequencies show that 25.6% of the respondents achieved a low or medium level of academic progress through Microsoft Teams use; meanwhile, 74.4% of the high or very high level. Central tendency values for the respondents (M = 3.424; SD = 0.909), reveal the same tendency for values as measured by frequencies. Hence, there are considerable differences between the low or medium levels of academic progress through Microsoft Teams use values (25.6%), and the high or very high levels (74.4%). Therefore, most students (74.4%) claim that they achieved high or very high levels of academic progress through Microsoft Teams use during the academic year.

3.4.2 Inferential Analyses

H # 1

As shown in Table 3.6, there is a relatively positive high correlation between lecture attendance through Microsoft Teams and academic progress through Microsoft

Table 3.6 Pearson correlation outputs of the relationship between lecture attendance through Microsoft Teams use and academic progress through Microsoft Teams use

Correlations			
		Academic progress through Microsoft Teams use	Lecture attendance through Microsoft Teams use
Pearson Correlation	Academic progress through Microsoft Teams use	1.000	0.619
	Lecture attendance through Microsoft Teams use	0.619	1.000
Sig. (1-tailed)	Academic progress through Microsoft Teams use		0.000
	Lecture attendance through Microsoft Teams use	0.000	
N	Academic progress through Microsoft Teams use	238	238
	Lecture attendance through Microsoft Teams use	238	238

Teams use variables, $r = 0.619$, $n = 238$, $p > 0.005$. Hence, high scores of lecture attendance through Microsoft Teams are associated with high scores of academic progress through Microsoft Teams use (Table 3.7).

The R2 value of the relationships between lecture attendance through Microsoft Teams and academic progress through Microsoft Teams use is 38.3%, F (1, 0.383), $p < 0.005$. This result indicates that 38.3% of the data according to fit the regression model. The model gets statistical significance (Sig. = 0.000; this means $p < 0.0005$).

As shown in Table 3.8, the beta value for academic progress through Microsoft Teams use is 0.619. The result means that 61.95% of the variance on academic progress through Microsoft Teams use is explained by lecture attendance through Microsoft Teams use. Based on statistical outputs shown above, H # 1: The variance in academic progress through Microsoft Teams use is explained by lecture attendance through Microsoft Teams use, which is supported (Table 3.9).

H # 2

As shown in Table 3.9, there is a relatively low positive correlation between seminar attendance through Microsoft Teams and academic progress through Microsoft Teams use variables, $r = 0.279$, $n = 238$, $p > 0.005$. Hence, high scores of seminar attendance through Microsoft Teams are associated with high scores of academic progress through Microsoft Teams use (Table 3.10).

Table 3.7 R Square value of the relationship between lecture attendance through Microsoft Teams use and academic progress through Microsoft Teams use

Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F change	df1	df2	Sig. F change
1	0.619[a]	0.383	0.381	0.82460	0.383	146.803	1	236	**0.000**

[a] Predictors: (Constant), Lecture Attendance through Microsoft Teams

Table 3.8 Standardized Coefficients Beta values of the relationship between lecture attendance through Microsoft Teams use and academic progress through Microsoft Teams use

Coefficients[a]

Model		Unstandardized coefficients		Standardized coefficients	t	Sig	Correlations		
		B	Std. error	Beta			Zero-order	Partial	Part
1	(Constant)	0.577	0.211		2.730	0.007			
	Lecture attendance through Microsoft Teams	0.742	0.061	0.619	12.116	0.000	0.619	0.619	0.619

[a] Dependent Variable: Academic progress through Microsoft Teams use

Table 3.9 Pearson correlation outputs of the relationship between seminar attendance through Microsoft Teams use and academic progress through Microsoft Teams use

Correlations			
		Academic progress through Microsoft Teams use	Seminar attendance through Microsoft Teams
Pearson correlation	Academic progress through Microsoft Teams use	1.000	0.279
	Seminar attendance through Microsoft Teams	0.279	1.000
Sig. (1-tailed)	Academic progress through Microsoft Teams use		0.000
	Seminar attendance through Microsoft Teams	0.000	
N	Academic progress through Microsoft Teams use	238	238
	Seminar attendance through Microsoft Teams	238	238

The R2 value of the relationships between seminar attendance through Microsoft Teams and academic progress through Microsoft Teams use is 7.8%, F (1, 0.078), $p < 0.005$. This result indicates that 7.8% of the data according to fit the regression model. The model gets statistical significance (Sig. = 0.000; this means $p < 0.0005$).

As shown in Table 3.11 the beta value for academic progress through Microsoft Teams use is 0.279. The result means that 27.9% of the variance on academic progress through Microsoft Teams use is explained by seminar attendance through Microsoft Teams. Based on statistical outputs shown above, H # 2: The variance in academic progress through Microsoft Teams use is explained by seminar attendance through Microsoft Teams use, which is supported.

H # 3

As shown in Table 3.12, there is a relatively low positive correlation between Moodle's easy use and academic progress through Moodle use variables, $r = 0.218$, $n = 238$, $p > 0.005$. Hence, high scores of Moodle easy use are associated with high scores of academic progress through Moodle use (Table 3.13).

The R2 value of the relationships between Moodle's easy use and academic progress through Moodle use is 4.8%, F (1, 0.048), $p < 0.005$. This result indicates that 4.8% of the data according to fit the regression model. The model gets statistical significance (Sig. = 0.001; this means $p < 0.0005$).

Table 3.10 R Square value of the relationship between seminar attendance through Microsoft Teams use and academic progress through Microsoft Teams use

Model summary									
Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F change	df1	df2	Sig. F change
1	0.279[a]	0.078	0.074	1.00859	0.078	19.876	1	236	0.000

[a] Predictors: (Constant), Seminar Attendance through Microsoft Teams

Table 3.11 Standardized Coefficients Beta of the relationship between seminar attendance through Microsoft Teams use and academic progress through Microsoft Teams use

Coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig	Correlation		
		B	Std. error	Beta			Zero-order	Partial	Part
1	(Constant)	1.979	0.250		7.915	0.000			
	Seminar Attendance through Microsoft Teams	0.332	0.074	0.279	4.458	0.000	0.279	0.279	**0.279**

[a] Dependent Variable: Academic progress through Microsoft Teams use

Table 3.12 Pearson correlation outputs of the relationship between Moodle easy use and academic progress through Moodle use

Correlations			
		Academic progress through Moodle use	Moodle easy use
Pearson Correlation	Academic progress through Moodle use	1.000	0.218
	Moodle easy use	0.218	1.000
Sig. (1-tailed)	Academic progress through Moodle use		0.000
	Moodle easy use	0.000	
N	Academic progress through Moodle use	238	238
	Moodle easy use	238	238

As shown in Table 3.14 the beta value for academic progress through Microsoft Teams use is 0.218. The result means that 21.8% of the variance on academic progress through Moodle use is explained by Moodle's easy use. Based on statistical outputs shown above, H # 3: The variance in academic progress through Moodle use is explained by Moodle use, which is supported.

3.5 Discussion

The purpose of the study is to investigate the effect of Moodle and Microsoft Teams' key competencies on academic progress through Moodle and Microsoft Team's use. The prior assumption was that Moodle and Microsoft Teams' key competencies impact academic progress through Moodle and Microsoft Team's use.

The study found that there are differences between the low levels of download lectures values (never or sometimes: 21.3%), and the high levels (frequently or always: 78.2%). It is revealed that the most of students (78.2%) download lectures from Moodle most frequently or always during the academic year. The study showed that there are differences between the low levels of download exercises or other supported material values (never or sometimes: 23.8%), and the high levels (frequently or always: 85.7%). It is found that the most of students (85.7%) download exercises or other supporting material from Moodle most frequently or always during the academic year. The study indicated that there are huge differences between the low levels of lecture attendance through Microsoft Teams values (never or sometimes: 13.4%), and the high levels (frequently or always: 86.2%). It is shown that most of the students (86.2%) attended lectures through Microsoft Teams most frequently or always during the academic year.

Table 3.13 R Square value of the relationship between Moodle easy use and academic progress through Moodle use

Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F change	df1	df2	Sig. F change
1	0.218[a]	0.048	0.044	0.93538	0.048	11.819	1	236	0.001

[a] Predictors: (Constant), Moodle easy use

Table 3.14 Standardized Coefficients Beta values of the relationship between Moodle easy use and academic progress through Moodle use

Coefficients									
Model		Unstandardized coefficients		Standardized coefficients	t	Sig	Correlations		
		B	Std. error	Beta			Zero-order	Partial	Part
1	(Constant)	2.098	0.203		10.319	0.000			
	Moodle easy use	0.208	0.060	0.218	3.438	0.001	0.218	0.218	0.218

[a]Dependent Variable: Academic progress through Moodle use

The study also indicated that there are considerable differences between the low levels of seminar attendance through Microsoft Teams values (never or sometimes: 13.4%), and the high levels (frequently or always: 82.4%). It is revealed that the most of students (82.4%) attended seminars through Microsoft Teams most frequently or always during the academic year. It is found that there are differences between the low levels of using the Moodle values (never or sometimes: 22.2%), and the high levels (frequently or always: 77.4%). The study found out that the most of students (77.4%) use Moodle most frequently or always during the academic year. It is also found that there are considerable differences between the low levels of using the Microsoft Teams easy values (never or sometimes: 15.9%), and the high levels (frequently or always: 77.4%). The study revealed that the most of students (83.7%) use Microsoft Teams most frequently or always during the academic year.

The study indicated that there are differences between the low levels of easy test access in Moodle values (never or sometimes: 13.8%), and the high levels (frequently or always: 85.7%). The study showed that the most of students (85.7%) access the tests easily in Moodle most frequently or always during the academic year. The study indicated that there are differences between the low levels of test access in Microsoft Teams values (never or sometimes: 16.3%), and the high levels (frequently or always: 83.2%). It is shown that most of the students (83.2%) access the tests in Microsoft Teams most frequently or always during the academic year.

It is indicated that there are differences between the low or medium levels of academic progress through Moodle use values (33.4%), and the high or very high levels (66.5%). The study found out that, the most of students (66.5%) achieved high or very high levels of academic progress through Moodle use during the academic year. It is also indicated that there are considerable differences between the low or medium levels of academic progress through Microsoft Teams use values (25.6%), and the high or very high levels (74.4%). The study revealed that the most of students (74.4%) achieved high or very high levels of academic progress through Microsoft Teams use during the academic year.

It is found a relatively positive high correlation between lecture attendance through Microsoft Teams and academic progress through Microsoft Teams use variables ($r = 0.619$). This indicates that high scores of lecture attendance through Microsoft Teams are associated with high scores of academic progress through Microsoft Teams use. The R2 value of the relationships between lecture attendance through Microsoft Teams and academic progress through Microsoft Teams indicates that 38.3% of the data according to fit the regression model. The study found out that 61.95% of the variance on academic progress through Microsoft Teams use is explained by lecture attendance through Microsoft Teams. The result was consistent with some previously reported works, which argued that lecture attendance through Microsoft Teams predicts academic progress through Microsoft Teams use (Neuwirth et al., 2020; Shehata et al., 2020).

The study found out a relatively low positive correlation between seminar attendance through Microsoft Teams and academic progress through Microsoft Teams use variables ($r = 0.279$). This indicates that high scores of seminar attendance through Microsoft Teams are associated with high scores of academic progress through Microsoft Teams use. The R2 value of the relationships between seminar attendance through Microsoft Teams and academic progress through Microsoft Teams use indicates that 7.8% of the data according to fit the regression model. The study revealed that 27.9% of the variance on academic progress through Microsoft Teams use is explained by seminar attendance through Microsoft Teams. The result was consistent with some review research, which argued that seminar attendance through Microsoft Teams predicts academic progress through Microsoft Teams use (Williams & van Rooij, 2017; Wart et al., 2017; Wan & Nicholas, 2010; Boling & Beatty, 2010).

It is revealed a relatively low positive correlation between Moodle's easy use and academic progress through Moodle use variables ($r = 0.218$). This indicates that high scores of Moodle use are associated with high scores of academic progress through Moodle use. The R2 value of the relationships between Moodle's easy use and academic progress through Moodle indicates that 4.8% of the data according to fit the regression model. It is shown that 21.8% of the variance on academic progress through Moodle use is explained by Moodle's easy use. The result was consistent with some literature review works, which argued that Moodle use predicts academic progress through Moodle use (Dalziel, 2011; Kim et al., 2011; Hollyhead et al., 2012; MacLeod et al., 2018).

The results of the study also supported by other research about the influence of Moodle and Microsoft Teams' key competencies on academic progress through Moodle and Microsoft Teams have significant implications for future research. Such research should investigate the relationships between academic progress through Moodle and Microsoft Teams use and other variables. The results of this study also have significant implications for practice. The important support should be designed to develop and support students because it is confirmed by this study that Moodle and Microsoft Teams' key competencies influence academic progress through Moodle and Microsoft Team's use. Overall, the findings of this study fostered theoretical and practical understanding as Moodle and Microsoft Teams' key competencies are important variables that impact academic performance through Moodle and Microsoft Team's use.

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Chapter 4
Critical Considerations on the Digital Potentialities, Vocations, and Needs of Teachers in Training in Bolivia

Vladimir Costas-Jauregui, Sonia Manzur, and Violeta Costas-Jauregui

Abstract Currently, there is interest in the scope of digital literacy in pre-service teachers due to the incorporation of ICT in education and its increasing use by society. This work reviews the research articles related to the ICT use for the training of future teachers. The study has a critical perspective of the Bolivian educational model showing it is not possible to assess digital literacy by focusing on the competence models of digital skills conceived from the global vision of UNESCO and the EU. We carried out a systematic literature analysis by selecting documents (n = 14) from three databases: Google Scholar, Scielo, and Eric; the researchers also consulted virtual libraries of the Bolivian Teacher Training Schools. The review stands that there is no concrete proposal for incorporating ICT appropriate to the Bolivian approach. Therefore, it is necessary to reflect, debate, and deepen the integration of ICT and its correspondence with the educational model of Bolivia under three components: the digital divide, the interaction assumed by the government, and the current scope of ICT as instrumental use in education. Understanding and evaluating ICT incorporation on the Bolivian educational model triad are necessary to consider the native people's worldviews with a decolonized orientation.

Keywords ICT · Digital literacy · Digital competence · Pre-service teachers · Bolivia

V. Costas-Jauregui (✉)
Universidad Mayor de San Simón, Oquendo SN, Cochabamba, Bolivia
e-mail: vladimircostas.j@fcyt.umss.edu.bo

S. Manzur · V. Costas-Jauregui
Asociación Cultural Amistad y Ciencia (ACAC), Cochabamba, Bolivia
e-mail: smanzur.acac@gmail.com

V. Costas-Jauregui
e-mail: acac.proyectos@gmail.com

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4.1 Introduction

Education in the last decade has incorporated information and communication technology (ICT) elements into its processes and contents. This incorporation comes from the significant changes in society due to the intense penetration of ICT in daily life's economic and productive aspects, even in those aspects of social interaction and fun.

The integration of ICT in educational processes requires knowledge, analysis, understanding, and practice with the software and hardware used to create educational spaces that allow the appropriation of learning; these requirements are for both the teacher and the student. The teacher must critically understand technical management and "the issues that always revolve around the power-media relationship" (Villanueva, 2018). From that understanding, master ICT is to create meaningful educational experiences and manage them to accompany students in their learning process. At the same time, the student must have the basic knowledge and have the necessary tools to handle the ICT that the teacher proposes critically.

Since the nineteenth century, reading and writing have been considered essential; literacy is a compulsory learning activity in society. People learn to handle books and use sheets of paper to express ideas, perform mathematical calculations, design structures and devices. All this is not possible without knowing how to read and write. However, the insertion of ICT changed the scene of daily life, work, and education; today, in addition to handling the spelling and its interpretation through orality, it is necessary to know and manage ICT to be considered a literate person.

Literacy is a kind of imposition in the cultural context of people because globalization produced a concept of illiteracy in native people. However, they have oral traditions and different spellings representing *the educated* and *the learned* concept as an interpretation of wisdom and knowledge. From this approach, the insertion of technological aspects in education is understood, respecting questions of cultural identity without exclusion.

UNESCO and the European Union each present a conceptual reference model of integrating ICT in teaching and learning: ICT Competency Framework for Teachers (UNESCO, 2019) and DigCompEdu (Redecker, 2017). Latin Americans refer to these two models, both from UNESCO and the European Union (EU), when they talk about digital competence. There is no model of Latin American countries as a proposal for education that conforms to the geographic and cultural needs of the continent; however, there are some efforts such as the Chilean model—also from competence approach—described in (Ministerio de Educación de Chile-ENLACES, 2011).

The lockdown due to the COVID-19 pandemic during the years 2020 and 2021 has forced Bolivian schools, where possible, to carry out training by virtual means, despite the lack of access to technology by a large part of the population in rural and urban areas of low resources (Fuentes & Rodríguez, 2020). During the lockdown, the teachers and students have not prepared to use virtual platforms and digital media; it is a reason for analyzing the training of future teachers who guide the process and introduce the student regarding the use of learning tools for their education. Similar situations have occurred in other countries at the international level. From the lockdown experience, education experts project a future of education with a vital component in using and applying ICT in teaching/learning processes. This document presents an exploration and perception of the ICT use and application in education that students of the Higher Schools of Teacher Training of the Plurinational State of Bolivia (ESFM) have; the study carries out a systematic literature review with the terms commonly used concerning the study topic for the exploration. The criteria and characterization of the concepts related to knowledge, skills, and abilities in ICT for education are analyzed and discussed—which experts in the area have called digital competence—against the model proposed by the education law in the socio-cultural context of Bolivia.

4.2 Theoretical Framework

An essential element is socio-cultural since it constitutes a component that permeates and gives a particular meaning to technological matters. It is the basis of the educational and technology approach in the context of the people of the Plurinational State of Bolivia. From this approach and in coherence with the objective set for this analysis, we will dwell on the conceptualization regarding three elements: the competence in education, digital competence, and the focus on the potentialities, vocations, and needs of education in Bolivia. In alignment with Education Law 070 "Avelino Siñani-Elizardo Pérez", the latter will allow us to have a clearer vision of the Bolivian position and policies in education.

4.2.1 Competence in Education

The Organization for Economic Cooperation and Development (OECD) defines skills and competencies as: "those skills and competencies that young people require to be effective workers and citizens in the knowledge society of the twenty-first century" (Ananiadou & Claro, 2009). This definition recognizes that skills and competencies are used interchangeably globally due to variations in meaning and different languages. However, Ananiadou and Claro (2009) affirm that competencies are a broader concept and can even include skills, attitudes, and knowledge.

UNESCO defines *competencies* as: "the development of complex capacities that allow students to think and act in various fields […]. It consists of acquiring knowledge through action, the result of a culture with a solid base that can be put into practice and used to explain what is happening" (Oficina Internacional de Educación de la UNESCO, n.d.).

The study of Velásquez et al. (2019) analyzes the definitions found of the concept of competence in Latin America, bringing the meaning closer to "those knowledge, skills, and capacities that an individual possesses to fulfill a task, that is, suitability efficiently".

The competency definitions of the OECD, UNESCO, and the approach to competency in Latin America coincide in general terms. It is also evident that the definitions and terms used are broad, and there is no universally accepted definition (Ananiadou & Claro, 2009; Velásquez et al., 2019).

The definition of competence in the educational field is problematic. Westera (2001) identifies two problems: to set cognitive standards for behaviors that cannot be standardized, and competencies are a subcategory of cognitive skills from a research point of view. Finally, Westera does not deny or prohibit using the term *competence* as a label to indicate associated knowledge and skills as a product of professional practice. Westera concludes that "when all is said and done, the only determinants of human abilities are possessing (knowledge), feeling (attitudes), and doing (skills)".

The definition and assumption of the term *competence* have a political and ethical position that one has, not only of education but also of the person and their being and being in the world observed in the concepts of competence noted above. The Bolivian proposal, embodied in the Education Law 070 "Avelino Siñani-Elizardo Pérez" (Gobierno de Bolivia, 2010), is unmarked from the concept of *competence* and goes to others (indicated in Sect. 2.3); who are in tune with the foundation that sustains from the ideological/political point of view. It focuses on promoting the experience of decolonization of diverse people and nations, based on the community generation of knowledge and know-how emanating from and for different realities.

4.2.2 Digital Competence

When we talk about education, we must consider technology, which is now part of our world, and daily life activities involve its use. The Internet use through devices is known as Information and Communication Technologies (ICT). The world must recognize that ICT is also part of the discussion regarding the benefit and need for adherence in indigenous people, despite not being incorporated into many indigenous people and populations marginalized by the economy and cultural exclusion of a globalized world. ICT is a discussion that involves all the planet's people on the need to incorporate education and its impact on people, as expressed (Forero, 2010) and (Vayas-Ruiz et al., 2018).

UNESCO and the European Union have addressed ICT in education for the last 20 years, emphasizing its insertion in schools. ICT in education focuses on competence education, and both the EU and UNESCO define it as *digital competence*:

"A spectrum of competencies that facilitate the use of digital devices, communication applications, and networks to access information and carry out better management of them. These competencies allow creating and exchanging digital content, communicating and collaborating, as well as solving problems to achieve effective and creative development in life, work and social activities in general" (UNESCO, 2018).

“The safe and critical use of information society technologies for work, leisure, and communication. It is based on basic ICT skills: the use of computers to obtain, evaluate, store, produce, present and exchange information, and communicate and participate in collaboration networks through the Internet” (European Parliament and of the Council, 2006).

There are coincidences between both definitions that allow us to recognize that they involve using devices for access, communication, and production of information through the Internet, specifically, in the communication and collaboration networks that they conform. The use of devices and information that are digital resources is not possible if they are not known; likewise, to use them, the person has to acquire the ability to handle them. Using ICT already involves their participation in various daily life environments such as work and home. ICT is present in almost every area of life, from work, play, socialization, and education.

The definitions allow us to glimpse how ICT is a conception from a unidirectional vision of the world from a critical perspective. They respond to a western cultural model oriented to efficiency and labor competitiveness. These conceptualizations leave pending a reflective process and the construction of a conceptual body regarding ICT that responds to the realities experienced in Latin America and, particularly in Bolivia, given the socio-community-productive model that governs Bolivian education today.

4.2.3 Education in Bolivia

In Bolivia, education in the last 100 years had three critical milestones: The Education Code of 1955, Law 1565 of education reform of 1994 (Gobierno de Bolivia, 1994), and Law 070 of education “Avelino Siñani-Elizardo Pérez”, 2010 (Gobierno de Bolivia, 2010). The Education Code of 1955 represents the expansion of schooling towards indigenous people, finishing a long exclusion from the educational system. This code declares anti-feudal and anti-imperialist education; however, the development was reduced to *citizenship*, denying the cultural identity of the people.

Law 1565 of educational reform presents a change in education, orienting itself with a neoliberal ideological/political sense and adopting competence as an educational purpose. The rejection of law 1565 was from teachers and social groups because of the low participation of Bolivian pedagogues in its structuring and implementation.

Law 070 “Avelino Siñani-Elizardo Pérez” represents a change in the vision of education, which declares: decolonizing, liberating, revolutionary, de-patriarchal, and transforming economic and social structures. Its orientation is on the concept of *Living well* (Sumaq Kawsay), reaffirming the culture of the original indigenous nations and people. It proposes a socio-community-productive educational model (MESCP), contrary to the competence model (Gantier, 2020). The model in Bolivia is pluralistic, respecting the cultural and collective diversity of the people; being productive has a complementary perspective of harmony. This model opposes the instrumentalization for unlimited progress.

The socio-community-productive educational model named in Ministerio de Educación Bolivia (2012) assumes the multidimensionality of the human being as the essence that goes through the entire socio-educational process. We are body and mind; bodies and minds that think, feel, do, commit, all at the same time (Manzur & Costas, 2019).

Humans are a plurality dimension, and human beings are always in a state of possibility, that is, of projection towards an emancipating feeling, thinking, knowing, and acting. The dimensions allow us to print our stamp on the world, in reality, in our time and space. The axiological dimension has its grounds in values, the epistemological approaches from a derivation of wisdom and knowledge, the ethical represents the guidelines to our actions and the political as a choice and decision aligned with the common good.

Such dimensions pretend to respond to a situated human being, what makes a subject what she is; insofar as it feels, thinks, acts, dreams, shares, and lives in the community. On the one hand, while the being goes to the personal, in deciding action makes visible what he assumed in the personal level open towards the community from a political and transforming sense. On the other hand, knowledge represents the personal and the doing, while applying wisdom and knowledge has a transformative intention in the community view.

In turn, the dimensions of knowing and doing, in time to be affected by being and deciding, illuminate them from a recursive process, back and forth. Since the knowledge learned, practices, and productions developed are not neutral, they respond to finality, to a purpose. See Fig. 4.1.

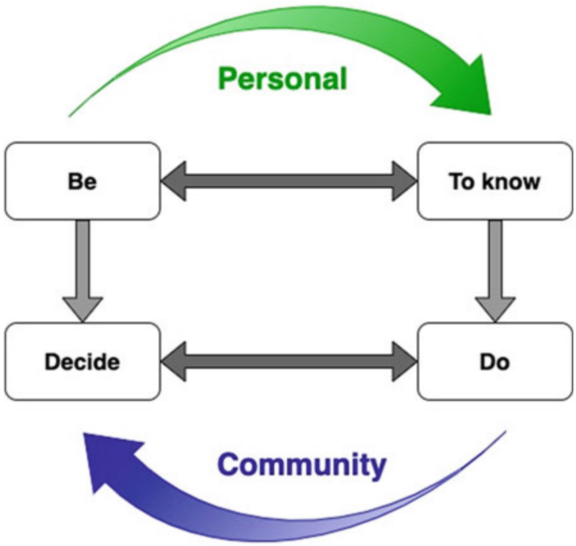

Fig. 4.1 Recursive process of dimensions in the MESCP (Image designed by Sonia Manzur and Violeta Costas in a workshop for rural teachers in Bolivia. 2014)

In this way, the model separates itself from the logic of competencies and proposes three complementary and integrative categories that allow reconfiguring power relations: potentialities, vocations, needs; the interwoven of these three categories with the dimensions of the human being is experienced from being, knowing, doing, and deciding, in the processes of community production.

The potentialities allow "to revitalize the human faculties" (Ministerio de Educación, 2014), those that can be developed, making visible what the person can achieve personally and as a community. Vocations respond to the qualities and skills present, put into action. The interwoven potentialities and vocations let us respond to needs from the logic of complementarity. The needs to respond are personal and community.

The model is an innovative proposal in coherence with the approach that supports it; it is also dynamic and reconstructed from experience. Therefore, it is always in a state of possibility. This state of possibility allows us to glimpse that, although the model conceptualizes dissident terms and processes to the competence approach, it still does not make them explicit in a concise manner through structured definitions.

4.2.4 Technology Approach in Education in Bolivia

Technology is integrative from the Bolivian education approach in Law 070. The wisdom and knowledge of the people and communities are valid to the same extent as the universal ones. There is recognition that wisdom and knowledge are focused on the experience of each culture. Science, technology, and arts are developed from these recognitions, with a pluralistic vision of inclusion and production-oriented to the community-society. In law 070, the conception of technology is broad, concerning the areas in which technology participates in its development, such as technology developed in chemistry, physics, etc. In the same way, Information and Communication Technologies are part of this conception.

The development of training in and with technology is an objective described in Law 070: "scientific, technical, technological and productive training must be developed, based on wisdom and knowledge, promoting research linked to the cosmovision and culture of the people, in complementarity with the advances of science and universal technology throughout the Plurinational Educational System". This objective highlights the influence of applying wisdom and knowledge of the people and communities part of the Plurinational State. There is a substantial nexus with the cosmovision and culture of the people; that cosmovision does not dissociate with the concept of being complementary: the spiritual, socio-cultural, economic, work, and the scientific technology from a holistic interpretation of life. Finally, it has a sense of empowerment of universal science and technology, with the concept of being complementary.

There is a recognition that technology of ancestral origin of the people is originated in their cosmovision and is strongly related to the flow of mother nature. This ancient technology must be complementary to universal science and technology.

This complementarity does not mean assuming the universal and explaining the dissolution of the own or vice versa (Dirección general de formación de maestros, n.d.).

According to Dirección general de formación de maestros (n.d.), the development of technologies is not dissociated from the didactic. The didactic means are developed to preserve and give continuity to the knowledge in the diverse and productive activities of each people and native nation, closely interrelated to the spiritual and natural world. In an educational process related to technological practices, ancestral people have communicated technological knowledge from generation to generation, up to our times. In this sense, technological practices, developed integrally in daily life, are translated into didactic means that make their permanence possible, without resorting to formal education and thinking about the training units that currently present us (technical training centers, universities). This knowledge and technological practice were transmitted and continue the transmission in the community from one generation to another (Dirección general de formación de maestros, n.d.) in care of education from and for life.

ICT, currently used in Latin America, is the product of a universal technological revolution. This revolution has happened at a time of minimization and substitution of the original Latin American people's cultures, practices, and knowledge. Thus, the conception of development has its basis on western knowledge and practices under a strongly eurocentric cultural conception. The educational models, methodological designs, and ideological currents related to pedagogy applied in Latin America have a strong base in western thought; most texts and research works refer to Greco-Latin roots of science and knowledge.

Understanding and direct ICT use in technological development, culture, and society are necessary. This understanding must consider ancestral wisdom and knowledge, the cultural traits, and the cosmovision that accompany the Latin American people; this means decolonizing the technologies. Nowadays, ICT is present in all societies and influences people's daily lives. Remember that under the light of *deciding*, there may be people and cultures that choose to live differently, which in no way implies entering into *illiteracy* or *backwardness* of civilization. It is possible to respect these decisions and value their technologies and cultures in acceptable diversity.

Also, in the Bolivian educational field, ICT has entered the work of the teacher and the student. ICT is considered in education because it is related to information and communication. Both information and communication are critical elements for the dimensions proposed by the Bolivian educational model; because decisions about what, how, and purpose to inform and communicate. On the other hand, expanding the look beyond information and communication, when ICT becomes part of the lives of the men and women of a community, they must integrate the existing technologies into complementarity with the culture, wisdom, and knowledge. In said community and in the projections, they have as a town. This complementarity and decolonization is an important goal in Bolivian education.

It is convenient to delve into an important aspect: intraculturality[1] and interculturality are components of vital importance within the educational field. From the model's vision, the education conception is in a space that promotes and makes explicit the knowledge and experiences of the subjects, communities, and towns as constructions that enrich diverse knowledge, diverse existences. It is about conceiving a socio-educational praxis as a necessary condition for openness and dialogue with *the Other*. This praxis starts with the locals building and enhancing the intracultural and intercultural (ACAC-Bolivia, 2020).

4.3 Methodology

4.3.1 Objective

This work aims to have a vision that allows us to understand and relate the potentialities, vocations, and needs to be developed in ICT by pre-service teachers in Bolivia for its application in the Bolivian education system. To provide a description that relates the socio-community values, wisdom, knowledge, skills, and abilities in digital technologies acquired by pre-service teachers, framed in the socio-community-productive educational model. This description will allow delineating how the achievements in abilities and skills achieved by the students in the Teacher Training Schools in Bolivia are understood and, in addition, to propose a critical relationship of the *digital potentialities, vocations, and needs* with the concept of *digital competence* internationally widely used.

The research questions of this study are:

RQ1: How do we understand the incorporation of ICT in the training processes of pre-service teachers?

RQ2: How do they assess to pre-service teachers the scope of potentialities, vocations, and needs in ICT for education?

RQ3: What are the criteria and characterization of incorporating ICT potentialities, vocations, and needs in Bolivian education?

4.3.2 Method

We used a systematic literature review to answer the questions posed in the previous section. This method reviews the relevant documentation in the study area obtained from relevant databases (Okoli & Schabram, 2010).

[1] Intraculturality is to look at ourselves culturally within our person and our culture, trying to get to know ourselves and value ourselves socially and culturally through our own social group's complexity and internal difference.

The databases consulted for the review were: (1) Google Scholar, (2) Scielo, (3) the Educational Resources Information Center (ERIC), and (4) Sources related to online libraries of the Higher Education Schools of Teachers (ESFM) from Bolivia.[2] Google Scholar is a search engine for scientific documents that brings together many publications and journals: with the extended search of documents in Scielo to broaden the dataset with documents produced in Bolivia and related to the subject of study. The ESFM online libraries expanded the number of documents for consultation; however, there is a need to consider that these documents are not easy to find. There is no information about the documents published in the ESFM library review process.

4.3.2.1 Sources and Search Criteria

The documents searched and reviewed are in the publication year range from 2000 to 2021. The search parameters focus on pre-service teachers, ICT, and digital skills; the search keywords are related to ICT and pre-service teachers. The searches that included the most used terms worldwide are related to those included in the Bolivian educational model. The search was carried out considering the logical operators as observed in the following query predicate: ("ICT capabilities" OR "digital competence" OR "digital literacy" OR ICT OR "Information technologies") AND Bolivia AND ("teacher training" OR "teachers" OR "ESFM" OR "teacher training"). The query predicate has been used in the search in Spanish and its corresponding translation into English to expand the results to publications related to Bolivia in a foreign language.

4.3.2.2 Selection and Inclusion

The selection process consisted of five stages:

1. Search the selected databases using the constructed predicate and search alternatives for keywords that make up the predicate. The result was a dataset.
2. Make a selection of documents by peer-review criteria. Documents were categorized into relevant, probably relevant, and excluded. The three researchers marked those documents with relevant titles.
3. Selection of documents according to abstract. At this stage, the same technique used for titles was used. The introduction section verified those documents that do not have an abstract.
4. Document location and download of selected documents, then duplicates are removed.

[2] Biblioteca del Ministerio de Educación de Bolivia http://biblioteca.minedu.gob.bo/, Biblioteca de la ESFM Villa Aroma https://www.esfmvillaaroma.edu.bo/, Biblioteca PROEIB Andes http://biblioteca.proeibandes.org/.

5. Content review to validate the relevance of the documents. The three researchers reviewed the assigned documents to verify the semantic context of the keywords. It was a qualitative review of the most relevant documents.

The researchers collaborated stages 2 and 3 to mark the relevance and add observations regarding the relevance criterion in the reviewed documents. These two execution stages were in cycles; at least two researchers reviewed a document. Each researcher in a communal table annotated the relevance and observations assessment. The ratings were reported under three categories: relevant, probably relevant, and excluded. The observations noted in the box next to the assessment allow a qualitative review of the assessment of at least two researchers. The third party is to issue a final category in case of discrepancies or ties between the relevant and excluded categories.

The fifth stage was a qualitative review in which the researchers assessed the context of the keywords present in the document. The findings recorded are in a table that allowed reviewing the specific content in the document and drawing conclusions to answer the research questions.

The inclusion criterion for the documents was that they explicitly refer to teacher training and the use/application of ICT in the training process. The reliability of the coding was based on the agreement of two researchers; in case of discrepancy, a third-party assessment solves it. Disagreements were discussed among the three investigators to consolidate a reliable assessment.

Only 14 of the 92 documents obtained by consulting the databases and additional libraries were selected (Table 4.1). In stage 2, due to the semantic revision criterion of the title, 62 documents that the researchers consider not relevant have been eliminated. In stage 3, after discussing the findings in the context of the summary of the documents, eleven documents that were far from the exploration purpose were rejected. In stage 4, four documents were identified that resulted in duplicate publications; these duplicates were removed from the selected documents. Finally, in stage 5, a document was detected whose context was related to technology; however, the content was concentrated on purely theoretical aspects of the MESCP, which is why it was eliminated from the set of selected documents.

Table 4.1 Selection of documents

	Total	Rejected
Stage 1: Search	92	
Stage 2: Selection by title	30	62
Stage 3: Selection by abstract	19	11
Stage 4: Exclusion of duplicates	15	4
Stage 5: Selection by context	14	1
TOTAL SELECTED	14	

Of the 14 documents obtained in the selection, Ruiz Zardán (2011) is the oldest that refers to technologies in education. From a different perspective: it is a biocosmocentric[3] of educational science. This biocosmocentric perspective has a decolonizing and intercultural vision and approach. The authors will discuss this perspective in Sect. 5. Bolivia has not had a formal and clearly defined plan and development of ICT in education until the educational revolution that began with the Avelino Siñani Law. Although the educational reform of 1994 touched on development within the ICT framework, this probably did not translate into research documents that deal with ICT in education, possibly due to the low publication in Bolivia of this kind of research, which has recently been observed in the engines search like Google Scholar.

4.3.2.3 Limitations of the Research

One of the most important limitations is the low publication of documents in the study area and the availability in digital format. The study was limited to documents that are available in digital format in Spanish and English. Note that despite the pluralist ideology of Law 070, documents in native languages are no part of the study; due to the difficulty of translating and the lack/absence of known repositories for documents related to the area in native languages.

The researchers of this document are aware that the literature related to pre-service teachers and ICT in Bolivia is scarce, probably because it is not published on the web, possibly its existence in printed format. The printed documents are probably internal to institutions related to the Ministry of Education and the ESFM. These are significant limitations that must be considered when evaluating the results of this research.

4.4 Results

The selected publications carry out their study through surveys of teachers; in some cases, they survey other actors or review documentation from the Bolivian government, see Table 4.2. Several studies analyzed documents published about ICT in the Bolivian educational field and, in some cases, related the state of ICT and education in Bolivia to models from other countries and with other regions.

The publications with quantitative studies, resulting from a survey, are six. Most of these documents complement the study with qualitative analysis, either derived from survey questions or the documentation analysis results. The documentation

[3] The Native Indigenous Nations and Indigenous Peoples' vision puts life at the center, recognizing that all in Mother Earth and the Cosmos have life. The relationships with other living beings are interdependent horizontally based on values of reciprocity, complementarity, harmony, and balance of subject to subject and not subject to object. Let us overcome the anthropocentric approach centered on the human being.

Table 4.2 List of publications and type of study

Document	Survey/Interview	Analysis and exploration documentation
Farfán Sossa and others (2015b)	Teacher survey	Review documents related to government publications, ICT application models in education, experiences from other countries
Landívar and Puerta (2019)	Teacher survey	Review and analyze the National Plan for new information and communication technologies for education (PNNTICE) and a relationship with the Bolivian educational model
Landívar (2017)	Teacher survey	Descriptive research with analysis of government, ESFM, and PROFOCOM documents regarding training booklets and national regulations
Crespo and Medinaceli (2013)	Interview with the technical staff of the government ICT services	Review of documents related to the subject
Zuñiga (2020)		Compilation of experiences
Ruiz Zardán (2011)		Main aspects synthesis of the model, extracted from the Ministry of Education working documents
Portanda (n.d.)		Review of documentation related to the training of the company Quipus on Technological Floors and review of the training programs of the ESFM and PROFOCOM 2014 and 2013
Jordán and Calisaya (2015)		Compilation of some interviews with educational authorities and critical reflection
Fuentes and Rodríguez (2020)	An online survey of open questions to teachers, parents, and students	Exploration of a quantitative-descriptive nature
Yapu Choque, (2017)		An analysis of the MESCP and the structure for teacher training. A Study of analysis of Law 070, PROFOCOM, and ESFM training
Landívar and Puerta (2016)		Documentary compilation and comparative analysis

(continued)

Table 4.2 (continued)

Document	Survey/Interview	Analysis and exploration documentation
Farfán Sossa et al. (2015a)		Descriptive exploratory research
Costas-Jauregui et al. (2020)	Survey of pre-service teachers	Diagnosis of the sample
Tomczyk et al. (2021)	Survey of pre-service teachers	Diagnosis and relationship with other countries in Latin America and Europe

they analyze refers to quantitative results from the government and other local and Latin American organizations. Two of the reviewed papers do not clearly define how the study was conducted: Zuñiga (2020) and Ruiz Zardán (2011). The document (Zuñiga, 2020) is an article in the ESFM magazine "Villa Aroma" that considers the perceptions and experiences of the author in the context of its activities. On the other hand, Ruiz Zardán (2011) explores unexplained documentation related to teacher training in Bolivia, taking a critical stance from the decolonizing and biocosmocentric conception that touches on technology.

Of the 14 documents reviewed, 3 explicitly reference digital competence models formulated by international organizations or governments, as shown in Table 4.3. The most common are: UNESCO's "ICT Competency Framework for Teachers" in its different versions since 2008 and the 2013 "European digital competence framework" DIGCOMP. The Chilean ICT model studied in Farfán Sossa et al. (2015b) draws attention because it is the one that appears named as a formal model worked in Latin

Table 4.3 List of publications and reference to models of digital competence

Publication	Reference model digital skills
Farfán Sossa et al. (2015b)	1. Framework skills of teachers in ICT (UNESCO, 2008) 2. Digital European DICGOMP Competence Framework (European Commission. Joint Research Centre. Institute for Prospective Technological Studies, 2013) 3. Analysis of ICT in education in Latin America (UNESCO, 2013) regarding the framework (UNESCO, 2011) 4. Chilean ICT model (Ministerio de Educación de Chile-ENLACES, 2011)
Landívar (2017)	1. Framework skills of teachers in ICT (UNESCO, 2008) 2. European digital competence framework DICGOMP (European Commission. Joint Research Centre. Institute for Prospective Technological Studies, 2013) 3. SITES 2006, A report of International Association for the Evaluation of Educational Achievement (Carstens et al., 2006)
Portanda (n.d.)	1. Analysis of ICTs in education in Latin America (UNESCO, 2013) regarding the framework (UNESCO, 2011)

America; however, it does not transcend outside of Chile and remains within the framework of the competence models.

Most of the studies refer to digital literacy as a task in process in the Plurinational State of Bolivia (see Table 4.4); the training is at the level of the use of computers and cell phones, as well as the use of the most common applications (office automation,

Table 4.4 List of publications and findings on digital literacy, accessibility, and ICT use

Publication	Digital literacy	Accessibility	Basic use of ICT
Farfán Sossa et al. (2015)	ICT training for teachers is low Teachers make instrumental use of ICT	There is training in Internet access for teachers Access has limitations: academic units have few devices and Internet access (worse in rural areas)	Teachers know about basic office automation and Internet use The average skill is medium. Some teachers have high skills and abilities using office automation
Landívar and Puerta (2019)	The use of the computer and office automation is primary for teachers		Basic knowledge of office automation
Landívar (2017)	There is technical training in ICT for teachers Training is developing, mastery of ICT is primary in education	Teachers are interested in using the Internet Training in Internet access is helpful in the teacher's professional development	Office automation training is basic
Crespo and Medinaceli (2013)	Teacher training focuses on basic and instrumental access to ICT It refers to the concern for inclusion and access in rural and peripheral areas to achieve ICT use	Access for teachers and their students is through the technological floors (provision of the Internet access and through a local network server with kuaa laptops at the school)	Office automation training is inclusive, accessible, and concentrated at a primary and instrumental level
Zuñiga (2020)	The training of pre-service teachers considers digital mediation and the instrumental use of ICT	In the ESFM, there is difficulty in accessing the Internet and devices	The training is in technological tools, both office automation, and multimedia Consider digital material recognition training

(continued)

Table 4.4 (continued)

Publication	Digital literacy	Accessibility	Basic use of ICT
Portanda (n.d.)	Digital literacy development for teachers is through workshops at the ESFM and the state-owned company Quipus with the devices it produces with installed educational tools and resources	Accessibility is limited, and training has limitations	The Quipus company training includes the instrumental management of office automation and the basic management of pre-installed resources The ESFM workshops have an orientation to the use of office automation
Jordán and Calisaya (2015)	Literacy for practitioner teachers training is through the Complementary Training Program for Teachers (PROFOCOM)	PROFOCOM covers accessibility training	The study gives a reflection on the use of ICT in education
Fuentes and Rodríguez (2020)	There is training in the basic handling of the computer and its applications Most of the teachers state that they received some training in ICT	There is an asymmetry in Internet access, especially in rural versus urban areas	Teachers and students report high use of mid-end and low-end cell phones The type of devices limits the use and access to the Internet and resources
Yapu Choque (2017)	Training in PROFOCOM and the use of technological floors to achieve knowledge and use of ICT primarily is a gradual process	Technological floors are the strategy of access to the Internet and ICT; however, they have limitations in rural areas	Office automation is for primary use
Landívar and Puerta (2016)	There is training for the use of laptops and their resources for teachers	Internet access is limited to its coverage and costs. Teachers access the Internet through the computers assigned to them by the government	Training in office automation is basic
Farfán Sossa et al. (2015)		The program gives Internet coverage data	Teachers trained within the program "one computer per teacher"
Costas-Jauregui et al. (2020)	The study indicates a low level of literacy in teachers in training	Access to the Internet and computers is limited in training centers	Most of the teacher students declare ability to use middle-level office automation

(continued)

Table 4.4 (continued)

Publication	Digital literacy	Accessibility	Basic use of ICT
Tomczyk et al. (2021)	Digital literacy learning of students is on their own and not in the ESFM training		

web browser, multimedia playback). The digital literacy effort emphasizes accessibility difficulties, both to devices and the Internet. The strategies such as: "One computer per teacher", "One computer per student", Technological Floors and Telecentres; try to cover the access to devices. The plan of one computer per teacher is how the Ministry of Education deals with teachers' entrance to technology; in the same way, it reduces the digital divide with the provision of kuaa (laptops produced by the state company Quipus) to schools.

The digital literacy and device access efforts referred to in the analyzed documents are independent reports from the reports of the Electronic Government and Information and Communication Technologies (AGETIC) in Agencia de Gobierno Electrónico y Tecnologías de Información y Comunicación (2018) and the Strategic Plan for telecommunications and ICT for social inclusion (PRONTIS, 2014).

The provision of Telecenters (a kind of computer lab with Internet access, open to the use of the community and to which rural schools can access) covers accessibility problems in rural areas. The other alternative has been the provision of Technological Floors (computer labs installed in schools, which consist of installing the electrical network and the Internet, in some cases, a local server with all available educational resources, and Kuaa laptops produced by the state company Quipus). Technological Floors and Telecenters are part of the government's plans to grant accessibility to the Bolivian people (PRONTIS, 2014).

The government's Strategic Plan focuses on reducing the digital divide, ensuring that teachers access technology through computers and training in office automation and other essential applications. According to the analyzed documents, the training lets them acquire the skills for use and, in the future, the appropriation of knowledge and ICT skills.

Internet coverage, low access to computers, and an asymmetry between rural and urban areas and between social classes in cities show the difficulties in launching more ambitious literacy digital and ICT use programs at the population level and specifically in education.

Teachers' production of teaching material in Bolivia is low, and there is evidence of a stage of use of ICT in education. However, a small group of teachers had dedicated themselves to exploring the production of educational material. In the Teacher Training Schools, some workshops allow them to examine the production of didactic material with ICT. Due to the low contact with the technologies by pre-service teachers, there is little use of these courses traduced into insufficient appropriation of technology, as shown in Table 4.5, which summarizes the findings in this regard in the documentation analyzed.

Table 4.5 List of publications and production of didactic material

Publication	Production of teaching resources with ICT
Farfán Sossa et al. (2015)	6% of those surveyed declared that they participate in an ICT production project The use of multimedia production is low and basic; material production is for teacher exposition in front of the class Most teachers who produce resources do so in private schools
Landívar and Puerta (2019)	The production of resources is low The Word application is preferred to create educational resources
Landívar (2017)	The production for the development of the subject is low Some didactic resources were produced with basic office automation
Crespo and Medinaceli (2013)	The EducaBolivia (currently offline) is a pilot program to which around 500 teachers joined to access resources and production capacity
Portanda (n.d.)	The pre-service teachers have workshops to obtain skills in producing didactic resources The EducaBolivia portal is a pilot to promote the production of resources by teachers and other organizations that work with education with ICT and teachers
Fuentes and Rodríguez (2020)	Despite the confirmation of teachers to have training in platforms and use of ICT with didactic criteria, the material production is low
Yapu Choque (2017)	The study clarifies that the production of didactic resources with technology is a goal of the MESCP
Landívar and Puerta (2016)	The EducaBolivia portal aspires to produce didactic resources, but this is low, and the quality is not high
Costas-Jauregui et al. (2020)	It highlights that teachers generally perceive the need for use, but the production of resources for the educational process is not central due to their low digital literacy
Tomczyk et al. (2021)	There is moderate skepticism regarding the use of technology in education. The use of technology is instrumental

From the results presented, it is evident that there are no criteria positioned about technology for the training of teachers, which account for the magnitude of the Bolivian model, as a proposal decolonizing. Therefore, it is not easy to assess the achievements. The categories proposed in the Bolivian model: potentialities, vocations, and needs imply considering other non-linear and non-universalist forms of those elements that can account for the significance of learning and its application in personal and community life.

Due to the needs arose COVID-19 pandemic, training and practice in technology present a primarily instrumental approach. The realities have not allowed reflective processes on the why-what-how to approach a decolonizing education in ICT.

4.5 Discussion

The socio-community-productive educational model of Bolivia has no framework or model related to ICT; there is no evidence of a similar model to the UNESCO, (2019) and Redecker, (2017), which are the best known most used frameworks for integrating ICT in education. However, both models approach the training by competence, contrary to the Bolivian model as indicated by Gantier (2020) and Ruiz Zardán (2011). Ruiz Zardán concludes that the proposal is coherent and adequate if the challenge of decolonization of education is assumed. At the same time, N. E. J. Landívar (2017) observes no coherence between the MESCP and the National Program of new information and communication technologies for education. This lack of coherence may be due to the absence of its ICT integration model adjusted to the Bolivian education framework; at worst, attempting to make the MESCP compatible with the integration models of ICT in education with an opposed approach to that of the Bolivian model.

To understand ICT in teacher training in Bolivia, one must think about the dimensions posed by the MESCP: Being, Knowing, Doing, and Deciding; these dimensions integrate into two planes: the community and the personal. Thus, the dimensions and the two planes are interwoven, meaning *sumaq kawsay* (living well). When living well interleaves technology, it must interweave with dimensions and planes in an integrating and complementary sense. It is evident that all efforts to incorporate ICT into Bolivian society respond to the need (greater in cities than rural sectors) and the vocations of the person and their community for production. Production is understood for life, not for unlimited exploitation in the workplace due to the sense of current capitalism that demands competitiveness. By necessity, vocations move towards developing potentialities so that the community (and the person who is an integral part of it) can live well. The incorporation of ICT must be in this sense of potentials, vocations, and needs that make up the three categories of the Bolivian model.

Synthetically, we can say that the Bolivian model seeks the integration of ICT in education and, therefore, in teacher training orientation. This integration suits the triad: the potentialities, vocations, and digital needs required by people and the community to fulfill the MESCP objectives.

This work does not propose a model to integrate ICT in Bolivian education. Still, it is necessary to be clear about this model's approach. It would not be easy to talk about the level of integration of ICT in education and, therefore, in the scope of the training of teachers in the potentialities, vocations, and digital needs instead of exposing them as digital skills.

Although the competence orientation is opposite to the MESCP, it is possible to make approximations by the coincidences in the evolution of the appropriation of knowledge. The approximation works because every human being and the society she participates in involves learning in knowledge appropriation. This approach helps to understand the level of progress in integrating ICT in teacher training. The criteria considered in the approach have an integrating and complementing spirit of ICT integration related to the MESCP that is always in a state of possibility due to its evolving condition dynamic.

To make an approximation, we will start from the findings and proposals of (Jordán & Calisaya, 2015) with the Bolivian pedagogical strategy for integrating ICT based on three pillars. These pillars are one-to-one model and training, Technological infrastructure and platforms support and training, pedagogical strategy in the classroom. These pillars can be related to the TPACK (Mishra & Koehler, 2006), and the digital competence model is proposed by Krumsvik (2009).

According to the Krumsvik model, the one-to-one models in providing computers to teachers in Bolivia have the objective of adopting ICT by teachers; it means going from being a teacher who does not use ICT to a teacher who uses ICT. In other words, he can use them; he has basic skills in ICT. The second pillar referred to technological infrastructure, and support platforms aim to integrate ICT with the didactic-pedagogical component. In the Bolivian model, the teacher uses ICT from the pedagogical aspect. The second pillar in Krumsvik could be mapped to didactic skills with ICT, scaling to the levels of adaptation and appropriation of ICT. Finally, the pedagogical strategy in the classroom means raising the level of awareness of ICTs and taking them to the degree of appropriation, which in Krumsvik's model are learning strategies. According to Krumsvik (2009), the high awareness of digital skills and the innovation degree in ICT practice is the Digital Bildung. The Digital Bildung in the TPACK is the intersection of the pedagogical with the content and the technology.

More specifically, the Bolivian strategy initiates the use of ICT with teachers, following the natural line from Krumsvik (2009): adoption, adaptation, appropriation, innovation in their proposal for incorporating the ICT by teachers. Additionally, the teacher must complement this incorporation with a high awareness of ICT and skills to handle ICT, with its didactic component and content of the subject that it dictates.

All the authors emphasize adopting ICT by teachers and incorporating the same in the pre-service teachers, except Costas-Jauregui et al. (2020); Ruiz Zardán (2011); Tomczyk et al. (2021). In all cases, the provision of computers to teachers, technological floors to schools, and Telecenters to rural communities are recurrent topics. Likewise, all agree that the path to achieving the adoption and adaptation of teachers with ICT will take time. The documents referring to ICT application in the classroom by teachers and pre-service teachers in the ESFM and their daily practice during the COVID-19 pandemic restrictions have shown that teachers in Bolivia were not prepared to use ICT in virtual and blended modes. Teachers faced problems using ICT during COVID-19 social isolation due to the coincidence of all the studies in which the use of ICT by teachers is instrumental. The ICT tools' everyday use is to develop office automation resources for class presentation without student interactivity. Clearly, Farfán Sossa et al. (2015) identify 6% of teachers who produce teaching resources with ICT, which is also in the initial stages of the appropriation of multimedia (video, graphics, and sound).

An important point to highlight is that Tomczyk et al. (2021) recognize the digital divide between Latin America and the European Union regarding ICT in education.

Despite the gap, it also recognizes that ICT is generally instrumental in the Latin American and European countries that were part of the study. Just as there is an asymmetry between continents, in Bolivia, there is an asymmetry in access to technology between urban and rural areas, a situation that several of the selected documents show. The digital divide between urban and rural areas in Bolivia influences the adoption of ICT by teachers since, in the absence of technology, the rural teacher cannot introduce it into the classroom. The study in Costas-Jáuregui (2019) refers to Bolivia's urban–rural situation in terms of ICT and education; likewise, it relates to the PRONTIS project in Bolivia that aims to reduce the digital divide until 2025 in rural areas.

The previous findings lead us to think in a series of problems and questions that should be reflected, debated, and deepened, at the level of the Plurinational State, as well as organizations and communities, regarding a position that accounts for the socio-cultural, economic, and political realities experienced in the various contexts of Bolivia.

For example, it reflects how the digital divide manifests itself in the lack of opportunities to access information and communication technologies and the impossibility of having the necessary devices. This reflection includes the lack of economic resources to insufficient training that allows having those essential learning for the management, the forms and purposes directed towards the social transformation, and the communicative and cultural segregation of the subordinated voices.

Therefore, the insurgency in the face of the colonial technological perspective is an urgent and essential matter to address, in attention to the foundations of a decolonizing education.

Furthermore, precisely, a proposal for a decolonial education in technological matters, in coherence with the MESCP, would have to address three critical questions, understood as emerging difficulties of reflection/training/practice, which we must face from a decolonizing technological project: The *For what*, understood as one that invites us to evoke the social purpose assigned to technology, understood as a transforming purpose, the *What*, as it refers us to take into consideration the contents in entire interrelation with the dimensions of Being, Knowing, Doing and Deciding and, of course, in line with the why and the *How*, from the adoption of coherent socio-pedagogical tools capable of promoting personal and community transformation. Within this approach, the triad: potentialities, vocations, and needs, implies considering other non-linear and non-universalist forms of those elements that can account for the significance of learning and its critical application in personal and community life. Criticism aims to see beyond the obvious:

> We must be cautious in sustaining a discourse of appropriation associated with uses, which makes invisible the fact that large corporations and governments are unleashing an important planetary war to appropriate what is openly at stake today: the personal data of users. It is not only about encouraging people to have access and intensive use of technologies. If we believe that access to technologies is a right, we must consider that it is a right to know what technology is made of, how it works, what it is for, who it is for, what are its consequences for each one and society (Rivoir & Morales, 2019).

In any case, a critical element that will allow us to enter into a technology-oriented educational proposal is to consider it, precisely, as a decolonization tool. Understanding that is also a tool of resistance and decolonization, as it allows the resonance of voices, experiences, memories, and struggles of subordinated bodies. Still, it is an instrument of colonial power to generate dominant discourses, social practices, and new identities outlined towards coloniality of knowledge, languages, memories, and imaginations. The decolonization tool implies facing an open fight against the inequalities produced by the digital divide, inequalities that intersect and show the importance of breaking the binary vision with which the concept is frequently associated (ACAC-Bolivia, 2020; Manzur & Costas, 2019).

4.6 Conclusion

Regarding the integration of ICT in the training processes of pre-service teachers, it has been possible to perceive that it contains steps from the natural line of adoption, adaptation, appropriation, innovation. Steps that do not differ from those assumed by other countries and that, by themselves, are insufficient to account for the decolonization perspective proposed by the Bolivian educational model. The linear process of these steps in Bolivia presumably has two reasons: a light reflection on how to face ICT use from the conception of the technology proposed by the MESCP and the sudden manifestation of socio-educational needs not contemplated as a result of the COVID-19 pandemic.

Correspondingly, the training processes for the group of pre-service teachers are characterized by the instrumental use of ICT, without delving into other aspects derived from the primary foundations of the MESCP.

However, taking a holistic view of the realities, the paths undertaken for the integration of ICT in the educational field are affected and, at the same time, impact other areas related to the socio-cultural, economic, and political. The digital divide, understood broadly, is not being overcome with the elements adopted in the training processes. Moreover, it is possibly becoming more acute, especially in rural areas and, consequently, for many of the students of the Higher Training Schools who come from rural areas.

There is no practical proposal for the appropriation of ICT at the educational level that corresponds to the MESCP. The proposal must have a decolonizing view, which denotes the interrelation between potentialities, vocations, and needs with the dimensions of knowing, being, doing, and deciding. The evaluative question is, like the proposal, in suspense and possibility.

The dynamism and possibility of the Bolivian model let to keep in the process of reflection and construction. This process will allow entering a critical discursive corpus, which accounts for the why, what, and how to assume ICT in the educational process, not only for the teachers-in-training but also the entire system. It is from this critical discursive corpus that the operational guidelines for transforming action will be derived.

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Chapter 5
Digital Literacy of Students of Teacher Training Colleges in Bosnia and Herzegowina—Literature Review and Analysis

Elma Selmanagić Lizde, Amina Đipa, Izela Habul Šabanović, and Jasmina Bećirović Karabegović

Abstract This research aims to express an effort to systematically introduce into education, with an emphasis on higher education, a way of teaching digital literacy and training for students of teacher training colleges within the scope of digital competencies. Also, the goal is to study the level of digital literacy and digital competencies of students of teacher training colleges in Bosnia and Herzegovina, based on the analysis of previous research in the past two decades. The analysis presented here was done based on eight scientific research articles in which the research in the field of digital and information literacy was approached. For this research, we used the electronic database search: Central and Eastern European Online Library (CEEOL) and ScienceDirect (Procedia-Social and Behavioral Sciences). The following databases were found, searched, and analyzed within CEEOL: Journal "Education of Adults"; Romanian Journal of Library and Information Science; Proceedings—Association of IT Experts, Librarians, Archivists, and Museologists; Sarajevo Journal of Social Affairs, Faculty of Political Sciences, University of Sarajevo; Journal of the Faculty of Philosophy, University of Zenica, "saZnanje"; Proceedings of the Department of Pedagogy; Proceedings—Social and Behavioral Sciences. A systematic approach was chosen for the analysis of different research perspectives on this topic, as well as for the synthesis of academic literature. Based on the research on Bosnian and Herzegovinian students, which was available, the following was noted: (1) the data show that most teacher training colleges do not develop digital literacy and digital competencies among students; (2) research is dominated by quantitative techniques and methods; (3) research lacks psychometric characteristics except for one research; (4) the level of digital competencies is mainly based on student responses through different types of tests; (5) samples in surveys are mostly not representative; (6) research results indicate that students of teacher training colleges consider digital literacy and competencies important for life in the modern age; (7) the need for

E. S. Lizde (✉) · A. Đipa · I. H. Šabanović · J. B. Karabegović
Faculty of Educational Sciences, University of Sarajevo, Skenderija 72, 71000 Sarajevo, Bosnia and Herzegovina
e-mail: eslizde@gmail.com

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research tools that could determine the level of digital literacy and digital competencies was expressed; (8) there is a strong need to modernize access to different digital platforms; (9) most of the research is based on respondents in Sarajevo Canton.

Keywords Digital literacy · Digital competencies · Teacher education study · Students of Bosnia and Herzegovina · Systematic literature analysis · Higher education

5.1 Introduction

The way of living and communication in our modern society has changed significantly under the influence of digital media. The educational process, students and teachers, as well as all those who are part of this process, are not exempt from it. Although educational institutions recognize that teachers are the most important factor in student achievement and the quality of the education system as a whole, creating a unique model of teacher qualifications that would include all initial competencies is a great challenge even for economically more advanced countries with far more organized education than it is in Bosnia and Herzegovina.

Teacher training departments at universities in Bosnia and Herzegovina are such only by name: in reality, students are mainly educated within the subjects studied within certain studies, while their pedagogical education is marginalized, just like methodical/pedagogical practice, whereas digital literacy and its achievements are particularly marginalized in this regard.

Bosnia and Herzegovina's education system is a decentralized and fragmented structure consisting of two entities and the Brčko District. Competencies are focused on the entities, cantons, and the Department of Education in the Brčko District. Due to the complicated administrative arrangement, the responsibility for education in BiH lies with the entities: the Federation of BiH and the Republika Srpska, and a separate organizational unit—the Brčko District. Within the FBiH, the responsibility has been transferred to 10 cantons. This means that in BiH 13 educational subsystems are under the jurisdiction of the Ministry of Civil Affairs of BiH. That is, the education policy in the FBiH is organized at several levels, including the federal, cantonal, municipal, and school levels, while in the RS, the centralized education management is maintained (Dedić-Bukvić, 2016).

Study programs for teacher training in the Sarajevo Canton are implemented at nine higher education institutions, i.e. at 25 study programs that educate teachers of certain profiles. Teacher training lasts a total of 5 years of study and includes undergraduate and graduate studies. Within the teaching process, students—future teachers—are prepared to work in class and subject teaching at the primary and secondary levels of education.

Teacher training departments, especially in the first cycle of study (bachelor), train future teachers to be competent in the field of science they have chosen, while only a few studies at this level already offer the content related to the future career in school (Abadžija, 2015). Curricula that educate students to be knowledgeable in general subjects, not lecturers and experts in school teaching, or even in digital media, are the result not only of the negligence of the academic community towards the professional future of such students (bachelor general) but also the decline of scientific research institutions who need such experts.

The problems with the pedagogical education of future teachers are based primarily on the undefined relationship between the core subject and the pedagogical-psychological content but also on the lack of courses focused on the development of practical teaching skills, such as pre-service school practice with mentoring. Furthermore, we encounter an insufficient diversity of content that cannot respond to the modern needs of teaching practice: an inclusive concept of teaching, teaching in an intercultural environment, and working with gifted students; then the use of modern technologies in teaching, digital competencies, digital literacy, innovations, and in particular, subject teaching methodologies, scientific and research competencies specific for researching teaching and the like.

Generally speaking, the development of digital and information literacy in Bosnia and Herzegovina is still in its infancy. In teacher education, topics related to digital competencies and media literacy are part of a very limited number of classes and their quality is assessed as modest (Tajić, 2013). Consequently, among students of teacher training colleges, as well as among teaching staff, digital literacy is still poorly developed, especially in terms of the ability to assess the reliability and quality of information.

Adaptation of teachers, who by the nature of the profession are representatives of traditional and institutional education, is not a simple process, and there is a lot of talk about it, but little discussion on this topic is based on the research processes (Mavrak and Vehab 2016).

The basics of computer literacy today are common to the majority of the population, which is dictated by the universal human need to be in contact with other people: the use of Skype, Viber, or mobile telephony belongs to everyday life regardless of age, material and social status of the average resident of a region. The everyday functionality supported in this way is unjustifiably equated with digital literacy as the ability to choose information and make decisions based on an argument choice of knowledge. When the average resident does not have the information literacy competence, his cultural and political socialization is called into question. Today we have Tablets, PCs, mobile iPod phones, mobile phones with an Android operating system to assist us in doing business. The advancement of technology day by day is inevitable, and one has to keep up with that progress if one wants to be efficient and competent in what one does. This efficiency and competence are related to the social roles of each of us because not every role insists on these competencies equally. Those, like teachers, who are responsible for educating others, cannot negotiate with the possession of these abilities. If the teacher does not have information literacy, the whole communication process of teaching is called into question, especially concerning learning outcomes. The problem of digital and information literacy has caught many education systems in the world with the question of "how to proceed", including the education system in Bosnia and Herzegovina. The concept of lifelong learning implies an educational system that will provide every individual, every moment, with the opportunity to master new functional knowledge. Information and digital literacy should become the focus of educational institutions at all levels (Grahovac and Egić 2012). Therefore, digital and information literacy of students at teacher training colleges, but also the teaching staff as holders of a large number of functions related to programs, organization, pedagogic instruction, evaluation, research, and management, should be at a very high level.

5.2 Theoretical Framework

By analyzing the available literature, concerning the given criteria, it is not uncommon to come across different terms within information and communication technologies (ICT), without having the same meaning. Thus, the texts mention digital literacy, media literacy, information literacy, digital competencies, and information competencies as synonyms. ICT is an abbreviation that most often covers the set of skills necessary for the development of digital competencies, while the areas of digital competencies, according to the Framework for Development and Understanding of Digital Competencies from 2013, are: information, communication, content development, security, and problem-solving. According to the 2006 Recommendation of the European Parliament, digital competence is considered one of the eight key competencies that develop the reliable and key use of the full range of digital technologies for information, communication, and solving basic problems in all aspects of life, where a special emphasis is put on digital skills critically and systematically.

Digital literacy refers to an individual's ability to find, evaluate, and gather clear information through writing and other media on a variety of digital platforms. Digital literacy is assessed by grammar, composition, typing skills, and an individual's ability to create text, sound, and design, using technology. The American Literary Association (ALA) defines digital literacy as "the ability to use information and communication technologies to find, evaluate, create, and communicate information, which requires both cognitive and technical skills" (Šimić and Špiranec, 2015). When researching Bosnian literature, we generally come across similar definitions. Although digital literacy was initially focused on digital skills and personal computers, the advent of the Internet and the use of social media have led to a shift of part of its focus to mobile devices. Similar to other extended definitions of literacy that recognize cultural and historical modes of meaning, digital literacy does not replace traditional forms of literacy but builds on and expands the skills that form the basis of traditional forms of literacy.

Digital literacy is based on the growing role of the social sciences in the field of literacy, as well as on the concepts of visual literacy, computer literacy, and information literacy. In general, digital literacy has become an increasingly popular term in education and higher education institutions and is used in both international and national standards.

By reading the texts available to us, we found that higher education students are most often taught literacy skills, such as how to check credible online resources, list websites, and prevent plagiarism. Google and Wikipedia are often used by students "to explore everyday life", and these are just two common tools that facilitate modern education. In addition to these, a smaller percentage of higher education students use platforms/applications such as Google Classroom, Messenger, and Zoom, although Edmondo, WhatsApp, Microsoft Teams, Microsoft Office 365, Skype, Jitsi Meet, Webex Meet are also in use. The fact is that these platforms have largely started to be used due to the danger of the spread of coronavirus (COVID 19) when regular teaching has been replaced by an alternative form of teaching, i.e. "online teaching with the use of information and communication technologies".

Closely related to digital literacy are digital competencies. The notion of competencies has a certain rhetorical appeal, and it implies a diversion of attention from exclusively what the teacher needs to know to what he can do. The idea of competence is practical and more holistic because it encompasses knowledge, skills, and activities into a single whole. Competencies are, simply put, what people who complete a particular study can do, that is, the knowledge, abilities, and skills that an individual can demonstrate after completing a program or study, and they can be referred to as learning outcomes. Digital competence is the key to learning, working, and actively participating in society. It is not only important for higher education to understand the competence itself but it is also important to know how to help develop that competence. In the analysis of the Center for Policy and Management, called Initial Education of Subject Teachers in BiH, Abadžija (2015) points out that these areas are based on the knowledge and skills that one must acquire to become a literate person: general knowledge and functional skills; knowledge of the basics of digital devices and their use for basic purposes; ability to integrate digital technologies into activities in everyday life; specialized and advanced competence for work and creative expression; the ability to use ICT to express their creativity and improve professional performance; technology-mediated communication and collaboration; the ability to connect, share, communicate, and collaborate effectively with others in the digital environment; information processing and management; use of technology to improve the ability to collect, analyze, and judge the relevance and purpose of digital data; be able to protect their privacy and take appropriate security measures; behave appropriately and in a socially responsible manner in the digital environment, and be aware of the legal and ethical aspects of the use of ICT; demonstrating an informed, open, and balanced attitude towards the information society and the use of digital technologies; understanding and awareness of the role of ICT in society, as well as understanding the broader context of the use and development of ICT; research of new technologies and their integration; knowledge of the most relevant or common technologies; reliable and creative application of digital technology to increase personal and professional efficiency and effectiveness.

The mentioned competencies are based on each other. The first three represent the basic knowledge and skills that one must have in order to be a fully digitally literate person. Once these three competencies are acquired, the others can be upgraded with the mentioned knowledge and skills.

The situation we suddenly found ourselves in during the past months meant the transition to an online model of teaching at all levels of education. This model has caught the educational system and all its actors in Bosnia and Herzegovina totally unprepared. It was difficult to provide digital devices or a stable internet connection for teaching in the same capacity. At the same time, it was a good indicator of how weak the digital competencies of students, as well as those of teachers at all levels of education, were actually. According to the 2018 PISA Report for Bosnia and Herzegovina, only 32% of schools surveyed had a sufficient number of teaching facilities, of which 56% had satisfactory availability of software that improves the teaching and learning process (APOSO, 2019).

Digital and technological literacy is one of the school's most important goals for the twenty-first century. On the other hand, technology in teaching provides the possibility of efficient and innovative ways to present subject content. At first glance, it seems perfectly logical to pay special attention to the use of modern technologies in teaching within the studies that educate science teachers, which is the case at the Faculty of Natural Sciences and Mathematics in Sarajevo, through the courses of Multimedia in Experimental Chemistry and Computers in Mathematics. However, this topic is extremely important for other teaching areas as well, for example in teaching a language, where modern phono equipment can contribute a lot to language teaching, and it is similar to art subjects, such as fine arts and music. These specializations do not offer such courses within the faculty curriculum, and possible reasons are, in addition to not recognizing the importance, poor equipment in classrooms at colleges, but also in school premises in most schools in Bosnia and Herzegovina, and also the lack of staff in this area.

Digital literacy as a competence that supports and develops critical thinking and functional literacy should be a mandatory part of all programs for future teachers.

Namely, as well as critical thinking and functional literacy, it is not acquired and developed by content, but with approach and methods.

Some of the teacher training colleges have classes dedicated to media literacy within the language and pedagogical education and/or as an elective subject Media Culture. Other teacher education programs do not significantly include the development of digital competencies, except for two departments of journalism at the Faculty of Political Sciences, which have the subject of Media Literacy (Dedić-Bukvić, 2016). Stimulating critical thinking, access and use of information skills, and the use of information technology, for example, are mentioned among the components of modern teaching in the Republika Srpska Education Development Strategy for 2016–2021, while in the Principles and Standards in Adult Education in BiH in 2014, "the ability of adults to understand and use media and other information" is also mentioned.

In the document "Strategic directions of education development in BiH with the implementation plan 2012–2022", the need for modernization of the educational process is mentioned, including encouraging the development of digital competencies. Only 20 lessons during primary education are dedicated to topics related to media literacy, within school subjects such as native language, art education, and informatics, and in secondary schools, digital literacy is part of the subject Democracy and Human Rights, with two lessons dedicated to freedom of expression and two lessons dedicated to the role of the media in democracy (Tajić, 2013). At the universities in Bosnia and Herzegovina, within the framework of teacher training studies, the presence of courses belonging to the ICT group of subjects is very scarce. For these programs, we can only assume that their curricula develop digital literacy and digital competencies of students.

Namely, civil society organizations are so far the only social sector in BiH that has been active in the development and implementation of various educational programs, research, and raising awareness in this area. Civil society organizations have so far organized numerous short-term training, primarily for pupils, students, and educators. Among the first training marked as IT, literacy training in BiH were media literacy clinics for university students, organized by Internews in BiH, in 2013 and 2014 (Hodžić et al., 2019).

5.3 Research Methodology

5.3.1 Research Procedure and Technique

For this research, we used manual search, to detect relevant studies in database searches. Manual search, also called "hand search" (Chapman et al., 2010), refers to reviewing the entire content of individual journals or conference proceedings for a number of years.

Manual search can be useful, in addition to searching electronic databases, for at least two reasons:

1. not all research reports are contained in electronic bibliographic databases;
2. even when they are, they do not have to contain relevant search terms in titles or abstracts, nor must they be included with terms that allow them to be easily identified as research; Dickersin et al. (1994).

In addition to this, we also used electronic database searches: Central and Eastern European Online Library (CEEOL) and ScienceDirect (Procedia-Social and Behavioral Sciences). The following databases were found, searched, and analyzed within CEEOL:

1. Journal "Education of Adults";
2. Romanian Journal of Library and Information Science;
3. Proceedings - Association of IT Experts, Librarians, Archivists, and Museologists;
4. Sarajevo Journal of Social Affairs, Faculty of Political Science, University of Sarajevo;
5. Journal of the Faculty of Philosophy University of Zenica -"saZnanje";
6. Proceedings of the Department of Pedagogy;

7. Procedia—Social and Behavioral Sciences.

A systematic approach was chosen for the analysis of different research perspectives about this theme, as well as for the synthesis of academic literature (Booth et al., 2012).

Systematic literature reviews are scientific investigations in which the unit of analysis is the original primary studies. These are used to answer a clearly formulated question of interest using a systematic and explicit process. For that reason, systematic literature reviews are considered to be secondary research ("research-based research" (González et al., 2011). By reviewing relevant literature, we understand the breadth and depth of the existing body of work and identify gaps to explore (Watson & Xiao, 2019). The literature used in this analysis was collected in the period August–September 2021.

Two databases were used in this systematic literature review: CEEOL and Procedia-Social and Behavioral Sciences. In the first systematic review, the following search keywords were used: (i) "digital competence", "digital literacy", "students", "Bosnia and Herzegovina". Only one article that included all the listed terms was found.

In the second systematic review, the following search terms were used: "information and IT competencies" and "teachers". The studies identified through the database had to meet a set of relevant inclusion criteria based on which they would be included in the analysis.

Searching for empirical studies that, in addition, had to be written by researchers in Bosnia and Herzegovina, exclusively in Bosnian/Croatian/Serbian, we came across interesting data within the "grey literature" (Savin-Baden & Major, 2013). However, we did not consider these sources in the analysis, as well as book chapters, dissertations, short papers, government and research reports, and conference proceedings. Also, one of the predictors for the analysis was that the research included students of teacher training colleges, i.e. those who opted for the teaching vocation to be their profession. Precisely because we were limited in our research and analysis, and due to the extremely small number of scientific articles on digital literacy and digital competencies, we took into account some studies that question the digital competencies of teachers already working in schools.

In this paper, we have defined the criteria for including and excluding publications selected for the review process. The inclusion criteria were: researchers from Bosnia and Herzegovina, studies published between 2000 and 2020, and only empirical studies. Exclusion criteria are as follows: articles published before 2000, theoretical work without empirical results, books and book chapters, conference proceedings, short papers, grey literature (Table 5.1).

One of the originally planned criteria for exclusion was determined by the answer to the question: does a certain study deal with the digital literacy of students who aspire to pursue the teaching profession? However, as already mentioned, we did not find any research that examines the digital competence of students/future teachers who are at the initial level of education, but only IT literacy of teachers already working in schools and students of other fields (e.g. communication). Due to the

Table 5.1 Criteria for systematic analysis of literature

Criterion	Included	Excluded
Databases	CEEOL and Science Direct	Web of Science, Scopus
Timeframe	From 2000 to 2020	Research done before the year 2000
Focus	Only empirical studies	Theoretical papers without empirical results
Type of publication	Proceedings, articles published on the Internet	Books, book chapters, conference reports, editorials
Language	Bosnian/Croatian/Serbian, English	Other languages

above mentioned, we abandoned the inclusion of this exclusion criterion, because we would be left without a basis for conducting further research process.

5.4 Results

5.5 Discussion

Analyzing the literature and, unfortunately, a small number of research papers, general conclusions can be drawn regarding digital literacy and digital competencies of teacher education students in Bosnia and Herzegovina. Young people predominantly use new media and social networks, regardless of education or orientation. The most popular social networks among students are Facebook and Instagram. Most students are considered media and information literate. It is worrying that more than half of the students (surveyed through the above-mentioned research) have never used fact-checking portals and that most of them check the information only in one additional source eventually (Table 5.2).

Digital literacy and IT competencies enable class and subject teachers to search, collect, store, present data and information, apply information technology in teaching as well as in other educational activities, create distance learning programs, and create digital teaching materials. The presented data indicate that most teacher training colleges in BiH do not develop digital literacy and digital competencies.

Based on the analysis of existing articles, it is very difficult to believe that teachers who complete study programs at universities in Bosnia and Herzegovina have developed digital and IT competencies. Ultimately, BiH's education policy needs to harmonize the requirements set by the European Higher Education Area for higher education institutions. This means establishing a better link between higher education and the changing needs of the labor market in line with competitive economic relations at the global level so that higher education institutions can contribute to building European societies and knowledge economies.

Based on one presented survey, we found that teachers consider media and information literacy an important competence for life in the modern age, as well as that

Table 5.2 Summary of results of systematic literature analysis

Authors (year of publication)	Scope of research (number of respondents, the year of research)	Research techniques that are used, psychometric features, measuring areas, number of research items	Source of data	Results
Ivanković et al. (2018)	The research was undertaken among 807 students from different study groups, both undergraduate and graduate levels 2013	The research was done anonymously, and the used questionnaire consisted of two parts. The first part was related to students' personal characteristics, their habits of using and working on the computer, whereas the second part consisted of a test that contained 15 questions. Each of the 15 questions from the ICT literacy test was individually presented via frequencies and percentages according to the accuracy of the responses of the test specimen. Tested variables are presented as descriptive statistics, with the arithmetic median (age), and the frequency and percentage. For testing the connection between ICT literacy with some characteristics of the sample (age, years of study), and habits of using a computer was used correlation according to Spearman	*Procedia—Social and Behavioral Sciences*	The study has shown that 98.51% of respondents use the computer and only 1.49% do not. Students of Faculty of Philosophy, University of Mostar usually use the Internet for communication and email browsing (49.20%), for finding different types of documents and information (43.25%), entertainment and amusement (38.91%), and learning (19.83%) The highest correlation of ICT literacy is with a student's self-assessment about their understanding of computers and computer technology. Students with higher self-assessments scored higher results on the ICT literacy test. Then, the amount of time spent at the computer positively correlated with ICT literacy, i.e. students who spend more time at the computer have higher scores on the test. Also, self-assessment of their own ICT literacy was associated with performance on the test. Students who considered themselves ICT literate had higher scores on the ICT literacy test. Lower positive correlations were found for the relationship between age and years of study with ICT literacy, older students and students of higher years of study achieve higher scores in one degree on the ICT literacy test. The results of the conducted study have shown that more systematic and institution-wide approaches are needed to raise the level of ICT literacy among students

(continued)

Table 5.2 (continued)

Authors (year of publication)	Scope of research (number of respondents, the year of research)	Research techniques that are used, psychometric features, measuring areas, number of research items	Source of data	Results
Dedić-Bukvić (2016)	25 curricula (University of Sarajevo) and 25 departments that prepare future teachers for educational work 2016	Work on documentation or content analysis	*Education of adults*	The data obtained in this research indicate that most teacher training colleges at the University of Sarajevo do not develop information and digital competencies for future teachers
Mavrak and Vehab (2016)	The target sample in this study was 81 respondents. 2016	The testing technique was used in the research. For the purposes of this research, the measuring instrument was taken from the educational program of the computer school "NIMIKO" 6 and supplemented with new items created with the support of the "component permeation model" as the basic theoretical concept of the research. The test consisted of two parts. The first part of the test examined the computer literacy of teachers, and the second part the information literacy. The IT literacy test gathered 21 questions distributed in seven areas that are relevant for IT literacy and was taken from the official website of the computer school "NIMIKO". The test has examined all metric characteristics. The information literacy test defined with the help of the "component permeation model" consisted of a total of 11 questions, divided into four areas: content, skills, evaluation, and an educational component. Verification of the statistical significance of differences in the obtained results was done by t-test for independent samples and analysis of variance at two levels: basic analysis using the Scheffer procedure and post-hoc analysis with a search for p-values	*Education of adults*	The researchers used a comparative method and testing technique to find that teachers achieve better results on the computer literacy test compared to the information literacy test. Also, the research showed that there are no statistically significant differences in the level of IT literacy of teachers who teach and work in Kakanj and teachers who teach and work in Sarajevo, regardless of socio-economic differences in these two environments. The results showed that there are no differences in the level of IT literacy of teachers concerning gender and that there are no differences with the subject area that the teacher teaches in school. The research, however, showed that there are differences in the level of IT literacy of teachers concerning their age. On the information literacy test, teachers achieved the weakest results within the skills component and then within the evaluation component, while the results were slightly better within the education component. The best results in information literacy were achieved by teachers on issues dealing with the content component

(continued)

Table 5.2 (continued)

Authors (year of publication)	Scope of research (number of respondents, the year of research)	Research techniques that are used, psychometric features, measuring areas, number of research items	Source of data	Results
Musa and Dizdar (2018)	The total number of respondents is 273, of which 37% are male and 63% are female. The research involved first, second and third-grade students of the Grga Martić Gymnasium and the International Private Gymnasium Mostar, as well as second and third-year students from the study of information sciences and the study of the English language and literature at the Faculty of Philosophy, University of Mostar	A Questionnaire to assess difficulties during the research process. The questionnaire consisted of 20 questions about difficulties during the research work and the approach to the research work. Each statement is graded on a Likert-type scale from 1 to 5, where 1 is very difficult and 5 is very easy. For this research, the questionnaire was shortened to 10 questions. The reason for this is the practicality of application, the Information Competency Assessment Instrument (Welsh and Wright, 2010). The original version of the questionnaire contains 40 claims related to the ability to find information when writing research papers. For this research, the questionnaire was shortened to 20 particles, where each of the factors contains two particles. The reason for this is the practicality of application. IT literacy test. The test consisted of 15 questions and for each question, there is a correct answer. The maximum number of points that can be achieved is 15	*Proceedings—Association of IT experts, librarians, archivists, and museologists*	The results indicate that the respondents who were included in this sample were mostly at the intermediate level of information and computer literacy

(continued)

Table 5.2 (continued)

Authors (year of publication)	Scope of research (number of respondents, the year of research)	Research techniques that are used, psychometric features, measuring areas, number of research items	Source of data	Results
Šejtanić (2018)	Teachers in the lower grades of primary school (N = 103)	The technique used refers to a questionnaire that explored ICT through indicators of information, communication, content development, security, and problem-solving in ICT	*Proceedings of the Department of Pedagogy*	The results show that teachers are familiar with the basics of information literacy, but that in order to move to a higher level of critical assessment of information, it would be necessary to continue their professional development Throughout the realization of the teaching process, teachers largely use computers and modern ICT, they possess the competencies necessary to create digital content, but still not to a sufficient extent They are aware of possible abuses of the Internet and the need for security (M 4.14 and M 4.0), but still are not sufficiently aware of how to protect your computer and your personal data (M 3.81 and M 3.83) Teachers most often use digital technology for some easier and simpler actions, while higher levels of knowledge are still unattainable for most. The obtained results indicate that teachers in 42.33% of cases only "sometimes" solve digital problems

(continued)

Table 5.2 (continued)

Authors (year of publication)	Scope of research (number of respondents, the year of research)	Research techniques that are used, psychometric features, measuring areas, number of research items	Source of data	Results
Cerić et al. (2018)	N = 416 respondents, of which 226 are employees (teachers and librarians) of primary schools and 190 are employees of secondary schools. In the total sample of 416 respondents, 80% of the respondents are female, while 19.2% are male. It was a stratified multi-phase random sample within which the first stratum consists of municipalities, and the second number of students enrolled in primary and secondary schools	The technique of self-administered survey and a questionnaire that is distributed to the target population in the form of face-to-face or by individual completion of the questionnaire and via the Internet (online) link, i.e. surveys that could be accessed by respondents who were not selected to the control group. The survey questionnaire was divided into three parts: Part A had six questions related to the sociodemographic characteristics of the respondents. In Part B, the measuring instrument gained insight into attitudes about the current concept of media and information literacy through seven questions measured by the Likert scale and one question about the attitude on how media and information literacy in formal education should be taught. The last part, (part C) of the survey questionnaire, was aimed at examining the attitudes and opinions of respondents about their own competencies for teaching MFA in primary and secondary schools, which was done through 20 Likert-type questions where respondents were expected to express their agreement or disagreement with the views offered. According to the above, the survey questionnaire had a total of 34 questions. Statistical analyses were of a descriptive type, i.e. a univariate (distribution of answers) analysis of the collected data was performed	*Sarajevo Journal of Social Affairs*	The results indicate that teachers consider media and information literacy an important competence for life in the modern age, as well as that it encourages critical thinking, and thus functional literacy. Teachers believe that they know the concept of media and information literacy, but they still need additional education in terms of teaching students. The views are that media and information literacy should be part of existing courses and not a separate course and that to some extent, content in the field of media and information literacy is already taught in schools, but often not in a way that would have a desirable learning outcome for students. In their opinion, schools have technical and technological capacities for teaching media and information literacy, which means that special investments in equipment and working conditions in classrooms for this purpose are not necessary

(continued)

Table 5.2 (continued)

Authors (year of publication)	Scope of research (number of respondents, the year of research)	Research techniques that are used, psychometric features, measuring areas, number of research items	Source of data	Results
Hajdarpašić and Khattab (2019)	The statistical population of the study was 50 BA (excluding first-year) and MA library science students at the Faculty of Philosophy, University of Sarajevo. 42 students participated in the survey, where all 42 students provided complete answers. Of the total of 42 respondents, 87.5% were female and 12.5% male 2019	An online questionnaire was created based on the model called Permutation Model Components (PMC). The model consists of four categories: 1) Content, 2) Skills, 3) Evaluation, 4) Education. The survey was used to gather open-ended questions, as well as personal and demographic information 30 questions divided into three main categories and constructed based on the 5-point Likert scale (1—disagree, 5—strongly agree)	*Romanian Journal of Library and Information Science*	Answers provided by library students in all four categories of the PMC model indicate that in some segments library science students have low self-efficacy beliefs in terms of their information literacy competencies which certainly requires the redefining of the information literacy content delivery practices. Further steps need to be undertaken to provide appropriate delivery of information literacy-related content, maybe in terms of creating and adopting a standalone information literacy course in curricula, at the bachelor's level
Silajdžić (2020)	N = 69 students, students of the Faculty of Political Sciences, University of Sarajevo, Department of Communication 2020	Empirical data were collected using a survey questionnaire, which contained 12 questions, of which 10 closed-ended questions (with offered answers) and 2 open-ended questions	*saZnanje*	The research confirmed that young people predominantly use new media and social networks, regardless of their level of education or orientation. The most popular social networks among students of the Department of Communication/Journalism at the Faculty of Political Science, University of Sarajevo are Facebook and Instagram. The data are worrying that a large number of students who study at the department of communication never follow a particular type of media. Most students are considered to be media and information literate. Also worrying is the fact that more than half of the students have never used fact-checking portals, and that most of them check the information only in one additional source

it encourages critical thinking, and thus functional literacy. Teachers, as well as students, as respondents from the above-mentioned research, believe that they know the very concept of digital literacy, but in terms of teaching their students, they still need additional education. The views are that media and information literacy should be part of existing courses, not a separate course, and that to some extent, content in the field of media and information literacy is already studied in colleges and schools, but often not in a way that would have a desirable learning outcome for students/pupils.

According to a very small number of respondents, schools have the technical and technological capacity to teach digital literacy, which means that special investments in classroom equipment and working conditions are not necessary for this domain.

Students, as it turns out, typically use the Internet to communicate and view e-mail, to find different types of documents and information, to entertain and learn, and the greatest connection to digital competencies is found in students' self-assessment of understanding computers and computer technology.

The data obtained in this research indicate that most teacher training colleges in Bosnia and Herzegovina do not develop the digital and IT competencies for future teachers. The need to take further steps to ensure the need for lifelong learning has been recognized, and digital literacy should be one of the priorities in teaching students. The diversity of Bosnia and Herzegovina's educational reality can sometimes deceive us and create a misconception that leaves no room for progress. The situation is, of course, much more complex and serious. In the set of necessary competencies and literacy that adults, especially students of teacher training studies in the twenty-first century, have to master and transfer information literacy, which is recognized as important because it enables the acquisition of meta-competencies necessary for lifelong learning.

The state's commitment to the development of information literacy and digital competencies has not yet moved beyond the declarative recognition of its importance, and activities and strategic goals in the field of improving information literacy have never been more precisely defined.

First of all, the competent institutions have not adopted systemic solutions within the education system, which would permanently weave the goals of media and information literacy into the activities of educational institutions. Programs related to the digital competencies of teachers are still very poorly included in the higher education curricula. Through formal education programs, students of teacher training colleges are partially acquainted with various media forms and the basics of using new technologies, but there is a particular lack of effort to develop critical thinking, understanding skills, critical analysis, and production of media content among this population.

5.6 Conclusion

It follows from the above that traditional literacy, such as reading and writing, and more recently computer literacy, is not sufficient in today's conditions. Literacy for the twenty-first century introduces a new set of skills and knowledge needed for a successful and quality life in a knowledge society. Competencies that are increasingly referred to in the literature and educational strategies as a starting point for lifelong learning are called digital literacy. Given the expressed features and characteristics of information literacy, its realization is the common responsibility of many: the formal education system with emphasis on higher education, cultural institutions: libraries, archives, museums, organizations dealing with information dissemination, profitable educational institutions, international organizations, governments.

What could and should be a recommendation, in the end, is that an individual, be it a pupil, a student, or a teacher, has to master the media so that the media would not control him. Digital literacy must become an integral part of educational programs that will lead to media culture and digital competencies. Thus, it is necessary to understand the integration of digital competencies in terms of students' (or pupils' and teachers') needs in the higher education (or school) system because it leads to the overall development of media education in modern pedagogy.

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Chapter 6
Digital Competencies Among Brazilian Pre-service Teachers: An Overview

Maria Amelia Eliseo, Cibelle Albuquerque de la Higuera Amato, and Ismar Frango Silveira

Abstract The development of digital competencies is currently being considered as one of the key factors for everyday life, impacting education, professional careers, as well as the access to a full citizenship. Since these competencies are not innate and they must be developed in some period of life, it is important to investigate how teacher training courses in Brazil are dealing with them, since they are meant to be future teachers of the new generations. For this purpose, a systematic analysis of the literature (peer-reviewed articles) indexed in repositories and scientific databases such as Google Scholar, ERIC (Education Resources Information Center) and SciELO (Scientific Electronic Library Online) was used, and the period established for the search was from 2001 to 2021. It is expected these students to be fully aware of the importance of these competencies and their impacts in current and future lives. However, results have shown that such competencies are not being adequately considered in curricula or in pedagogical projects at teacher training courses. The lack of proper infrastructure in schools and the digital gaps in Brazilian society are additional barriers that must be faced by these pre-service teachers.

Keywords Pre-service teachers · Brazil · Teacher training · Digital competencies

6.1 Introduction

Brazil, a country with 220 million inhabitants and a land area equivalent to 80% of Europe, has a complex, diverse and challenging educational context. Spread among 179,533 schools that offer from primary to secondary education, there are students from different contexts—rural or urban; rich or poor; digitally well-developed or

M. A. Eliseo (✉) · C. A. de la Higuera Amato · I. F. Silveira
Universidade Presbiteriana Mackenzie, Rua da Consolação, 930, São Paulo 01302-907, Brazil
e-mail: mariaamelia.eliseo@mackenzie.br

C. A. de la Higuera Amato
e-mail: cibelle.amato@mackenzie.br

I. F. Silveira
e-mail: ismar.silveira@mackenzie.br

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excluded (BRAZIL, 2020a). The whole cycle of primary education lasts 9 years, not counting kindergarten, and to deal with these students—in fact, mainly the future ones, there are currently 1,687,367 pre-service teachers enrolled in training courses. From all pre-service teachers, 75.6% of them are women, above the national average of 60.2% of feminine concluding students (BRAZIL, 2020a).

Teacher training in Brazil is performed in HEIs (Higher Education Institutions), specifically in courses that are classified as *Licenciaturas*. Among these courses, the Pedagogy course is responsible to train those teachers that will work with students in kindergarten or the first five years of primary schools—or, in other hand, assuming some school' administrative functions. Currently, there are 742,459 Pedagogy students in Brazil, 71% of which are enrolled in distance learning courses (BRAZIL, 2020a). To act as teachers in the last 4 years of primary education, pre-service teachers are meant to be enrolled in other kinds of *Licenciatura* courses, in specific matters—History, Language, Math or Biology, for instance. The students of these courses are also able to act as teachers at the 3 next years of secondary level—in Brazil, there are 944,908 students enrolled in other *Licenciatura* courses than Pedagogy (BRAZIL, 2020a).

Despite these impressive numbers, the research on Education in Brazil is not enough or comprehensive to cover its complexity. There are 191 Master and PhD programs in Education and 184 in Teaching, as registered at Coordination for the Improvement of Higher Education Personnel (CAPES), the government agency responsible for research funding and consequently for these programs (BRAZIL, 2021). However, not sufficient research has been performed to fulfill the requirements and challenges imposed by global digital transformation processes, which made technological artifacts, devices, and systems to be part of everyday lives of common citizens, even though literature reveals that Education has proved to be one of the most reticence fields of application of digital solutions. Some authors blame teachers' natural resistance to novelties that could change their pedagogical action, but most of them agree with being the lack of adequate public policies and governmental investment the main barrier to a real adoption of technology in Education (Pinto, 2008; Schuhmacher, Alves, & Schuhmacher, 2017; Zanella & Lima, 2017). Even being the pre-service teachers—here considered as the students of all *Licenciatura* courses—belonging to younger generations, most exposed to digital technologies and extremely more aware of the need of developing digital competencies for life than in-service teachers, most of the curricular content and didactical practices at *Licenciatura* were not affected by the recent digital transformations that arose around the world in the last few decades—there is a widespread joke among Brazilian teachers that says if a teacher from the past century has been frozen and brought to life nowadays, it would be enough to him to be given a couple of chalks and a blackboard that he would be able to normally give a lecture. This reveals a complete and profound detaching of the educational environments from the "world outside"—at many schools, technology plays no role at all. Besides, the effects of the digital divide in Brazilian society (Tomczyk et al., 2019) are relevant, and they have been brought to light during the COVID-19 pandemic, when the dependency of digital technologies became more evident.

Comprehensive recent research done with in-service teachers (CETIC.br, 2019) revealed some barriers in adopting technologies in schools, which strongly affects the education of future teachers. The aspects more often cited were: lack of adequate infrastructure at schools (82% of teachers strongly complain about the insufficient number of computers per student; 78% of them do the same about the insufficient number of computers connected to the Internet; 74% refers to obsolete equipment; 70% about the Internet speed; and 67% about the lack of technical support or maintenance), absence of a proper training on adopting technology as a didactic tool (mentioned by 58% as a factor of strong hindering) and a strong pressure to cover the curricula (43% considering as a factor of strong hinder and 36% a hindering factor), without "spending time" with collateral activities are also mentioned as important barriers for the development of digital competencies by in-service teachers, with affects the perception of pre-service teachers, giving them the impression that technology is not a key factor in Education. These factors could have postponed the need for developing digital competencies by in-service teachers, which directly affected the pre-service teachers training programs, since this perception of necessity was currently barely present at schools—until COVID-19 pandemic.

The recent—and ongoing, at the time of the writing of this chapter—pandemic of COVID-19 changed completely—and maybe, definitely—the relationship among teachers including pre or in-service teachers (Araujo, Amato, Martins, Eliseo, & Silveira, 2020). The emergency of remote classes, mostly dependent on digital technologies, made students, in-service and pre-service teachers to rethink the role of such technologies in education and to build conscientiousness about the need of developing digital competencies for the current and new challenges that are to come with new scenarios that are forecast for education, like the adoption of hybrid approaches and the spreading of distance learning-based initiatives in the Brazilian context (Silveira, 2021).

6.2 Theoretical Framework of Digital Competencies in Brazil

The broad definitions for digital competencies for teachers are adopted in Brazilian contexts in different—and particular—aspects. While many works deal with digital competencies in virtual environments, like Barros et al. (2008), others focus on Distance Learning, like Cassundé, Mendonça, and Barbosa (2017). The COVID-19 pandemic brought the focus of preoccupations of digital competencies to those related to the skills mobilized during remote classes, as can be seen in the works of Sanchotene, Engers, Ruppenthal, and Ilha (2020). Nevertheless, it was remarkable the fact that the need of activating or having to develop in real time the minimal digital competencies for dealing with remote classes made many stressing factors arise in Brazilian teachers, as shown by Araujo et al. (2020).

Brazilian national guidelines for teacher training programs mention, in few parts, the need for developing digital competencies in pre-service teachers, including “the development of practices suited to the context of students, incorporating current innovations and the use of technological resources to promote learning”, “use of digital languages”, “promoting the use safe and responsible of the ICTs” and “understand, use and create digital information and communication technologies in a critical, meaningful, reflective and ethical way in the various teaching practices” (BRAZIL, 2020b).

In the Brazilian context, some frameworks are adopted by scholars and researchers—but not by national curricula—for guiding the development of Digital Competencies, but not always with a specific focus on teacher training. In this sense, Silva, and Behar (2019) present a comprehensive study about the different definitions that serve as basis for digital competencies to be developed in different educational levels, from primary school to higher education, passing by teacher training programs. Some of the most relevant frameworks cited by some Brazilian authors like the aforementioned, Bastos (2019), Carvalho, Marroni, and Tavares (2020) and Araújo, Carvalho, Ovens, and Knijnik (2021), for instance—which makes a specific study focused in one area, are systematized by Fig. 6.1.

A framework frequently mentioned in Brazilian literature is the European DigiCompEdu framework (Redecker, & Punie 2017), composed by six areas (each one corresponding to different aspects of educators’ professional activities), as follows:

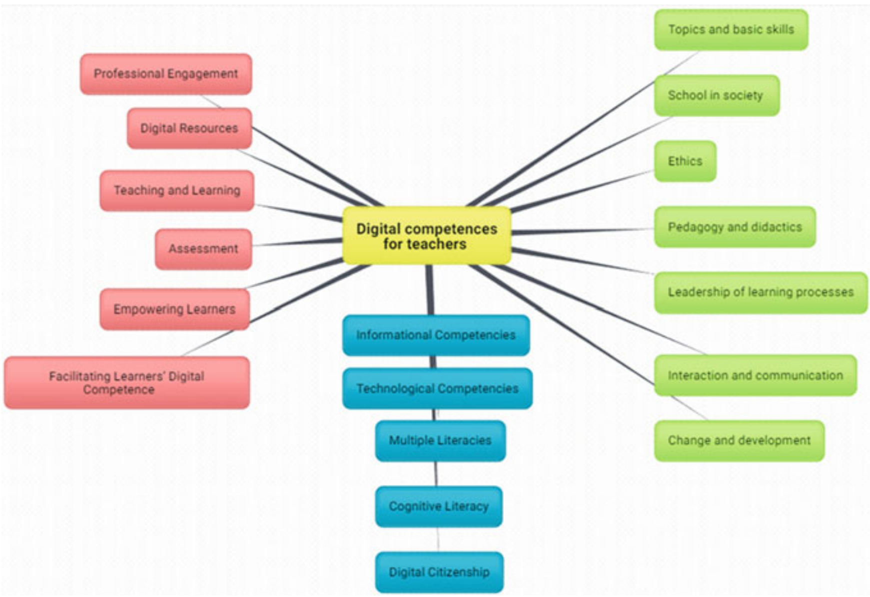

Fig. 6.1 Three different frameworks for digital competencies. *Source* Authors, based on: Redecker, and Punie (2017)—in red; Adell (2005)—in blue; and Kelentrić, Helland, and Arstorp (2017)—in green

"Professional Engagement", related to the use of digital technologies for communication, collaboration and professional development; "Digital Resources", which involves creating and sharing them; "Teaching and Learning" and "'Assessment", related to those competencies about the adoption of digital technologies directly for enhancing the execution of such activities; " Empowering Learners" relates to inclusion, learning personalization and engagement; and "Facilitating Learners' Digital Competence" is about to develop the general digital competencies on students, when in service.

Also referred, Adell (2005) brings a simpler, but wider, framework for digital competencies to be developed by teachers—all of them are strictly related to the strategies and didactical methods to develop such competencies. For this, the author mentions that vision, leadership, media and technical support are preconditions for this development.

Kelentric et al. (2017) are the authors of the last-mentioned study, whose framework brings seven main digital competencies to be shown by in-service teachers—which means that they are expected to be developed by pre-service teachers in their training process. Amongst these competencies, it is important to point out the "Leadership of learning processes", which is related to the ability of understanding different roles assumed by teachers, like tutor and mediator in a digital environment. The competence of "Change and development" is also notable, which is related to transposing already existing competencies to digital contexts.

It is noteworthy that some relevant frameworks, for instance, those presented by Wilson, Grizzle, Tuazon, Akyempong, and Cheung (2011)—which brought the well-known MIL Framework (Media and Information Literacy Curriculum for Teachers) or Law, Woo, Torre, and Wong (2018), both related to UNESCO-sponsored works, did not deal with the Brazilian context—the former one, for instance, has a quasi-worldwide coverage, except for Latin America.

The work of Bastos (2019) brings a proposal for a national framework, named TEDE, based on international ones. She organizes the digital competencies for teachers in seven different dimensions, as shown in Fig. 6.2.

Falcão (2021) and Falcão, and França (2021), in the context of teacher education, stress out the need of developing skills and abilities that goes beyond the simple use of digital technologies under an utilitarian approach. The authors defend the need of developing Computational Thinking skills (which involves the concepts of abstraction, algorithm design, pattern recognition and problem decomposition) applied to different fields of knowledge.

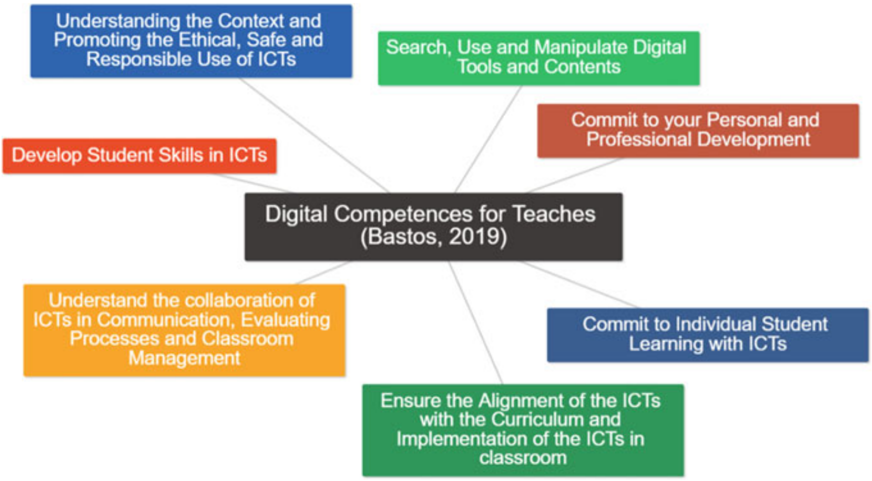

Fig. 6.2 Bastos (2020)'s framework for digital competencies for teachers in the Brazilian context. *Source* Authors

6.3 Research Methodology

6.3.1 Objective and Subject Matter

The aim of the study was to investigate the level of digital competence of pedagogy and undergraduate students in Brazil. In the Brazilian reality, these students form the majority group of future teachers, involved in pedagogical and didactic practices. The research also sought to broaden the understanding of how the digital competence of future teachers has been measured. For the investigation, databases were consulted and scientific publications in Brazilian and foreign journals based on pre-established descriptors and publication date were considered as inclusion criteria for the study.

6.3.2 Test Procedure

To answer the research question, several search criteria for scientific production were established. Keywords used both in Portuguese and translated into English were selected. The use of English aimed to expand access and considered the understanding that many Brazilian researchers have their productions published in international journals that use the English language. First, the keywords were used: digital competence, pre-service teacher, and Brazil. Considering the small number of publications found, the search was expanded with the following keywords: digital skills, digital literacy, pedagogy students, degree students and training teachers. The entire search was performed by various combinations of keywords in both languages. The period established for the search was from 2001 to 2021 and to access scientific publications, the search considered searchers of scientific texts, namely: Google Scholar, as well as the database of ERIC (Education Resources Information Center) and SciELO (Scientific Electronic Library Online) data. The search choice had as a criterion to be references to produce knowledge in national education area. The flowchart of the research procedure is shown in Fig. 6.3.

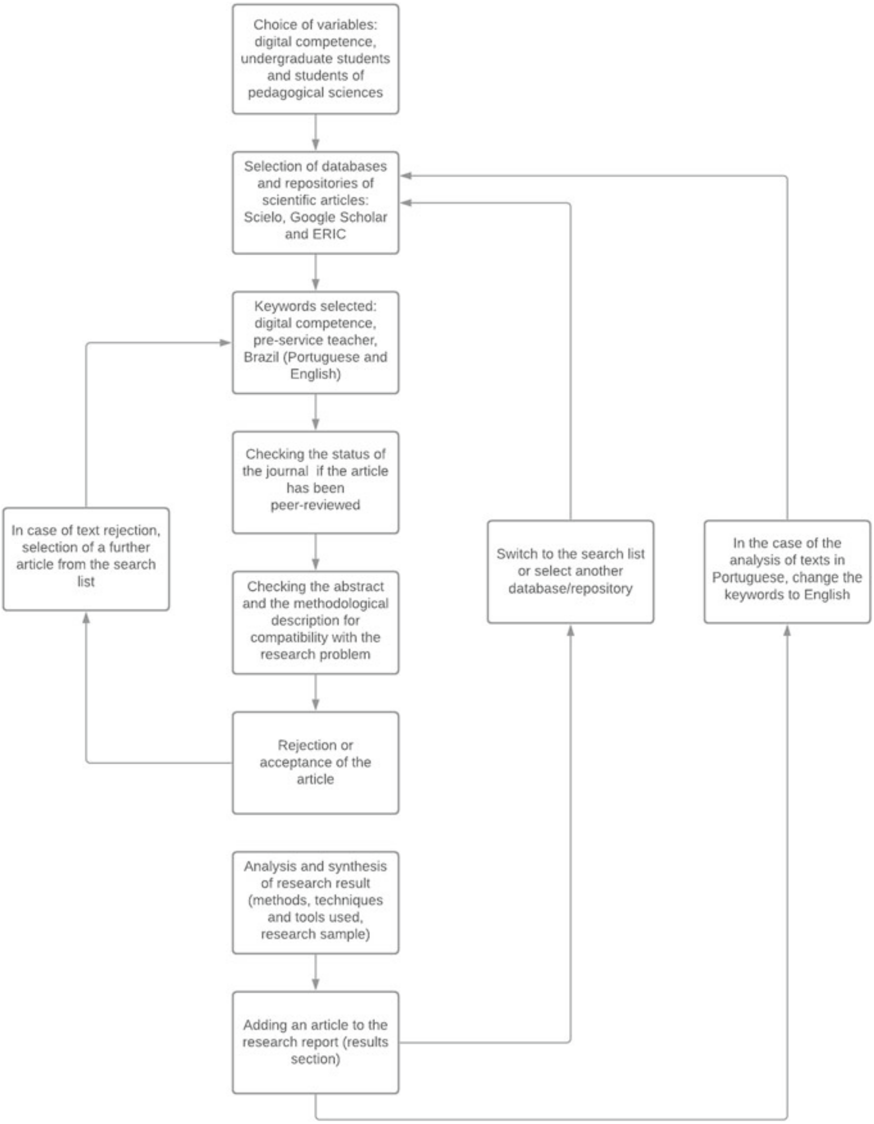

Fig. 6.3 Outline of the search procedure

The criteria established for the search and selection of scientific publications significantly reduced the number of scientific articles included in this investigation. Although the initial search provided a large number of publications, the criteria included only those studies carried out with undergraduate students, in the national context and with description of the results, significantly reduced the sample. Another relevant exclusion criterion was the criterion to select full articles published in open access journals.

6.3.3 Research Technique

The entire methodological path of the research followed pre-established criteria and described in detail. A research question was established, the search criteria, selection and description of each of the analyzed studies were defined. The analysis was carried out from the abstracts and description of the methodology used in the research. The description and detailing of the established criteria allow for the reproducibility of the study. The studies that were part of this research were presented in terms of the number of participants involved, methodology and results obtained.

6.3.4 Research Limitations

This study suffers from a considerable amount of limitations that must be clearly pointed out. First of all, the adopted search criterion was considerably narrowing, limiting the studies to be included in this analysis to those that dealt exclusively with pre-service teachers. Second, there are an important amount of works that might have not been covered by the academic databases (ERIC, SciELO and Google Scholar were considered for this study) or excluded by some other criteria. It is important to mention that relevant work that is published in Brazil in Education and Teaching is often limited to Masters' or Ph.D. thesis, books, book chapters or conferences without peer reviewing, which have been excluded from the results.

6.4 Results

The systematic literature analysis involved the study of four papers that reflect the digital competence among Brazilian pre-service teachers. The search for information about research conducted in the last two decades was conducted using a multi-source analysis of materials in digital form due to the scattering of available articles. Based on the search results, it was noticed that, in Brazil, there are few works that address digital literacy for pre-service teachers. The research emphasizes the importance of using ICT in education and the need to reflect on the integration of digital technologies in teaching and learning practices in teacher training.

Most studies were applied in Brazilian Federal Universities, in the context of the classroom. One paper addresses teacher training to teach English Language classes and another for Chemistry classes. Two of them investigated possibilities of building collaborative approaches from/to the virtual environment in the development of the technological competence of teachers in training. The research tools, mostly, were questionnaires and interviews.

A detailed summary of the systematic literature analysis including the study authors, the year of the study, the number of respondents, a description of the research tool, the theoretical framework, and the results of the study are presented in Table 6.1.

6.5 Discussion

In spite of all the articles have been written over real-world interventions, the number of students involved is low or imprecise. None of them has psychometric measures—most of them use reflexive, theoretical approaches instead of precise measures and more strict methodologies that could generate more robust scientific evidence. It must be also considered that the broad, vague definitions of digital competencies and the lack of a nationally adopted framework for defining and evaluating them could have not contributed positively for the analysis presented by these papers.

All selected articles, except one—Junqueira (2015) —were written in Portuguese and published in national journals or conference proceedings. Most of the articles deal with tangential aspects of digital competencies, but none of them brought robust conclusions about how future teachers are developing such competencies. Even though the adoption of qualitative analysis could have brought good results, maybe quali-quantitative approaches could have resulted in better, more powerful outcomes.

Discussions about the need to rethink the teacher training process are not new and are frequent. For instance, the relatively recent inclusion of the need for dealing with disabled students in inclusive education in the Brazilian context in 2015 brought a deep discussion about the need of reshaping the educational practice and proposals for teacher training—similar to what occurs with digital competencies, soft skills and so on. However, all these educational challenges are often relegated to a second plane, in a further moment, maybe in continued education programs, like post-graduation, since all of them are frequently considered additional skills, not being part of the core curriculum for teaching training. However, the recent emergency imposed by COVID-19 pandemics has brought the need for developing digital competencies as soon as possible, having in mind the emergence of hybrid models of education that are arising for a near future. In this sense, teacher training programs in Brazil need urgently to pass by profound modifications that would consider digital competencies as a part of future teachers' educational process.

Table 6.1 Summary of results of systematic literature analysis

Authors (Year of publication)	Survey area (number of respondents), survey year	Research tools used	Theoretical framework	Results—applications
Silva (2016)	Federal University of Minas Gerais—UFMG (10) 2011	Intensive experience with participants Qualitative analysis	Complexity paradigm	Explicit relationship between theoretical reflection that took place in the virtual environment and teaching action
Pereira, and Pinheiro (2020)	Federal University of São João del-Rei (2 groups) Year not informed	Questionnaire (16 questions) Vaguely specified Research items defining the use of digital resources in chemistry classes	Five-Resource Critical Digital Literacy Model	Lack of digital literacy of pre-service teachers in chemistry. Need for more collaborative educational processes between professors and students
Junqueira (2015)	Federal University of Ceara—UFC (not informed) 2014	Class experience	Lack of a clear theoretical framework	Pre-service teachers need of instructor's explicit guidance to select quality learning resources from the internet and how to transform them to develop learning materials that are appealing to the students
Mendes, and Finardi (2020)	Brazilian Primary Public Schools (six female and three male students) 2016	Questionnaires and interviews	Some notations about teacher education in the digital age	The data show that blended learning approach can provide pre-service teachers with new educational experiences that may favor reflective teacher education in relation to the integration of digital technologies in teaching and learning practices

6.6 Conclusion

This work presented a brief panorama on the development of digital skills by pre-service teachers in the Brazilian context from a systematic literature analysis. Considering the strictness of the search criteria adopted and the lack of clear guidelines in national documents for teacher training about digital competencies, only few papers were selected for analysis. Results have shown that there are some individual, localized efforts regarding the development of digital competencies with pre-service teachers in the Brazilian context. However, there is a significant lack of nationwide guidelines or national reference frameworks for this, which impacts in a negative way on the actions of implementing digital competence-driven approaches in pre-service training courses.

The emergency of COVID-19 pandemic could have accelerated the adoption of strategies for developing such competencies, since the perception of its necessity by pre-service teachers have been already mobilized by the wide advocacy in favor of remote classes brought by the social distancing and lockdown-like measures. Future scenarios for education might include hybrid approaches, and future teachers must be able to deal with new challenges that certainly will heavily depend on technological solutions, in a context where teachers' digital competencies will be increasingly more required.

The purpose of this research was limited to SciELO, Google Scholar and ERIC databases and considering articles that have been peer-reviewed, excluding master's or doctoral theses, books, book chapters or conferences without peer review. As future works, it is proposed to extend the systematic literature analysis to these publications and other databases, expanding the panorama of the study on digital competencies among pre-service teachers.

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Chapter 7
Dynamics in the Development of Digital Competence of Bulgarian Teachers

Plamena Zlatkova and Ivanka Kirilova

Abstract The current case study presents a short overview of the development and dynamics of the teachers' digital competence in the last two decades. The content analysis has identified a lot of legislative documents at a national level, related to the pre-service and in-service teachers' professional development, including in the field of ICT. At the same time, there is a need for quality assurance of the training in ICT at the university level and during the continuous teachers' professional development. This could be achieved by top-level regulation, recommendation, or standards on assessing teacher-specific digital competence before they enter into the teaching profession. The quality of continuous teachers' qualifications should also be investigated to ensure the development of teachers' digital competence and a smooth transition from face-to-face to distance learning, if needed. It is recommended for the educational institutions to conduct a training need assessment before training with the pre-service and in-service teachers so that to propose more individualized learning paths and to ensure the development of every teacher's professional digital competence.

Keywords Digital competencies · Information literacy · Students · Teachers · Education · Bulgaria

7.1 Introduction

Information and communication technologies encourage development in all spheres of life but they also place a dividing line between people and societies. Nevertheless, they have been an inseparable part of our lives for decades, and there is hardly anyone

P. Zlatkova (✉)
University of Library Studies and Information Technologies, 119 Tsarigradsko Shosse Blvd, Sofia, Bulgaria
e-mail: p.zlatkova@unibit.bg

I. Kirilova
National Institute of Justice, 14 Str. Exarh Yosif, Sofia, Bulgaria
e-mail: iva_kirilova@abv.bg

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who can imagine life without a phone, a tablet, a computer, or any other device by their side being "connected" with the world at all times and from every place.

People, however, are not born with the ability to handle technologies despite the common belief that those growing up with technologies skillfully work with them. Specific competencies need to be formed in childhood, those are to be upgraded in the period of active participation in the educational process at all levels (school and university), as well as in the process of non-formal education in order to build up the image of the professional—a teacher, a researcher, a librarian, a doctor, etc.

According to a UNICEF study, the results of which were published in 2017, the youngest among us are entering life online earlier, as the age limit is constantly decreasing, and one in three internet users is actually under age. This creates the preconditions for digital technologies to create a risk to privacy or other malicious acts (УНИЦЕФ, 2017). Therefore, the opinion that in the system of formal education it is necessary to teach knowledge and develop skills for working with information and communication technologies to build literacy (digital, information, media) comes since a necessity as ICT not only stimulate development and innovation but also contribute significantly to the dissemination of unreliable content and its creation, harassment, abuse, and other significant risks. This statement is supported by the results of a survey conducted in 2016 entitled "Online behavior of children in Bulgaria" according to which the average age when Bulgarian children are connected to the Internet is 8. This information corresponds to the disturbing: 15% have seen something disturbing in the online environment, and 87% of adolescents have profiles on social networks, and most of them are public. The study registers significant deficits in terms of children's knowledge and skills related to information assessment, safety, collaboration to achieve common goals and more.

This environment presents teachers with a number of challenges, while at the same time, they are full of a number of expectations. They need to comply with the students' interests, preferences, and learning needs. At the same time, teachers have to be innovators, apply interactive methodology, and use information and communication technologies in their daily teaching practice. The rapid development of digital technologies and the COVID-19 crisis have put additional pressure on teachers and forced them to strengthen their skills and competence. In this situation, the development of teachers' digital competence plays a key role in the quality teaching and learning in all stages of formal education. Considering these circumstances, the present case study focuses on the development of pre-service and in-service teachers' digital competence in the last two decades in Bulgaria. The methods used in the study consist of literature review, qualitative and comparative analysis of the past and present state of the problem. To investigate the topic of interest, the roots of the term digital competence will be briefly presented.

7.2 Theoretical Framework

The scientific literature on digital competence in Bulgaria exploits the term not only as a mere sum of discrete types of literacy, but rather as a set of teachers' knowledge, skills, and attitudes, abilities, strategies, and values for implementing ICT on the part of teachers in an educational environment for achieving specific educational objectives (Mizova, Peytcheva-Forsyth, & Gospodinov, 2021). The digital competence of the teacher is considered as the ability for using ICT with a good pedagogical and didactic ICT understanding, and the awareness of how this might impact the learning strategies and educational development of the students. It also includes knowledge and attitudes for using ICT, variable software, and online-based information, with a critical attitude towards the quality of resources and information, and problem-solving skills (Kaloyanova, 2020).

The UNESCO ICT Competency Framework for Teachers (ICT-CFT) is also among the concepts considered by the researchers. It highlights the importance of ICT in the teaching practice and includes six major areas:

(1) Understanding ICT in education;
(2) Curriculum and assessment;
(3) Pedagogy;
(4) ICT;
(5) Organization and administration;
(6) Teacher professional learning (UNESCO, 2011).

Another widely accepted concept in teachers' digital competence is the TRACK model, including three main components: content, pedagogy, and technology. Equally important are the interactions between and among these bodies of knowledge, represented as PCK (pedagogical content knowledge), TCK (technological content knowledge), and TPK (technological pedagogical knowledge) (Koehler & Mishra, 2009). The model is recognized and used by some Bulgarian researchers (Mizova et al., 2021).

In recent years, a complex framework for digital competence of Educators (DigComEdu) was elaborated and implemented at the EU level. It comprises of six categories, namely:

(1) Professional engagement for using digital technologies for communication, collaboration, and professional development;
(2) Sourcing, creating, and sharing digital resources for educational purposes;
(3) ICT managing and orchestrating the use of digital technologies in teaching and learning;
(4) Using ICT technologies in the field of assessment;
(5) ICT implementation for empowering learners' active engagement, motivation, and personalization;
(6) Facilitating learners' digital competence (Redecker, 2017).

Despite its complex and thorough base for the teachers' digital competence, DigComEdu is still considered and reviewed only in the scientific literature in

Bulgaria. The concept of key competence is the leading framework in the Bulgarian educational system. It forms the basis of the law for pre-school and school education. One of the competencies identified in this framework is digital competence. It is related to the confident, critical, and responsive use of, and engagement with, digital technologies for learning, at work, and for participation in society. Digital competence also includes information and data literacy, communication and collaboration, digital content creation (including programming), safety, (including digital well-being and competence relating to cyber-security), and problem-solving (European Parliament, 2006). This concept is widely accepted and used in the Bulgarian legislation related to teacher training at a national level. It regulates the preparation of the pre-service and in-service teachers, and the continuous teachers' professional development.

7.3 Methodology

The article presents desk research of the literature review concerning the digital competence of Bulgarian teachers in the last two decades. Its methodology includes content analysis, comparative analysis, and the case-study method. The theoretical background includes a short review of international scientific resources and leading concepts in the field of digital competence. Detailed information and a comprehensive review of the legislative documents in the field of teachers' digital competence in Bulgaria provide the context of the study. A significant part of the article reveals the studies of prominent Bulgarian researchers in the field of digital competence among students and teachers. Another important source of information contains data from non-governmental organizations and stakeholders interested in developing digital competence among teachers and students. The above-mentioned resources provide a solid base for analysis of the past and present state of the development of digital competence of Bulgarian teachers.

7.4 Research

7.4.1 Research on the Development of Teacher-Specific Digital Competence Before Entry to the Profession

As stated in Eurydice Report (European Commission, 2019a), in Bulgaria, teacher-specific digital competence is subject to regulations by top-level national authorities. This approach stems from the last decade of the twentieth century. According to the national regulation for the state requirements for the acquisition of professional qualification "teacher" from 1995, one of the compulsory scientific disciplines is audio-visual and information technologies in education. The minimum academic hours to successfully pass the above-mentioned discipline are 60. The training sessions in this academic subject are conducted by habilitated professors in the respective field. This approach is consistent in the next legislative regulation from 2016. The new regulation, which has been in force since the academic 2017/2018, postulates that the preparation of pre-service teachers includes compulsory scientific disciplines, one of which is information and communication technology in education and work in a digital environment. The minimum academic hours for this discipline are 30. The future teachers have also the opportunity to upgrade their professional preparation by selecting one of a few compulsory scientific disciplines, among which are digital competence and digital creativity (30 academic hours). A positive trend in this regulation is the fact that the teachers' competence is described in detail concerning knowledge, skills, and attitudes (including the application of ICT in education). The state requirements for digital competence of the teachers are further developed for pre-school teachers, primary school teachers, teachers on different academic subjects, and resource teachers.

At a university level, there are master-degree programs on information and communication technologies in education. Sofia University St. "Kliment Ohridski" proposed this program in 2010. Such a program is available at the University of Veliko Tarnovo "St. Cyril and Methodius". Plovdiv University has a master's program in distance learning, while South-West University "Neofit Rilski" in Blagoevgrad, Trakia University in Stara Zagora, and the Konstantin Preslavsky University of Shumen have developed a specialized master program for ICT in primary school. There is also a specialized bachelor program, including ICT, for example, "Primary school education and ICT" in the Konstantin Preslavsky University of Shumen.

As for the evaluation of digital competence, there are no special requirements or regulations regarding the assessment of future teacher-specific digital competence. In the scientific literature, the level of digital competence of pre-service teachers is usually researched and analyzed through performance assessments, tests, or self-assessment questionnaires (Тилева, 2019).

A self-evaluation survey was conducted by researchers from Trakia University in the spring semester of 2015. The empirical study focused on how students evaluate themselves about their own level of computer knowledge and skills, and the survey included questions for students' self-evaluation of their own level of knowledge and skills for work with information technologies for processing various types of information and for preferred mobile and web applications. The results showed that 38% of the pre-service teachers evaluate the level of their digital competence as excellent, 55% as very good, and 5% as good. Only 2% of the students rate their digital competence as satisfactory, while no students are describing their competence as unsatisfactory. Compared with the results of the test, the same student showed different results—only 12% performed an excellent level of digital competence, 25%—very good, and 37%—good (Branekova, 2015). The percentage of sufficient and poor level of digital competence of pre-service teachers is equal—13%. Judging from this perspective, Branekova proposes the necessity of training for catching up at the basic level of computer knowledge and skills, needed to form the future teachers' professional digital competence. The author also suggests integrating computer knowledge and skills in the framework of a common model of information processing. The computer knowledge and skills should also be related to a specific subject matter—profile training of students through assignments such as projects, course portfolios, didactic materials, etc. (Branekova, 2015).

In 2016, within the project NAVIGATE Information Literacy: A Game-Based Learning Approach for Avoiding Fake Content, a study was conducted on the level of digital competencies of humanity students at the University of Library Studies and Information Technologies (ULSIT). In examining the digital competencies of students from ULSIT through the Europass Digital Competences—Self-assessment grid, the Navigate team received data, which defines the educational needs of the present and the near future. The small percentage of the 111 respondents who completed the form (42.3%) shows that Bulgarian students are not ready to evaluate their digital competencies.

The analysis of the data shows that 27.7% of the students, despite the everyday use of a computer or a smart devise, have only basic skills in Information Processing. The biggest group of ULSIT students (66%) claims that they can use different search engines and filters to find information in the Network. Assuming this is true, their students' work shows, despite the results, that they can hardly compare and classify the information from different Internet sources. Only 6.4% of the ULSIT students can use advanced search strategies, can evaluate the information by different criteria, and can use retrieval systems and cloud technologies.

The communication skills are very well balanced between the three groups (Basic, Independent, Proficient user). 38.3% can communicate with others using mobile phone, Voice over IP (e.g. Skype) e-mail, or chat. They can share files and information under certain rules and can use digital technologies to interact with government institutions, banks, hospitals, etc. 34% feel they are independent users, which is normal given that students use their digital competencies primarily to communicate with each other and with their groups of interest. The same is the reason of self-assessment of 25.5% of the student as a proficient user, despite the fact that in Bulgaria, the level of public services and online teaching is not so developed as e-banking and online shopping. The close borders of the three groups and the imbalance of the digital development of Bulgarian digital society can be considered the reason for the lack of response in 2.1% of the participants.

68.1% evaluate their skills in content creating as basic, 31.9% consider themselves as independent users and nobody as a proficient user. Content creation is an important part of the digital competencies of today's students. However, the answers are diametrically opposed to those in question № 1 for Information possessing—27.7% basic users and 66 independent ones. This means that the respondent group from ULSIT uses their digital skills more as consumers than as creators of information in the digital environment. The lack of self-identification as professionals, which is also explained by the respondents' profile, confirms this opinion.

48.9% of the respondents are not too concerned (basic user) about the security of the devices they use. 36.2% install, run, and update security software on their own (independent user). They use security measures related with their profiles and passwords and can identify spam and scam massages. They claim to understand the impact of new technologies on people, society, and nature. 12.8% claim to be professional users in relation with digital security. This can be explained by the frequent media speaking in the field of Internet security. As in Question No. 2, we have 2.1% with no answers.

63.8% of the responding students can solve only basic problems in regard to using their digital devices. This percentage confirms that humanitarian students in Bulgaria are more likely to be consumers or rely on someone else's help in using digital devices. The level of independent users (21,3%) is the lowest in the poll but the level of the proficient users (14,9%) is lowest among the five questions, which can be explained by the use and combining of hardware and software from different generations as well as with the relatively frequent use of pirated software in Bulgaria.

First of all, it should be noted that a large number of students (57.7%) did not answer the questions, and the other answers are quite divergent, which speaks about the lack of self-assessment skills. The most trained respondents from ULSIT are in the field of communication and security (Safety). The average level of digital competence is the best in information processing and the lowest in computer safety. The basic level of knowledge is above average in content creation, safety, and solving problems. The most balanced situation is in the field of communication where students show a medium and high level of competency. The average level for the five categories shows us that 49.38% of the respondents have basic skills, 37.8% have medium skills, and only 11.9% own the culture of independent consumers, which also emphasizes the consumer attitudes of Bulgarian humanitarian students towards the global network.

The results are not only similar to those of teachers-to-be but are also directly related to the deficits registered in the school education system in Bulgaria and generally outline the need for educational policies to increase the competencies of students in the university education system (Encheva, Zlatkova, Tammaro, & Brenner, 2019).

Similar results are reported by Tileva in her dissertation theses. The pre-service teachers demonstrate high self-evaluation rates, which are not relevant to their digital competence, demonstrated on test items. The researcher concludes that even the most proficient students need to upgrade their knowledge and skills in the contextual application of digital technologies and objects concerning the confident use of ICT pedagogical-based approaches (Тилева, 2020).

Another useful dimension in the given research field is the pre-service teachers' attitude and willingness for using ICT, as a condition for the development of their digital competence. Attitudes toward online learning are a subject of a study, developed by researchers from Sofia University. It showed that most pre-service teachers have a positive attitude towards online learning. The finding implies that future teachers are more likely to accept it well as a mode of education. The majority of students (more than 50%) report using ICT not only in their everyday life but would also like to use ICT actively in their education. The authors also conclude that students' skills and experience to work with specific technologies and web applications in an educational context is a significant predictor of their attitude towards online learning (Peytcheva-Forsyth, Yovkova, & Aleksieva, 2018). Identifying the positive trends in this survey, it is interesting to determine whether these results remain unchanged during COVID-19, given the fact that future teachers were forced to learn online. An insight into this problem is given by a survey presented by researchers from Sofia University "St. Kliment Ohridski". It shows that students have no previous experience of online courses or other types of distance learning courses. At the same time, all students have personal digital devices and access to the Internet. The future teachers also demonstrated a positive attitude toward learning in a digital environment. The main advantage of online learning, according to the pre-service teachers, is the opportunity to learn from anywhere (almost 70%). The other popular options include the opportunity to learn at your own pace, and saving time and travel costs. The main disadvantages identified by the students are the lack of personal contact with the tutor and peers, as well as the overload with training activities. As a whole, the students expressed a positive attitude toward learning in a digital environment (Peytcheva-Forsyth et al., 2021). This might affect the development of their digital competence and the use of ICT in their future teaching practice.

In summary, the teaching profession in Bulgaria is not a regulated profession, but there are core professional competencies, required to become a teacher. They are regulated at a national level by state ordinances, regulations, and state strategies. The basic knowledge and skills are integrated into the initial teacher education programs. Higher education institutions have the autonomy in developing and delivering the content of the curriculum. As stated in the Eurydice Report, there is no specific digital framework for teachers. Digital competence is referred to in the requirements governing qualified teacher status and must be developed during the initial teachers' training in Bulgaria. At the same time, there is no top-level regulation or recommendation on assessing teacher-specific digital competence before they enter into the teaching profession (European Commission, 2019a). This trend affects the quality of university teaching at a national level and has a significant impact on continuous teacher professional development.

7.4.2 Research on the Development of In-Service Teachers' Digital Competence in Bulgaria

Continuous teachers' development is regulated at a top national level. One of the national regulations from 1996 defined it as a permanent process, which includes different forms for training and improving professional development. The Act postulates that the teacher preparation should reflect the teachers' interests and gives opportunities for the acquisition of new methods and techniques for training, support, and consultations of students (Министерство на образованието и науката, 1997). This regulation is repealed in 2016. The new national ordinance for the statute and professional development of teachers, directors, and other pedagogical specialists identifies in detail the main functions of the teachers, senior teachers, and head teachers in the different educational institutions. It also describes the knowledge, skills, and attitudes of the teachers according to their functions. One of the skills, required for the teachers in kindergartens and schools, is to implement information and communication technologies, to motivate students, and to develop their digital competence (Министерство на образованието и науката, 2016a). To meet these requirements, the teachers are obliged to continuously develop their professional qualifications. This process includes initial training (for example: for inexperienced teachers, or when there is a major reform in education). It is conducted at an institutional level, and the director assigns a mentor-teacher to the newly appointed teacher. Continuous teachers' professional development includes different forms of training or research activities. At an institutional level, the teachers are obliged to have at least 16 h of training per year. During the 4-year attestation period, in-service teachers should also attend courses in universities, or other educational institutions for at least 48 h (Министерство на образованието и науката, 2016b). The topics are a subject of teachers' choice and could be specialized in training in information and communication technologies. The last national regulation from 2019 further develops these ideas and postulates that teachers should apply interactive methods, information, and communication technologies in teaching. Moreover, amongst the functions of the teachers are effective uses of digital technologies (Министерство на образованието и науката, 2019).

At a national level, there are also numerous initiatives in the field of continuous teachers' training. There is a national strategy for the development of pedagogical staff (2014–2020). One of the measures in this strategy is providing training for continuous development of the key teachers' competencies, including digital competence (Министерство на образованието и науката, 2014). Another measure, proposed by the Ministry of Education and Science, is the national program, information and communication technologies in the system of pre-school and school education proposed for the sixth consequent year. Its general aim is to improve the quality and opportunities for e-learning in the system of preschool and school education, access to modern information and communication technologies, implementation of innovative modern teaching methods, and creating conditions for training of pedagogical specialists for their use (Министерство на образованието и науката, 2021). A specific aim of this program is to create a digital innovation center for continuing qualification of the teachers with the means of ICT. There is also a Strategy for effective implementation of ICT in education and science in the Republic of Bulgaria (2014–2020), which gives directions for the future development of teachers.

Providing the educational policy, it is important to investigate the teachers' participation rate in courses for continuous professional development in the field of ICT, and consequently the level of in-service teachers' digital competence. Within the framework of the "Science and Education for Smart Growth" operational program, the Ministry of Education and Science in Bulgaria undertook to lead a 3-year project (2018–2020) aimed at improving in-service teachers' specific digital competence through relevant training. The main focus of the program is on shaping the digital competence needed for teaching and learning and on the use of innovative technologies, interactive methods, and tools in the educational process (European). Following this direction, the Strategy for effective implementation of ICT in education and science in the Republic of Bulgaria (2014–2020), based on EU research in 2011–2012, concludes that the Bulgarian teachers' participation in ICT courses is 43%, which is above the average of the EU—42%. However, the authors of the above-mentioned strategy find that there is a lack of motivation among school and university teachers, who don't manage to adapt quickly to the new realities, and among students, who do not perceive education as a value.

Another study in this field carried out by researchers from Sofia University focuses on the science teachers' beliefs in using ICT. The research has shown that the science teachers' competence in basic computer skills is considerably lower than those of their students. The confidence of the science teachers to create animations and present digitally the content is around 30%. Most of the in-service teachers are consumers—40% of them are using resources from the Internet. The beliefs of the teachers for the effective use of ICT are further investigated by the researchers. According to the science teachers, ICT will be beneficial for effectively tracing the students' progress (69%), for individualization of the work with students (80%), and the presentation of new knowledge (86%). The respondents also believe that ICT will be used in the future for students' teamwork (85%), multimedia projects (80%), exercises (78%), students' research activities (73%), and other collaborative activities (71%). The authors also highlight the necessity for the development of teachers' competence in ICT. On the other hand, the science teachers are motivated to use ICT in their practice and to implement it in different teaching contexts (Kirova, Boiadjieva, & Peytcheva-Forsyth, 2012).

The in-service teachers' attitudes and use of ICT in their work are further investigated by scientists from the Bulgarian Academy of Sciences as the results were announced in 2014. The research reveals that 43% of all respondents have institutional support for using ICT, 25% have no asked for it, while 21% have no institutional support. Some of the teachers also rate their own motivation as the greatest factor for using ICT. 50% of all teachers in the survey use ICT every day or often (1–2 times weekly), whereas 15% use it rarely, and 35%—never. The teachers use ICT mostly for lesson preparation, including up-to-date information for students (about 40%). A large number of teachers implement ICT in their lessons (for presenting content, exercises, projects, or classroom work). Only 23% of the respondents believe that ICT is useful in preparing examinations, while 45% use it in composing tests. When asked about the context, the respondents report that ICT should be used in class lessons (77%), at home (61%), or in extracurricular activities (52%). The teachers also reported that ICT leads to increased motivation (52%), increased effectiveness of the learning process (57%), ICT competence—integration of new technologies (61%), and team working (50%). The main obstacle in using ICT (besides the lack of technical means) is considered to be the attitude of teachers, many of whom are afraid of using ICT due to lack of training. The other challenge related to the application of ICT is the change of the teacher's role in comparison with the traditional learning process. According to the respondents, their main functions in this context are to manage the learning process (over 77%) select/adapt learning units (61%), provide appropriate additional resources (about 55%), and assist students in knowledge acquisition (50%). Other activities that take a considerable part in applying ICT in teaching practice are structuring the learning units (52%) and their design (about 48%), knowledge delivering, and distribution of tasks and roles—both at 45% (Terzieva, Paunova, Kademova-Katzarova, & Stoimenova, 2014). The need to develop teachers' ICT through continuous teacher professional qualification is stated also in a survey with the training managers in 2016. Almost 97% admit that trainers need further opportunities to develop their skills in ICT (Мизова, Пейчева-Форсайт, Петкова, & Първанова, 2016). Similar results are presented in the Education and Training: Monitor Report 2019 for Bulgaria. According to the results, Bulgarian teachers reported one of the highest needs for continuing professional development in the knowledge of their subject field (19%, EU-23: 6%), knowledge of the curriculum (20%, EU-23: 5%), pedagogical competence (17%, EU-23: 8%), and ICT skills (23%, EU-23: 16%) (European Commission, 2019b).

Given the opportunities provided by the national authorities, it is important to determine whether the in-service teachers have attended specialized courses for developing their digital competence in the last few years. Such research is presented in the dissertation theses by a researcher from Shumen University. The target group of the study is the pre-school teachers. According to the results, 61% of all respondents have participated in an ICT course. Most of them represent the age group 34–55. The youngest and the oldest teachers in the group stated that they have never attended such courses. If young teachers are probably competent because they have completed a compulsory university course, the lack of motivation among the most experienced teachers is disturbing. Most of the teachers in the survey claim that they are informed about the new ICT (60% of all respondents), while 12% are not. 14% of the pre-school teachers in the survey could not give a definite answer. In combination with the teachers, who are not informed of the new ICT, this trend outlines a serious gap in the system for continuous teacher professional development. The same study reveals that less than 50% of the teachers know how to use different software in the respective field of training. This tendency applies also to the pre-school teachers' skills to develop their digital competence. The author concludes that there should be opportunities for every pre-school teacher to attend ICT training, as well as to develop standards and mechanisms for the evaluation of pre-school teachers' digital competence (Тилева, 2019).

A recent study on teacher professional development in the field of ICT presented interesting findings. The framework is based on a combination of the conceptual framework TPACK (Technological Pedagogical Content Knowledge) and the idea of ICT integration in education on the part of the teacher. The target group includes more than 600 teachers in grades 8–12. The results show that 82.93% of them took part in training courses for continuous professional development over the past 5 years. The training courses concerning the modern approaches in digital technology implementation are among the top three training courses in terms of attendance. 50% of teachers report attendance in such courses. The participants in the survey were asked to evaluate the level of their digital competence in three general categories of digital competence, measured in the study including the planning of the learning and teaching process, teaching performance, and management of ICT-assessment data. According to the data, there is a positive relationship between the training with active teacher participation and the development of a good level of digital competence in all three conditionally differentiated categories. The results from teachers' self-evaluation present high scores for all categories, but the most significant to the skill of planning the pedagogically appropriate ICT use in the learning process, virtual classroom integration of digital technologies in the light of the specifics of the subject they teach (and ensuring interdisciplinary approach), as well as the provision of ICT personalized student support. There is an indirect assumption that the teacher training courses in the field of digital technologies need to improve their quality to become a prerequisite for good digital competence for teachers (Mizova et al., 2021).

Earlier research developed under the European Social Fund on an Operational Program Good Governance and published in 2019 by Education Bulgaria 2030 reveals that the teachers' experience with the training is variable. There are positive and negative comments on the added values of these training events, according to the participants' in-depth interviews. The study also indicates that there are 3807 programs approved by the Ministry of Education and Science. The average length of the programs is between 16 and 64 academic hours. These programs are suggested by 206 professional organizations. The wide range of topics, trainers, and organizations makes the choice very difficult. At the same time, there is no feedback and information on the quality of these programs. This issue became even more up-to-date during the COVID-19 period when the in-service teachers needed to switch rapidly from face-to-face training to distance learning (Сдружение Образование България, 2019).

7.4.3 Research on the Dynamic of In-Service Teachers' Digital Competence during COVID-19

The teachers' motivation, attitude toward distance learning, and digital competence proved to be the crucial conditions for the success of the educational process during the pandemic. To determine whether this transition was successful, a research team from the Institute of Research in Education developed comprehensive research in the autumn of 2020. It investigates the technical provision for training, the organization of the educational process during the pandemic, the teachers' and students' preparation for distance learning. The multi-perspective survey included 4448 students from 5 to 12th grades, 1885 teachers and school principals (most of whom with over 15 years of experience in teaching), and 5403 parents. The results from the research indicate that most teachers (91%) have their own PC and Internet connection at home. The other pre-conditions for successful distance learning are the teachers' preparation. According to the research, within the period 2017–2020, 50% of the teachers have participated in a course for innovative training methods, 45%–in a specialized course on ICT in education, 25% work with specialized educational software and educational resources, 24% work with multimedia. In addition, the teachers' experience with ICT before the COVID-19 has also been investigated. The results indicate that 55% of all teachers have more than 5 years' experience in using ICT for educational purposes with their students, 13%—between 1 and 5 years, 16%—less than a year, and only 10% have not used ICT in their practice before the pandemic. After COVID-19, most of the teachers tend to apply synchronous training in a digital environment (48%), while 37% prefer a combination of synchronous and asynchronous training (Христова, Петрова, & Папазова, 2020).

The majority of the teachers also mentioned that the time needed to switch from face-to-face to distance learning is between 1 and 5 days. The quick transition is one of the key factors for the success of distance learning. The other pre-conditions for success are the available resources, the methodology of training, and the evaluation during distance learning. All these factors are analyzed by the authors of the mentioned research. On the question about the resources used in the training, most of the teachers (84%) respond that they are using ready and available training resources, while 66% design their own resources. 44% of all teachers also use resources developed by professional communities (Христова et al., 2020).

The research also analyzes the changes and adaptations made by the teachers during distance learning. According to the teachers, the most significant changes are related to the methodology and the organization of the training (90% of all respondents). The methods for giving and receiving feedback (89%), the consultations with the students (89%), and the platforms (86%) are among the other changes in the teaching practice during the pandemic. In most cases, the teachers tend to use more educational resources in distance learning than in face-to-face training. The opportunity to experiment with different methods during distance learning is also a reason for a change in the teaching practice. Among the most widely used methods during distance learning are teachers' presentations, students' discussions, project works, and group works (Христова et al., 2020).

Another study conducted by a sociological agency has shown a different perspective. The methodology of the research included in-depth interviews with different target groups—teachers, school principals, and other pedagogical specialists. In the interviews, the respondents share the view that most schools were unprepared for distance learning, and the teachers were not trained to work with online educational platforms. The teachers also commented that during the COVID-19, they had to learn by trial and error. They also needed more time to adapt to the new reality compared to their students. There are also positive trends, affecting the improved level of digital competence, gained by the teachers during the pandemic. New educational resources, innovative methods, and technologies were implemented in the educational process, which is also considered as a positive perspective. The negative factors that affected the quality of teaching are the professional stress of the teachers, the increased workload, the lack of personal contact with the students (УНИЦЕФ, 2020). In all cases, the in-service teachers needed to enhance their professional qualification and digital competence during COVID-19 and become more proficient in using ICT.

In 2020, two more surveys were conducted—among students and teachers, the purpose of which was to reveal the degree of formation of digital information skills in the conditions of distance learning. They were conducted by the civil organization Coalition for Media Literacy after the introduction of a state of emergency in Bulgaria and before the end of the official school year in the country. Given the importance of developing skills for critical evaluation of information to avoid unreliable content, the key issue was to find and verify the authenticity of the source. The results showed that although the conditions of e-learning were one of the most suitable for the formation of digital skills, most of the teachers in schools had missed that moment. The majority of teachers who used this type of assignment in their classes preferred to do it only once a month, and this was accompanied by acquaintance with the methods and criteria for assessing information sources during a special class, during the class itself or problems had been considered before the class. In general, the conclusions formulated in the study boil down to the fact that teachers largely try to simulate face-to-face learning, rather than adapting to the distance learning environment. Also, the authors of the study find it extremely insufficient to set tasks for searching, analyzing and evaluating sources once a month, especially since it is applied by only 37% of the teachers-respondents (Коалиция за медийна грамотност, 2020b).

7.5 Discussion and Conclusion

Digital competencies as a complex of skills related to the work with information and ICT are of primary significance for the formation and building of an information society. In the information society, knowledge and information are the power that drives the development in all spheres of life. Competencies, however, are not in-born, but acquired within the family, the kindergarten, school, university and no less in the process of self-study. Therefore, when speaking of digital skills among the students' and teachers' communities, we can't just ignore the environment where these skills are built.

The data from a survey back in 2020, after the lockdown in Bulgaria (March–May) conducted among students show that in terms of the training platforms used, in addition to advantages, learners also highlight disadvantages: the use of different tools by teachers has negative effect on the structuring of the learning process, accompanied by insufficient knowledge of the functionalities of the individual applications, technical problems and unsatisfactory level of communication between teacher and student. Also, less than half of the students (40%) who participated in the survey were given a task related to the critical evaluation of information sources, as a basis for the formation of digital and information competencies, even more so in the conditions of strong spread of fake and unreliable content (Коалиция за медийна грамотност, 2020a). In another study, one of the conclusions that stands out is the lack of knowledge and skills on ways to stay safe on the Internet (Кънчев, Георгиев, Хайдиняк, & Апостолов, 2016). Therefore, all institutions, including the private sector, need to work together to improve the level of digital skills, first among children and teenagers and then among students and professionals, not just teachers.

A good example of commitment in terms of promoting the acquisition of digital competence for a better life in the new technological environment is the initiative of one of the mobile operators in Bulgaria—Telenor (from 2022 it switches to the telecommunication brand Yetell). The company is developing the free mobile application Digital Scouts, which aims to form habits and skills for safe work on the Internet in children and teenagers, parents, and teachers (Дигитални скаути, 2021).

Another positive practice that is integrated into the teaching of library studies students is the educational game The Navigator. It is a simulation game mimicking text messaging applications (chat). Its purpose is to raise students' awareness of the criteria for evaluating information in order to avoid fake content. For both learners and trainers, a quantitative and qualitative assessment of the results achieved through the games is provided. The application of the game, which is specially developed for academic purposes, is wide, as it is open to adjust the content according to the educational needs of the trainers (The Navigator, 2021).

Knowledge of the NGOs involved in building digital competencies is also important. For example, the Bulgarian Center for Safe Internet organizes training for students, parents and teachers on important issues and aspects of online life (harassment, netiquette, etc.). It conducts and publishes research results related to the problem of safety and risks on the Internet, guidelines, and advice for teachers and parents, etc. (Център за безопасен интернет, 2021).

Another association, the Coalition for Media Literacy, brings together the efforts of experts from various professional fields, working to include media literacy in the educational process. A number of materials are available on the organization's website, including games that develop knowledge and skills in the field of digital and information literacy (Коалиция за медийна грамотност, 2021).

There is also a need for greater cooperation and work in partnership with non-formal organizations and public institutions, such as libraries. Bulgarian libraries are actively conducting trainings for the formation of digital skills among two important age groups: children and adults. Although the librarians themselves need to further develop their knowledge (Дончева, 2021), they are a natural partner of schools and universities in the process of forming new competencies much needed for the successful integration in a world dominated by technologies.

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Chapter 8
Letting the Light Shine in: A Tapestry of Digital Literacies in Canadian Faculties of Education

Helen J. DeWaard

Abstract The fabric of digital literacy learning and the measurement of digital competence in Canadian faculties of education is multi-colored and multi-textured. The threads connecting these digital literacy practices and research are loosely stitched together into a national tapestry, full of holes and imperfections. Yet, just as Canadian singer/songwriter Leonard Cohen suggests, these cracks allow the light to shine through. By reviewing research from across the country, this chapter illuminates distinctive patterns in teaching, learning, and research into digital literacies and digital competencies in faculties of education. Singular threads reveal trends that enhance digital literacy learning and digital competency development. Research into digital readiness, a digital competence profile, and self-study scholarship reveals the patchy nature of measurement of digital literacies in Canadian faculties of education. This chapter concludes with insights into contextual factors that impact teaching and learning in faculties of education in Canada. This chapter illuminates limitations and barriers, the cracks in the development of digital literacies in teacher education programs, which allow individual lights of innovation to shine across this vast and diverse country.

Keywords Digital literacy · Digital competency · Faculties of education · Canadian · Research

8.1 Introduction

The threads woven into the fabric of digital literacies learning and measurement in Canadian faculties of education is multi-colored and multi-textured. This fabric, loosely stitched together into a national tapestry, is full of holes and imperfections. Yet, just as the famous Canadian singer/songwriter Leonard Cohen recorded, "there is a crack in everything, that's how the light gets in" (Leonard Cohen Lyrics "Anthem",

H. J. DeWaard (✉)
Lakehead University, Orillia, ON, Canada
e-mail: hdewaard@lakeheadu.ca

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2021), these national limitations allow individual lights of innovation to shine from across this vast and diverse country.

Since education is not a nationally mandated public service, a patchwork results as each of the ten individual provinces and three territories determine not only policy, but the funding and delivery of educational programs (Gallagher & Rowsell, 2017; Hoechsmann & DeWaard, 2015). This fabric is further fractured by the various ministerial levels and layers that govern and oversee kindergarten to grade twelve (K-12) and higher education (HE) programs. Each faculty of education, within the larger university context, is a unique swatch of fabric, providing support and service to the larger education sector found within individual provinces and territories. Additionally, in some locations, governing bodies (e.g., Ontario College of Teachers) determine the accreditation status of faculties of education, which adds to the profusion of threads and colors woven into the governance of teacher education in Canada.

Into this tapestry, the issue of digital literacy is often called for, yet remains a thread that is challenging to firmly weave into faculty of education programs (Hoechsmann & DeWaard, 2015; McLean & Rowsell, 2020) and is sporadically in evidence within the curriculum documents in the K-12 sector across the country (Gallagher & Rowsell, 2017). The *Canadian Council of Ministers of Education* and the *National Council of Teachers of English* have emphasized the need for enhanced literacy development in conjunction with technology competencies in education for all provincial education jurisdictions. The *Canadians for 21st Century Learning & Innovation* document Vision for twenty-first century learning in Canada (2012) identifies key skills and competencies learners should possess, which suggests that teachers, preservice teachers, and teacher educators should also possess these skills and competencies. Challenges also lie in the terminology and definitions used when referring to digital literacies (DL) or digital competencies (DC), as well as perceived intergenerational preferences when teaching and learning with technology (Hadziristic, 2017).

Research literature from across the Canadian faculty of education tapestry reveals isolated courses and initiatives modelling digital literacies (Hagerman & Coleman, 2017), yet measuring the outcomes of student or educator's digital literacies is scarce (Blayone, 2018). While the federal government provides direction and influence, it has no mandated control over how education is managed, resulting in frequent calls from business and industry for a national, cohesive digital literacy strategy (Hadziristic, 2017). There are national level collaborations and organizations such as the *Council of Ministers of Education* (CMEC) and the *Association of Canadian Deans of Education* (ACDE) yet there remains little co-ordination of initiatives or funding that could impact the overall delivery of digital literacy programs within faculties of education (FoE) or initial teacher education (ITE) programs (Education in the Digital Age, 2020). Faculties of education are reflections of the larger Canadian digital literacy tapestry in both higher education and K-12 education, as shaped by current political, contextual, historical, cultural, linguistic, and financial influences (Hoechsmann & DeWaard, 2015; McLean & Rowsell, 2020).

This lack of a national strategy for digital literacies development and measurement is compounded by the additional fracturing of service provisions in the education sector since K-12 education, where the pre-service teacher candidates (PTCs) need to learn the craft of teaching, since this level of education is governed by a different ministerial department than that of higher education, where faculties of education reside. Thus PTCs, teacher educators (TEds), and mentor teachers continually attempt to bridge the mandates and constraints between the digital literacies expected in the K-12 and higher education sectors. In terms of digital skill acquisition, this plays out in significant differences in the technologies applied to teaching and learning, whereby specific digital resources used in K-12 may not be available to the HE environments where the PTCs are learning. This confusion of threads across the Canadian fabric leaves digital literacies and competencies within faculties in education in a complex tangle.

Into this profusion of fabrics, threads, and colors, there is light to behold. By seeking to answer three key questions, this chapter will reveal the cracks where digital literacy light shines through. Research questions: What are the current trends and practices in Canadian FoE, as revealed in research, relating to digital literacy and/or digital competence (DL/DC) within their programs? How might the DL/DC relating to the digital dimensions of teaching practice be measured and compared? What are the issues and challenges revealed in the research that shapes the teaching and learning of DL/DC in the Canadian FoE educational systems?

First, theoretical frameworks that influence digital literacy instruction in faculties of education in Canada will be examined. The methodology will explore how threads and patches were pulled into the bigger picture of DL/DC in Canadian FoE. The resultant research literature will explore and examine three unique qualities discovered within the warp and weft of the Canadian FoE digital literacy tapestry. The discussion section will reveal unique patterns in the FoE tapestry design, as well as uncover how the whole of the national fabric becomes greater than the sum of its parts. The chapter concludes by revealing cracks in the fabric, those issues and imperfections as seen through the research, which illuminate the Canadian digital literacy tapestry, in order to 'let the light shine through'.

8.2 Theoretical and Conceptual Frameworks

Faculty of education programs in Canada are influenced by the socio-cultural and constructivist theories of learning originating from Dewey (Dewey, 1916) and Vygotsky (Lowenthal & Muth, 2009; Roth & Lee, 2007). As a result of this influence, digital literacies are grounded within a socially constructed and experientially integrated model of teaching and learning with a "focus on the knowledge building, problem solving, critical and creative thinking skills, ethics and responsibility, digital literacy, and ICT fluency" (Brown & Jacobsen, 2016, p. 439). This is foundational in K-12 policy frameworks in education and within FoE as they prepare new educators to work within K-12 systems. Technology enables "teachers to work collaboratively and constructively in networked environments to build knowledge and ideas through inquiry" (Brown & Jacobsen, 2016, p. 431) and build connections to communities of other educators locally, provincially, nationally, and globally. From this socio-constructivist theoretical stance, digital literacies, and technology applications are more often infused into courses and curriculum. However, some Canadian FoE continue to offer stand-alone instructional courses with a focus on information and communication technologies (Martinovic & Zhang, 2012) and teaching with technologies (Bullock, 2013; Hagerman & Coleman, 2017; Hopper et al., 2018). As evident in the research presented in this chapter, Zhang's (2014) research calls for program-wide integration of technologies in order to prepare teacher candidates to develop mastery of technological, pedagogical, and content specific knowledge.

Conceptual frameworks that influence the understanding of digital competencies within FoE programs in Canada include theory/practice frameworks (Russell & Dillon, 2015; Russell et al., 2013), the community of inquiry (COI) model originating from Canadian researchers (Garrison, 2016; Garrison et al., 2000), and the technological pedagogical and content knowledge (TPACK) framework (Jaipal-Jamani & Figg, 2015; Koehler & Mishra, 2009).

Initial teacher education is challenged by the long-standing dichotomy between theory and practice, with both sides of this divide attempting to take precedence over the other (Goodnough et al., 2016; O'Connor et al., 2020; Russell et al., 2013). In most Canadian FoE, as evident by survey research conducted by Russell and Dillon (2015), there exists a push/pull between theory or practice, episteme or phronesis, knowledge or praxis. Russell et al. (2013) describe the difference in these conceptual frameworks as either a theory-into-practice or a practice-into-theory, while proposing the third option of a theory-and-practice approach. Russell et al. (2013) suggest there is an "epistemology of practice that takes fuller account of the competence practitioners sometimes display in situations of uncertainty, complexity, uniqueness, and conflict" (p. 15). Through the practice of reflection and 'teach-aloud' activities, the tacit knowledge implicit within patterns of action may reveal judgements, skills, and competencies (Russell et al., 2013). Case studies examples of Ontario FoE where theory-into-practice and theory-and-practice frameworks are applied reveal additional information about these frameworks (Russell et al., 2013). As an example of the practice-into-theory framework in Canada is seen in the teacher education programs in Quebec, where emphasis on practicum experiences highlight teacher competencies with an approach that is holistic, integrated, and global (Sterenberg et al., 2016). When considering the DL/DC within FoE, both course work *and* practicum placement experiences need to be considered. Goodnough et al. (2016) identify effective practices and program considerations to support the theory-and-practice approach. This includes the embedded practicum, the teaching and learning seminar, diverse assessments and pedagogical approaches within coursework, and embedding teacher reflection and inquiry practices. As evidenced in the research explored in this chapter, this theory-and-practice framework may break contested binary positions currently constraining the infusion of DL/DC within FoE.

The community of inquiry (COI) framework (Garrison et al., 2000) examines student interactions within a collaborative environment, both in person and online. The three interdependent elements are social, cognitive, and teaching presence (see Fig. 8.1). Garrison et al. (2000) explore categories and examples of indicators for each of these elements in their seminal research into computer conferencing in education. This framework "fuses personal reflection and shared discourse for a deep and meaningful learning experience" (Garrison, 2016, p. 53). Grounded in socio-constructive theory, COI enhances learning through a collaborative constructivist lens (Garrison, 2016). Key to this framework, from a DL/DC perspective, is the interplay between students, teachers, and subject matter content, while using and creating with technological tools and applications within an educational inquiry. The potential for deep learning requires restructuring content to focus on big ideas, providing time for meaningful engagement, reframing assessments for authenticity and recognition, and considering the cognitive and socio-emotional influences on learning and learners (Garrison, 2016). Fullan and Langworthy (2014) posit deep learning results when students and teachers become equal partners while gaining mastery of the learning process, leverages peer support, connects content to students' interests and goals, while continually analyzing learning progress and teaching strategies. In FoE, this COI framework underlies and is evident in much of the learning and research emerging from the past five years.

Similarly, the technological pedagogical content knowledge (TPACK) framework is evident in investigations, applications, and practices in Canadian FoE. This framework outlines the "complex interplay of three primary forms of knowledge" (Koehler, 2012, paragraph 2). This framework suggests that "effective technology integration for pedagogy around specific subject matter requires developing sensitivity to the dynamic, transactional relationship between these components of knowledge situated in unique contexts" (Koehler, 2012, paragraph 3). In their self-study of technology teacher educators, Figg and Jaipal-Jamini (2020) recognize four approaches to promote TPACK knowledge—learning-by-design, modeling, pedagogical reasoning

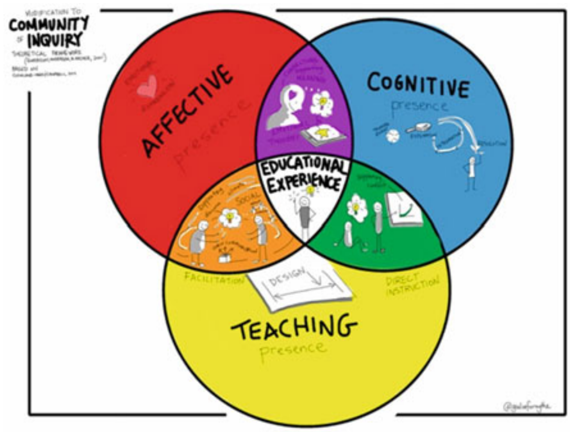

Fig. 8.1 COI Framework, CC-BY (Forsythe, 2014)

discussion, and reflective writing. The open sharing of stories of the lived experiences of technology affordances and challenges as part of teaching practice is seen as significant contributions to knowledge in the field of teacher education (Figg & Jaipal-Jamani, 2020). The TPACK framework can be applied to teaching and learning in any area of study within the FoE program but should include essential elements of DL/DC as part of the knowledge framework.

As a result of the COVID-19 global pandemic and the rapid deployment of online teaching and learning supported by video conferencing technology and learning management systems (LMS), the TPACK and COI frameworks have gained momentum as a means to establish understanding of how teacher education can integrate digital literacies and technology use, specifically within the design of digitally enabled, remote learning events.

While no standard definition for digital literacy and digital competency (DL/DC) exists within Canadian faculty of education contexts. Digital literacy frameworks such as the one presented by MediaSmarts Canada (Hoechsmann & DeWaard, 2015) support an understanding of how digital literacies can be applied within course designs in FoE. Digital literacies are framed by both the cognitive and social practices when using, understanding, and creating with digital technologies (Spante et al., 2018; Stordy, 2015). For this chapter, the digital literacies tapestry is composed with three main threads: "*the skills and ability to* use digital tools and applications; *the capacity to critically* understand digital media tools and content; and *the knowledge and expertise to* create and communicate with digital technology" (Hoeschsmann & DeWaard, 2015, p. 8, emphasis in original). These threads become evident in the research explored in this chapter.

Further to this, trends in research and teaching of digital literacies in Canadian FoE are grounded on multiliteracy perspectives posited by the New London Group (Collier & Rowsell, 2014; The New London Group, 1996) which includes situated practice, overt instruction, critical framing, and transformed practice. This is framed by critical literacy practices to develop skills, fluencies, competencies, and literacies in code breaking, meaning making, understanding and using, analyzing and creating, and developing digital identity (Hinrichsen & Coombs, 2013; Luke, 2012). The newly introduced conception of living literacies by Canadian and UK literacy researchers (Pahl et al., 2020) promises to enhance the development of digital literacy practices for years to come.

Digital competencies on the other hand are defined by the knowledge, skills, and attitudes necessary for purposeful and effective use of digital technologies (Ala-Mutka, 2011; Blayone, 2018). Through a systematic literature review, Spante et al. (2018) provide a distinction between digital literacies and digital competencies that is helpful in framing these concepts for this chapter. Digital competencies encompass the values, beliefs, attitudes, knowledge, and capacity to use technologies such as computer programs and the internet. In professional contexts such as FoE, this includes the effective pedagogical judgement for using technologies for learning, for both teacher candidates and teacher educators (Spante et al., 2018). As revealed later in this chapter, Blayone (2018) suggests that digital readiness is an additional factor that influences the development of digital competencies.

For my own work in teaching critical digital literacies in a Canadian FoE (DeWaard & Roberts, 2021; van Barneveld & DeWaard, 2022) I distinguish between the concepts of digital skills, fluencies, competencies, literacies, and citizenship that are necessary for pre-service teachers to know and show as they venture into the field of education as a teacher. While skills, fluencies, and citizenship should be considered important foundational components within and through which literacies and competencies emerge and connect, a fuller exploration of these concepts are beyond the scope of this chapter.

8.2.1 Methodology

Using references curated from my own research and work in the field of digital literacy in faculties of education as a starting point, I conducted a semi-structured review of the literature using the OMNI search tool available to Ontario universities and conducted full library catalogue searches through the University of British Columbia online library access portal. Since this review was not conducted in a structured format, as suggested by PRISMA protocols, the usual diagram outlining this literature review methodology is not included here. In this way, the gaps in this research literature may illuminate lights for future research inquiries.

For these searches, I consistently applied key words and truncations for “digital litera*”, “digital competenc*”, “facult* of education”, “teacher education”, and “Canad*”. These terms were applied to searches of abstracts, titles, and key words. The parameter for studies between 2000 and 2021 was also stipulated. From these search results, articles were set aside if they were not explicitly relating to instruction or measuring digital literacies of teacher candidates or teacher educators. Subsequent to this initial search, the reference sections of many research articles were scanned for additional literature resources. Finally, open web searches were conducted for organizational reports and white papers relevant to Canadian digital literacies that had potential impact on the contexts of teaching and learning both in K-12 and HE. These additional resources provided some national and international perspectives, expanding on the limitations from provincial or institutional contexts found in much of the university or FoE based research.

The abstract and key words were reviewed for all articles, further eliminating those that were not specific to digital literacy practices of pre-service teachers or teacher educators. For articles that appeared relevant, the introduction and conclusion sections were scanned and key phrases captured. Over eighty documents were selected as having potential relevance to the research questions posed. The full reference list is available on my Step-by-Step website [https://stepbystep.hjdewaard.ca/blog/digital-literacy-in-faculties-of-education-a-research-inquiry/].

8.2.2 Results

Researching DL integration in Canadian FoE is complex and multifaceted. As noted earlier, Canadian FoE is under the jurisdictional control of the ten provinces and three territories, resulting in a fractured and scattered dispersion of digital literacy practices and approaches. This is compounded by TCs being exposed to differing technological applications in both their coursework within the faculty and while on placements in local K-12 school contexts. As a result of the research explored for this chapter, three patterns emerge in the tapestry of digital literacies in faculties of education across Canada. First, digital literacies and competencies are interwoven within other areas of endeavour. Second, singular threads can be pulled to reveal unique textures and colors that are often hidden in the larger design across the Canadian FoE tapestry. Third, a consistent measurement system for digital skills, fluencies, competencies, and literacies in Canadian FoE are patchy, with pockets of innovation emerging to respond to provincial and national calls for greater standardization and accountability.

Inter-weaving. Across the research literature focusing on digital literacies from Canadian faculties of education, there are interwoven threads from other areas of study. As Brown and Jacobsen (2016) discover in their examination of one Canadian FoE, students are encouraged to leverage media and digital literacies throughout their courses to communicate and represent their understanding through the use of a variety of technological applications. The research shows that these inter-weavings include: combinations with media and multiliteracies (Hoechsmann & DeWaard, 2015; Hoechsmann & Poyntz, 2017; Rennie, 2015); infused into literacy instruction and literacy methods courses (Kosnik & Dharamashi, 2016; Leslie, 2010); categorized with information communication technologies (ICT) and emerging technologies (Martinovic & Zhang, 2012; Morris, 2012); applied to equity, diversity, inclusion, and multicultural strategies (Passey, Shonfeld, Appleby, Judge, Saito & Smits, 2018; Taylor & Hoechsmann, 2011); and enhanced through open teaching (Couros, 2010) and open educational pedagogies and practices (DeWaard & Roberts, 2021; Paskevicius & Irvine, 2019).

Media Literacy and Multiliteracies. Narratives about multiliteracies are often woven into topics of DL/DC (DeWaard & Hoechsmann, 2021; Hoechsmann & DeWaard, 2015; Hoechsmann & Poyntz, 2017; Rennie, 2015). Media literacy, through analytic and production activities, is central to Canadian teaching practices (Hoechsmann & Poyntz, 2017). Based on the foundational thinking of Canadian media theorist Len Masterman, Canadian educators continue to emphasize "investigation in media education and media production with the aim of having students determine how meaning is constituted and circulated in popular culture" (Hoechsmann & Poyntz, 2017, p. 8). Thus, in FoE courses, popular culture often becomes the focus for lesson development, whereby pre-service teachers design learning activities and units around current and trending media topics.

To support this integration of media with digital literacies, MediaSmarts Canada provides supports for teachers in the analysis, use, and production of digital and media lessons, projects, games, and products. The *Digital literacy training program* *for Canadian educators: Implementation guide* (MediaSmarts Canada, n.d.) provides guidelines for grade specific support, addresses some of the concerns of educators when considering DL/DC in the classroom, and provides links to media production tools and resources. This adds to the discourse in DL/DC as pre-service teachers in FoE make media, create and share digital products, and construct understanding with technology tools and applications.

Instruction in Literacy Methods. Courses in FoE are being transformed by the use of digital technologies (Darvin & Norton, 2017; Kosnik & Dharamashi, 2016; Leslie, 2010). This inter-weaving benefits the inclusionary practices of language learners from around the globe in Canadian classroom contexts since this infusion of DL/DC into literacy instruction supports the diverse needs of English language learners and immigrant learners, not only in FoE but in the K-12 classroom contexts into which these pre-service teachers will practice. These trans-literacy practices are helping teacher educators re-conceptualize the changing nature of literacy instruction and adjust teaching practices to incorporate digital technologies (Kosnik & Dharamshi, 2016). The influence of DL/DC on enhancing and enabling new forms of communication, social networking, participatory and collaborative practices, building authentic learning experiences, reframing issues, and bridging practice teaching with academic courses were noted in research results (Kosnik & Dharamshi, 2016). As a result of digital technologies being interwoven into literacy instructional practices, Kosnik and Dharamshi (2016) identify dynamic and recursive elements including gaining an international perspective, becoming part of an online learning community, creating products to consolidate learning, and authentic reflections of teaching and learning.

Information Communication Technologies (ICT) and Emerging Technologies. Issues in ICT, relating to the hardware and tools used to support teaching, are often co-mingled into discourses about DL/DC (Martinovic & Zhang, 2012; Morris, 2012; Zhang, 2014). Martinovic and Zhang (2012) surveyed pre-service teachers taking a *Computers in Education* course to determine levels of willingness and preparedness to use ICT in teaching. Self-reported skill levels improved during the course of study, with perceived importance and appreciation of ICT ranked high when learning to teach. Additionally, the results from Martinovic and Zhang's (2012) research echoed what Morris (2012) discovered, notably that the role of the teacher educator and mentor teachers in modelling technology use is crucial, and an understanding of the TPACK framework is important. Zhang (2014) indicates that knowledge and strategies for pre-service teachers' use of ICT in teaching and learning can be improved through an infusion of technologies into FoE courses and into teaching practice. Further to this, Zhang (2014) confirms the need for program-wide integration of ICTs into FoE courses in order for TCs to become proficient in understanding, using, and creating effective teaching events with the use of technology. Ensuring that ICT and emerging technologies effectively apply DL/DC into learning events in FoE courses and are authentically connected to the DL/DC teaching experiences in K-12 classrooms, would further solidify the acquisition of critical digital literacies for both pre-service teachers and teacher educators.

Equity, Diversity, and Inclusion (EDI). Issues of EDI within trans-literacy strategies are inter-woven into DL/DC topics (Passey et al., 2018; Zaidi & Rowsell, 2017). Through these inter-weavings, teachers and students in FoE negotiate their understandings of the places and spaces where artifacts, popular culture, and materiality of learning objects merge and converge (Zaidi & Rowsell, 2017). In efforts to bring issues of equity, diversity, inclusion, and multiculturalism to life in classrooms, some teachers use artifacts as objects of imagination, catalysts for stories, or materials to spur learning. While some become digital renderings, through which DL/DC become immersed in the making and sharing, others are experienced through traditional, culturally-responsive learning moments. As exemplified by the artifacts collected through the process of creating the Truth and Reconciliation Commissions' Calls to Action, artifacts create opportunities for "collective efforts to imagine critical pedagogies relevant to the 'stunningly diverse' students in our classroom today and for the critical work of reconciliation and renewal that is their present and future" (Honeyford, 2017, p. 132). Passey et al. (2018) suggests that the future of equity in education is in need of digital agency, "consisting of digital competence, digital confidence, and digital accountability—is the individual's ability to control and adapt to a digital world" (p. 426). For teacher education, this calls for greater awareness and an ability to empower self and others to adopt, adapt to, and use technologies wisely and responsibly. This notion merges with conceptions of digital literacies and that of digital citizenship. Further to this, Passey et al. (2018) suggests that digital agency emerges from learner agency, which is of great importance when considering equity and diversity in teaching and learning contexts. An interwoven thread can be pulled to reveal the connections between digital agency of diverse populations to such DL/DC topics as using, creating, understanding, and identity.

Open Teaching and Open Educational Pedagogies. Open teaching (Couros, 2006) and open educational pedagogies and practices (Harrison & DeVries, 2019; Paskevicius, 2018; Paskevicius & Irvine, 2019; Roberts et al., 2018; Veletsianos, 2015) are rife with connections and inter-weavings to DL/DC. Emerging from the creation of open-source technologies, Couros (2006) describes open teaching communities founded on principles of collaboration and sharing. Teachers involved in open teaching practices developed teaching materials and content, referenced as open educational resources (OER) which are published and openly available through open access web tools such as blogs and wikis (Couros, 2006). Out of this research emerged an image of the networked teacher, immersed in teaching with technologies (see Fig. 8.2). The open content created by teachers was framed as open educational resources (OER).

Through the creation, collaboration, and publication of these OER and digital resources, teachers gained ICT skills, shift their digitally competencies, and gain digital literacies. While OER application, production and dissemination can transform FoE course work, particularly when shared across institutional, provincial, and national boundaries, this "relies on individuals in educational settings to become open in the ways they produce and share knowledge, in the way they teach and assess students, and in collaborating with others" (*Digital Literacy Training Program for*

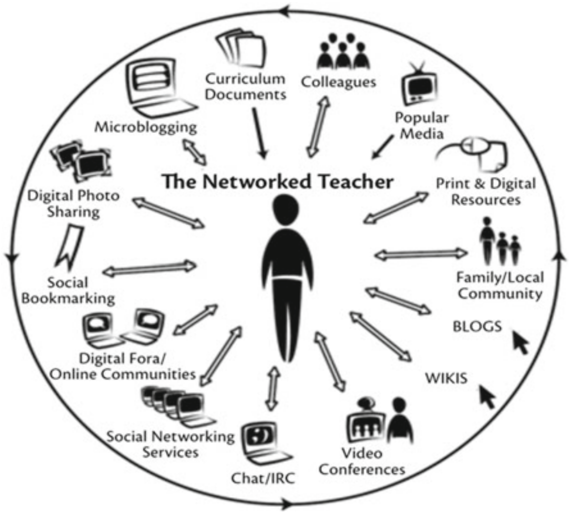

Fig. 8.2 The networked Teachers, CC-BY-SA-NC (Couros, 2006)

Canadian Educators: Implementation Guide, n.d.). This can lead to a shift in pedagogical praxis and result in open educational practices (DeWaard & Roberts, 2021; Paskevicius & Irvine, 2019; Roberts et al., 2018). Open educational practices (OEPr) in teacher education are interwoven yet remain relatively hidden within the overall DL/DC tapestry in Canada. Emergent visibility in FoE is evident in research, such as the Open Page Project (Stewart, 2020), and in the public profiles of teacher educators and pre-service teachers across the country. For some of these, review the supporting website at Digital Literacy in Faculties of Education: A Research Inquiry.

8.2.3 *Pulling Threads*

In FoE across Canada, there is evidence of singular threads that, when pulled together, reveal details of a rich and colorful tapestry of digital infusions into teacher education. These individual threads represent pedagogies, practices, locations, and applications, which support the development of DL/DC within teacher education. This includes research and application of the use of digital timelines (DeCoito, 2020); digital memory work (Strong-Wilson et al., 2014); wikis for poetry writing (Dymoke & Hughes, 2009); blogging as a form of authentic assessment in an open educational practice (DeWaard & Roberts, 2021); digital games and makerspaces (Hébert & Jenson, 2020; Hughes et al., 2020); the creation of digital or eportfolios (Brown & Jacobsen, 2016; Hagerman & Coleman, 2017; Hopper et al., 2018; Hughes, 2008; O'Connor et al., 2020; Paulson & Campbell, 2018) creating video in the form of digital story (Robertson, Hughes, & Smith, 2012; Watt, 2019) or "slowmation" (Vratulis, Clarke, Hoban, & Erickson, 2011); and the use of Twitter (Couros, 2009; Veletsianos & Kimmons, 2016).

Digital Timelines. The application of digital timelines was introduced into a science course design in one Ontario FoE to offer PTCs multiple sources and multimodal components to create representations of the "context-rich historical narrative of scientific discovery and invention" (DeCoito, 2020, p. 10). Through the acquisition of technology skills in the creation of digital timelines, while navigating affordances and constraints of timeline software, TCs reported experiencing "enhanced technology literacy in terms of learning about technology, software programs, and equipment" (DeCoito, 2020, p. 28). While this research reflects an increasing ability in digital skills and fluencies by TCs as a direct result of the application of digital timelines as an assignment in a FoE science course, this research could apply a critical application of DL/DC (Spante et al., 2018; Stordy, 2015).

Digital Memory Work. This teaching practice is based on the premise of remembering the past in order to change the future (Strong-Wilson et al., 2014). In Canadian FoE, this is necessary work in light of national reconciliation efforts with Indigenous peoples. In order to change the future, with support from DL/DC pedagogical practices in FoE, this digital memory work can explore individual and historical pasts to catalyze change in present and future teaching practices (Strong-Wilson et al., 2014). As with the digital timelines research, digital technologies are incorporated and infused into the actions and learning. Digital memory work can be conducted in a variety of subject matter, thus making it intersectional in nature. Strong-Wilson et al., (2014) apply digital memory work to examine how "teachers 'read' digital texts as well as produce digital texts" (p. 448). This research identifies the potential of creating a national archive of digital memory-work projects that not only highlight educational social justice issues that emerge from our collective remembering as educators but also deepen a national teacher identity. Creating a similar digital structure as the *Galileo Educational Network* (About, 2021) could build a pan-Canadian repository of learner and teacher centered resources and stories, as suggested by the *Association of Canadian Publishers* (Howell & O'Donnell, 2017). Strong-Wilson et al. (2014) mention the importance of "collective forgetting" which touches on the right to be forgotten, now referred to as the "right of erasure", seen as an essential digital citizenship practice. Similar to the digital timeline work already mentioned, this digital memory-work can be the impetus for deeper discourse and a catalyst for the development of DL/DC in FoE.

Wikis. Digital technology that allows for collaborative and shared writing, wikis were used in two locations, a UK and an Ontario FoE, to create an online community to "build collaborative knowledge about poetry among a group of pre-service English teachers" (Dymoke & Hughes, 2009, p. 91). This research mirrors the networked knowledge building spaces and knowledge building pedagogies studied by Canadian researchers Scardamalia and Bereiter (2002, 2007, 2014). While the intention of this research was focused on knowledge of poetry production, not the development of DL or DC, the application of using wiki technology for developing an online identity and creating digital productions including the use of webcams as mentioned in this research (Dymoke & Hughes, 2009), could be enriched with critical conversations linked to the development of DL/DC within teaching practices.

Blogging. The practice of using web publication software such as Wordpress or Blogger, this digital tool to support learning (Kosnik & Dharamashi, 2016) can be used as a form of authentic assessment in FoE educational practice (DeWaard & Roberts, 2021) and can expand the criticality of DL/DC. Blogging provides a "mechanism for explicit and open thinking about the topics and content" (DeWaard & Roberts, 2021, p. 315) that supports pre-service teacher's efforts to reflect not only through blogging, but on the process of blogging, with all its inherent affordances and issues. These digital productions can act as "distributed communication mechanisms" (Couros, 2009, p. 236). By applying a Freirean framework to their inquiry, DeWaard and Roberts (2021) explore how critical literacy can be illuminated through blogging practices in teacher education. They suggest that blogging can be a "mediating tool, providing learners with collaborative spaces for learning, helping them shape their understanding, knowledge building, and acquisition of skills" (DeWaard & Roberts, 2021, p. 320). Blogging is also a strategy used in S-STTEP approaches in Canadian FoE research whereby teacher educators, particularly those investigating their own growth in DL/DC, use blogging to openly share their explorations over time (Figg & Jaipal-Jamani, 2020).

Digital Games and Makerspaces. These digital technologies offer a catalyst for the infusion of DL/DC, as seen in these threads of endeavor by Canadian educational researchers (Becker & Jacobsen, 2021; Hébert & Jenson, 2020; Hughes et al., 2020). While digital is not a requirement when infusing games and makerspace pedagogies into FoE courses, there is an opportunity for collaborative engagements and the promotion of transformational change in teaching practice within these complex and dynamic learning environments (Becker & Jacobsen, 2021). Predominantly explored as part of Science, Technology, Engineering, Arts, and Mathematics (STEAM) areas of study, makerspace and gaming are driven by an inquiry-based approach (Hughes et al., 2020). The integration of makerspace and game-based learning events within a FoE course of study or practicum experience offers opportunities for both PTCs and TEds to enhance DL/DC through a design based pedagogical and research framework (Becker & Jacobsen, 2021). One hindering factor evident in the research is the lack of reliable and current technology infrastructures such as internet bandwidth and access to a variety of makerspace hardware such as robotics, mobile devices, and 3-D printers (Becker & Jacobsen, 2021). Hébert and Jacobsen (2020) discover in their research using Minecraft within open, guided/directed, and scaffolded teaching approaches, that pedagogical moves and teacher's decisions play important factors in whether DL/DC are developed.

Electronic Portfolios. Eportfolios can provide space and place for students to exhibit their knowledge, skills and competencies, foster phronesis (O'Connor et al., 2020), and gain practical wisdom. The intention is to bridge the gap between theory and practice that exists in FoE, by using pre-service teachers' practical experience as the base for reflection. Hopper et al. (2018) explore multiple potentials of digital technologies in their research within a FoE in British Columbia and describe eportfolios as a "living and emerging complex process serving multiple purposes and existing within a living learning system that is continually changing as it grows" (p.15). Applying digital software called Folioz, Hopper et al. (2018) outline the six stages used to support eportfolio integration, with resultant themes emerging from PTCs and TEds interviews that mention identity building, holistic meta-learning, reflective processes, appreciative assessment, and networked peer learning (Hopper et al., 2018). While DL/DC were not explicit in the research design or results, Hopper et al. (2018) conclude that the eportfolio became more than a digital collection of artifacts.

Similar to other eportfolio designs, the digital hub approach applied within an Ontario FoE is described as a professional digital web publication (Hagerman & Coleman, 2017). This web site production provides pre-service teachers with an "authentic space for identity construction, technical skill development, and digital literacies learning" (Butler-Kisber, 2017, p. 11). By design, the digital hub approach fosters digital literacies by explicitly examining values, communication, privacy, identity, and critical decision-making (Hagerman & Coleman, 2017). Similarly, in their case study research into eportfolio use in an education program, Paulson and Campbell (2018) examined the driving and restraining forces that sway the systemic structural and cultural benefits and barriers to program-wide eportfolio implementation within an FoE in central Ontario. One barrier is the lack of technical skills and fluencies of students and faculty, and inconsistent implementation planning, as well as the lack of "buy-in and training to integrate ePortfolios into an established curriculum" (p. 10). Paulsen and Campbell (2018) suggest combining a community of practice and a scholarship of teaching and learning framework to support the infusion of eportfolios to enhance adoption.

Video Production. Creating videos in teacher education often take the form of digital story production or "slowmation" (Vratulis et al., 2011), as a mechanism to contribute to the construction of digital literacies and to encourage TCs to think critically about teaching and learning (Robertson et al., 2012). In their research with digital story production in an Ontario FoE language arts methods course, Robertson et al. (2012) conclude that pre-service teachers "provided ample evidence that they can use their early learning experiences as stepping stones to a transformed future classroom, one with multiple literacies, a differentiated and inclusive curriculum, and a safe space for learning" (p. 89). In their research on video production in teacher education in a British Columbia FoE, Vratulis et al. (2011) introduce the concept of 'slowmation' pedagogy, a combination of pedagogical inquiry incorporating stop-motion animation. Their research revealed issues for TCs such as uncertainty, support, implementation, and their shifting roles as teachers and learners that impacted their potential use of this technology. Vratulis et al. (2011) determine that introducing new technologies into FoE courses is not enough. It requires "appropriate theory and practical application in grade-specific examples" (p. 1186) with explicit modelling and active reflection to increase the possibilities of inclusion in future transformative teaching practices.

Twitter. This form of social media micro-blogging is integrated into teacher education (Couros, 2009) and scholarship (Veletsianos & Kimmons, 2016), thus shifting the conversations and discourse into new digital spaces. While Twitter discourse is sometimes described as more authentic but difficult to track, the social networking provides valuable learning experiences, while the transparency of web communication models an openness that reaches beyond traditional learning management systems. For my own work with PTCs in critical digital media, I encourage awareness and an inquiring attitude toward the use of Twitter as part of a professional practice, where a professional learning community can support future directions into the field of education. The inclusion of Twitter in a FoE course of study can enhance critical digital literacies of TCs as they negotiate the issues and affordances of the software to manage privacy, permissions, safety, and security of their professional digital presence on the web.

By pulling these individual threads of research and practice into the light, it is evident that FoE across Canada are exploring DL and DC in unique and interesting ways. While this examination is by no means conclusive or complete, since many threads such as research into instructional design (Holden et al., 2021), integration of Facebook in teaching, and emerging technologies such as artificial intelligence, virtual reality, and augmented reality (Ivus et al., 2021) remain hidden in this DL/DC tapestry, this investigation does reveal the richness and color that shape this uniquely Canadian representation of FoE work to develop DL and DC in teaching and learning. What is not yet evident through this analysis is the presence of any substantial or sustainable mechanisms for the measurement of DL or DC in FoE in Canada, as there appears to be in European contexts with the DigCompEDU framework (Redecker, 2017). The measurement of DL/DC in Canadian FoE will be examined next.

8.3 Measuring

While Canada has a patchwork tapestry of fifty FoE programs across the country, the regulations and standards established for graduation from FoE programs by each of the ten provinces and three territories ensures quality measures for teacher accreditation across the country. Consistent with this collage of FoE, the measurement of DL/DC is found in patches, without explicit or consistent reporting of success in the DL/DC areas identified in the research literature. Starkey (2020) explores research of teacher preparation programs with a focus on digital competence, resulting in a framework for aligning digital competencies within FoE programs under the categories of generic digital competencies, digital teaching competencies, and professional digital competencies for both teacher educators and pre-service teachers. While Starkey's (2020) framework provides some program wide guidance for the review purposes, it fails to provide specific or measurable outcomes that can be targeted or tracked between students, teacher educators, courses, or between faculty programs. Research conducted by Cai and Gut (2020) examines the relationships between literacies and digital problem solving in teacher education across four countries, including Canada, the USA, Finland, and Japan, revealing that "educators' proficiency in literacy and digital problem-solving skills matters" (p. 185). This is not news to those in Canadian FoE who continue to find unique ways to infuse and attempt to measure DL/DC in teacher education, as evident in the research literature.

Here I will shed light on areas of measurement evident in the Canadian FoE contexts with some connections to DL/DC, specifically the digital readiness research by Blayone (2018) and van Oostveen et al., (2019), the digital competence profile compiled by Ally (2019) and the self-study scholarship of Baroud and Dharamshi (2020) and Figg and Jaipal-Jamani (2020).

Digital Readiness.

While recognizing the importance of measuring digital skills, attitudes, and competencies, Blayone (2018) provides insights into efforts to bridge the gap between digital competency research and the readiness factors required for digital competence to emerge. This research, being conducted in one Ontario university FoE, helps define, operationalize, and measure digital readiness of pre-service teachers in Canadian and globally situated FoE. The General Technology Competency and Use (GTCU) framework (Desjardins et al., 2001) and the online Digital Competency Profiler (DCP) application (Desjardins et al., 2015) attempt to measure the digital readiness as a factor of digital competence in online learning environments. At the individual student level, this readiness is determined by actors, attitudes, contexts, and outcomes (T. Blayone, 2018). The DCP, an incorporated and proprietary research instrument, measures the frequency, confidence, preferences, and abilities through online, self-reporting measures and the performance of fifteen digital activities by teachers and students (Blayone et al., 2018).

Van Oostveen et al. (2019) expand on this exploration of the digital readiness of pre-service teachers and teacher educators through their research applying a fully online learning community (FOLC) model, founded on the COI framework (Garrison et al., 2001). This research examines social and cognitive presence within digital spaces in order to operationalize and confirm the results of the GTCU framework. Results suggest that students who self-report feelings of digital competency on the DCP were able to complete authentic digital tasks to a high standard (van Oostveen et al., 2019). Interestingly, research into using the GTCU framework, the DCP measures, and the FOLC model shows how Canadian educational researchers are leveraging technologies to research digital-learning readiness (Blayone, 2018). While this research focuses on digital readiness for online learning, there is some merit in the potential of this measure to all Canadian FoE as a way to provide strategic support for students who may lack confidence in developing the skills, fluencies, and competencies required for digital integrations into their teaching and learning.

8.3.1 Competency Profile

In other Canadian research in the field of digital teaching and learning, Ally (2019) identifies a competency profile for future online instructors. While this is not specific to a Canadian FoE program, this research collected information through interviews, focus groups, and written responses from thirty-four selected experts based on their innovative use of technologies within their teaching practices. The resultant data revealed nine themes falling into 105 competencies. These themes and identified number of competencies for each area include digital teacher competencies in developing digital learning resources (9), re-mixing learning resources (5), using technology (15), communicating with learners (4), facilitating learning (29), assessing learning (4), applying pedagogical strategies (12), personal characteristics (15), and general competencies (12) (Ally, 2019). The intention of this research is not specifically to measure for accountability purposes but to identify gaps within current digital teaching competencies in order to set goals for future teaching practices. The specific emerging technologies are artificial intelligence, robotics, and the internet of things; it is essential that teachers stay a-tuned to future trends (Ally, 2019). Using this competency profile as a self-reflective tool is a worthwhile exercise, in order to see how current DL/DC measures up to these identified digital competencies not only for teacher educators but for future teachers currently learning in FoE across Canada.

8.3.2 Self-Study Scholarship

The application of self-study scholarship can put the measurement of digital literacies and digital competencies in the hands of those doing the work, the teacher educators, and pre-service teachers in the FoE. In Canada, the sharing of self-study of teaching and teacher education practices (S-STTEP) particularly in the area of digital literacy development in FoE is providing information from such user generated digital literacy measures (Baroud & Dharamshi, 2020; Figg & Jaipal-Jamini, 2020). Since the aim of self-study is to activate, contest, and enlighten (Berry, 2020), the process of examining and sharing your own digital literacy practices can provide insights for others to conduct similar self-reflective analyses.

First, research by Baroud (2020) examines the teaching practices of two teacher educators in two different provinces teaching critical digital literacies, in order to explore emergent digital literacy practices. Baroud (2020) concludes that her understanding of critical digital literacy practices was developed through her experiences conducting research and teaching in multiple contexts. By self-reflecting on digital literacy in teaching and learning, Baroud (2020) discovered that "deliberate and thoughtful design of learning opportunities that address technical "know-how" and immerse students in experiencing digital technologies through a social, cultural, and ethical lens supports them … to develop critical and digital competence" (p. 227). While this research does not specifically follow a self-study methodology, it provides some insight into how digital literacies are understood from teacher educator and pre-service teacher's perspectives, and models a self-reflective practice.

Second, Baroud and Dharamshi (2020) conduct a self-study of DL from a critical stance in order to "carefully examine and integrate diverse narratives connected to language, knowledge, and power as a practice of responsible educational engagement. Critical stance acted as a stimulus for dialogue and analyses to open new possibilities of thinking and practice in digital literacy education" (p. 167). Through this self-study lens, they conclude that a "deliberate and thoughtful design of learning opportunities that addressed technical 'know-how' and immersed teacher candidates in experiencing digital technologies through a social, cultural, and ethical lens supported them not only to develop digital competence but also begin developing and enacting pedagogies of critical literacies" (Baroud & Dharamshi, 2020, p. 179). This self-study provides insights for teacher educators across the country beyond that which may be gleaned from measures of DL/DC. The practice of self-study by teacher educators can be an important step toward critical reflection of teaching and learning practices with a focus on meaningful integration of DL/DC into FoE courses (Baroud & Dharamshi, 2020).

Third, Figg and Jaipal-Jamini (2020) share insights from a self-study into technology teacher educators' practices, since these individuals hold a unique place in FoE as supporting both their students and colleagues to develop and promote technology-enabled teaching and learning. They begin with an exploration of what technology teachers need to effectively address the affordances and constraints of technological tools and software, including a deep awareness of the TPACK framework as it applies to teacher education. They next identify strategies that support effective integration of TPACK into FoE courses, including (1) collaboratively designing lesson plans; (2) teaching tech-infused learning activities; (3) view and participate in modelled tech-enhanced instruction; and (4) infuse "demonstrations of teaching the technical skills using 'just-in-time' methods so that the focus was on the learning goals and not the tools" (Figg & Jaipal-Jamani, 2020 p. 994). The authors promote the use of self-study for its narrative quality to elicit stories of experiences, thus building a collection of examples and models that reveal significant contributions to the field of educational technology in FoE. Noticeably missing in the research literature are stories that describe "decisions, the findings and best practices that result from the rigor of self-studies that describe the trials and errors" including lessons learned (Figg & Jaipal-Jamani, 2020, p. 1008).

8.4 Discussion

The research into digital literacies in FoE in the Canadian context is diverse and complex. In this attempt to untangle these complexities while revealing interweavings and pulling threads into the light, it is worthy to note some underlying themes that color the DL/DC tapestry in Canadian FoE. The first is the impact and response to the legacy of colonialism, with specific action framed by the Truth and Reconciliation Commission's report (The Truth & Reconciliation Commission, 2015). Second is the complexity across Canadian contexts of diversity, distances, and the networking of people, places, and programs. Third is the use of DL/DC and technological innovations to push beyond borders—the borders that frame FoE within their larger HE environments, the borders that frame universities in Canada within provincial domains, and efforts to span the national borders that bind digital literacy practices in Canadian FoE thus restricting an understanding of how DL/DC are applied across the globe, as revealed in this particular text. It is through sharing the DL/DC practices in FoE across the country and around the globe that DL in teacher education will truly be transformed.

8.4.1 Truth and Reconciliation and DL/DC

Canadian FoE are addressing issues of colonialism, as part of the broader Canadian contextual efforts to fulfil the Calls to Action identified by the Truth and Reconciliation Commission (2015). This includes a critical lens to ensure that DL/DC practices support efforts to decolonize and recognize the teaching and learning needs of Indigenous peoples, rather than further marginalizing Indigenous populations (Schmidt & Gagné, 2016). While this is not a uniquely Canadian issue, technology integration with a lens to DL/DC should recognize place-based and community-based initiatives, respect culturally sensitive information, and respond to issues of access and control (Saunders, 2012). One example is research conducted by Hildebrandt et al. (2016) in Saskatchewan, examining digital storytelling as mechanism to support mandatory treaty education. This resulted in a shift in students' awareness of dominant discourses surrounding Indigenous histories and calls for greater responsiveness toward complex, non-linear knowledge production (Hildebrandt et al., 2016). Another such example from a Canadian context is Beaton and Carpenter's (2016) research using a critical settler colonialism lens when identifying digital technologies in educational opportunities with Indigenous communities in Northern Ontario while exploring issues of control, accessibility, quality, and decolonization.

8.4.2 Complexity and DL/DC

Scardamalia and Bereiter (2018) identify three cultural changes evident in the current push for internationalization and technological innovation in education which twenty-first century skills listings fall short in addressing. These include growing pressures for knowledge creation, the need to "move intelligently between dealing with abstractions and dealing with the concrete realities to which those abstractions relate" (p. 82), and complexity. Scardamalia and Bereiter (2018) position knowledge building networks as a means to engage students in complex, reality based, knowledge construction through unique projects such as planning a trip to Mars or evaluating the water purity in a local stream. There is no doubt that teaching and learning are mired in complexity at both the individual and organizational levels (Anderson, 2016).

Learning to teach, particularly with digital tools and technologies can be guided by an understanding of the TPACK framework, yet this is insufficient to bootstrap DL/DC into becoming. Bootstrapping is described by Scardamalia and Bereiter (2018) as "processes whereby a complex system emerges by starting simply and, bit by bit, developing more complex capabilities on top of the simpler ones"

(p. 85). Managing the complexity of integrating digital technologies into teaching and learning requires just such bootstrapping where growth, change, and transformation occurs at the "edge of chaos" (Garrison, 2016, p. 39). Such is the case, as seen in the research literature relating to DL/DC in Canadian FoE. The current trends in research, practice, and applications build from that which has been tried, shared, rejected, or enhanced by others. By pulling threads and examining inter-weavings, the complexity of the DL/DC tapestry grows in both design and production.

While the complexity that has emerged as a result of the global COVID-19 pandemic is not the major focus of this chapter, it is worthy to note that the issues and impact of DL/DC cannot be ignored in the rapid pivot to physically distanced, digitally enabled, online instruction that occurred in March 2020. There was no time to bootstrap, let alone support this transition with meaningful engagement in DL/DC in the design and delivery of learning with electronic tools and technologies. Teaching and learning in Canadian FoE became infinitely more complex in revolving cycles of repetitiveness, feelings of loss, struggles with self-efficacy, challenges to manage pressures of family and schooling, and issues with technological preparedness (VanLeeuwen et al., 2021). Understanding that remote emergency teaching using online learning technologies during such complex times is radically different than the well designed and technologically supported learning experiences offered prior to the pandemic (Hodges et al., 2020). This became a clarion call across departments in higher education organizations, not just faculties of education, with renewed calls for improvements in DL/DC (Wong et al., 2021). Faculty members, learning designers, instructional designers, and learning technologists within FoE and higher education institutions across Canada continue to respond to complex challenges resulting from this pivot, with further research beginning to reveal the inter-woven threads in this complex tapestry across the Canadian FoE and higher education sectors (VanLeeuwen et al., 2021).

8.4.3 Beyond Borders with DL/DC

While each individual FoE in Canada offers unique programming options for their students, there is a recognized need for a national strategy for teaching digital literacy (McLean & Rowsell, 2020), a pan-Canadian approach to FoE collaboration (Brown & Jacobsen, 2016; Ivus et al., 2021), the creation and curation of curriculum resources (Howell & O'Donnell), and research and knowledge mobilization (Government of Canada, 2018). The Canadian Association for Teacher Education / L'Association canadienne pour la formation des enseignants (CATE/ACFE) provides opportunities for collaboration, discourse, and research dissemination focusing on teacher education across institutional boundaries (Welcome to CATE, 2021). The *Polygraph Book Series* and *Working Conference Publications* from this organization are evidence of active and current collaborations in research and practices (Publications, 2021). Within this association are special interest groups that focus conversations to specific topics and fields of endeavor including one for technology and teacher education

(TATE), with emerging research evidenced in the special issue of the *International Journal of E-Learning and Distance Education* (Vaughan & Cotnam-Kappel, 2020).

Reaching beyond institutional and provincial boundaries, Hagerman et al. (2020) promote the exploration of digital literacies in Canadian educational contexts through a newly formed digital literacy collective (What Is Chenine?, 2020) with a call for researchers of digital literacies "to invest in designs and research methods that centralize in-the-moment insights, embrace complexity". Hagerman et al. (2020) describe research into virtual retrospective think alouds, eye-tracking, and spy glasses video in educational contexts as examples of research in pan-Canadian contexts in order to introduce the Chenine network, described as "a national, interdisciplinary Canadian Centre with global impact and reach. It inquiries into, creates, and coordinates technological, pedagogical, and curriculum innovation in education" (What Is Chenine?, 2020).

Additionally, pan-Canadian organizations supporting the work of educators to build DL/DC into curricular areas are found across the country. While a full listing of all potential supportive organizations is not possible, a few are illuminated here: MediaSmarts Canada (https://mediasmarts.ca/); Taking-IT-Global (https://www.tigweb.org/); Callysto (https://www.callysto.ca/callysto/); Canadian Geographic for Kids (https://www.canadiangeographic.ca/); A Kids Guide to Canada (https://akgtcanada.com/); Kids Code Jeunesse (https://kidscodejeunesse.org/); and the Digital Human Library (https://www.digitalhumanlibrary.com/).

A pan-Canadian and international approach to technology in teaching is imperative according to many of the organizations that influence and review teacher education and the education sector in both K-12 and HE (Burns & Gottschalk, 2020; Canadian Association of Deans of Education, 2014; CMEC, 2020; Ivus et al., 2021). This imperative is echoed in a recent report from the *Organization for Economic Co-operation and Development* identifying lifelong learning as a key to success when facing "megatrends, such as increases in life expectancy, rapid technological changes, globalisation, migration, environmental changes and digitalisation, as well as sudden shocks such as the COVID-19 pandemic"(OECD, 2021, p. 23). When specifically examining the cross-sector implementation of DL/DC in all educational contexts, many challenges need to be faced, including "fear of failure; insufficient professional development opportunities for teachers, particularly in the formal education system; the need to iteratively update curriculum; and difficulty securing sustainable funding" (Huynh & Malli, 2018, p. 51). As the research in this chapter illuminates, there are gaps in the fabric of DL/DC education, but many small lights of innovation within the K-12 and HE education sectors are illuminating the tapestry with their efforts to bring digital literacy and competency to the forefront.

This further illuminates the notion of knowledge building networks, connecting to the foundational work of Canadian researchers Scardamalia and Bereiter (2014), as evidenced in their research on knowledge building networks in classrooms around the world. Conceptions of knowledge building networks continue to develop and inform how teacher education course design can infuse DL/DC, through the explicit construction of meaning, the integration of problem solving into teaching practices, and networking beyond the confines of the courses within the faculty. By developing Canadian FoE can enhance the knowledge-creating society envisioned by Scardamalia and Bereiter (2018) to sustain ongoing learning for educators. This brings together the notion of communities of inquiry (Garrison et al., 2001) and professional knowledge building networks (Scardamalia & Bereiter, 2002). Much can be accomplished to transform pedagogical practices already evident in the DL/DC tapestry in Canadian FoE. The notion of living literacies posited by Huynh and Malli (2018, p. 51) can be extended and applied to the digital literacy development in FoE in Canada, with an eye to framing this within a more holistic conception.

8.5 Conclusion

If the words of Canadian thought leader Henry Giroux are taken to heart, the infusion of digital literacies and the measurement of the success of this infusion are vitally important to rethink not only "the relationship between education and democracy, but also the very nature of teaching, the role of teachers as engaged citizens and public intellectuals and the relationship between teaching and social responsibility" (Giroux, 2012, paragraph 1). Of particular importance to the infusion and measurement of DL/DC in teacher education programs is one caution Giroux (2012) presents that of "the commodification of knowledge and the privatizing of both the learning process and the spaces in which it takes place" (paragraph 6). It is essential, not only in Canadian FoE, but in FoE around the globe, to consider the human side of digital integration. It is through the criticality of thought emerging from the voices and choices of teacher educators and pre-service teachers that examination of DL/DC within courses and programs of study in FoE provide an "opportunity to engage in much needed self-critique regarding the nature and purpose of schooling, classroom teaching and the relationship between education and social change" (Giroux, 2012, para. 11).

Throughout the research into DC/DL in FoE in Canada, there lies an underlying thread of caution. With efforts to decolonize educational practices especially with the infusion of technology, policy makers, program developers, teacher educators, and students in teacher education programs need to be vigilant in how technologies can be used, infused, and refused within FoE programs. It is vitally important to "include the critical skills needed for students' to ethically and responsibly read digital texts from their particular subject positions, and compose content that diminishes inequities and/or seeks to solve community, regional, or national issues" (Baroud & Dharamshi, 2020, p. 165). This includes a critical lens on how measures of DC/DL in FoE enable deeper discourse into metacognition, digital citizenship, decolonization, the complexity of teaching, globalization, environmental sustainability, all while respecting the right to be included, the right to refuse, and the right to be forgotten. More specifically, the collective actions toward improving DC/DL from the knowledge builders and knowledge keepers in FoE in Canada should model and support systemic changes toward social justice, equity, access, and diversity. In this way, the individual lights created by researchers, preservice teachers, teacher educators, and FoE leaders will shine through the diverse tapestry of DL/DC in Canadian FoE.

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Chapter 9
Assessment of Digital Competencies in Initial Teacher Training in Chile: What Does the Research Say?

Juan Silva-Quiroz, Roberto Canales-Reyes, and José Garrido-Miranda

Abstract The purpose of this study is to investigate research published on the evaluation of digital competence and digital teaching competence in teacher training in Chile. The objective is to reveal the types of studies, their theoretical conceptual references, what is assessed in them and the main contributions and findings for the strengthening of Initial Teacher Training. From a methodological point of view, a documentary meta-synthesis has been made of the content of research articles published in the last ten years in the WoS, Scopus, and SciELO databases. The search is organized into three categories: Digital Competence, Digital Teaching Competence, and Curriculum Frameworks. Articles are systematized considering the size and context of the participants in the study, purpose and instrument used, theoretical reference, evaluation areas, and results. The main findings of the study show a gap between high levels of Digital Competence and low levels of Digital Teaching Competence among Initial Teacher Training students, and an effort to incorporate these competencies into curricular frameworks.

Keywords Initial teacher training · Digital competence · Digital teaching competence

9.1 Introduction

Please note that the first paragraph of a section or subsection is not indented. The first paragraphs that follows a table, figure, equation, etc. does not have an indent,

J. Silva-Quiroz (✉)
Universidad de Santiago de Chile, 9170020 Santiago, Chile
e-mail: juan.silva@usach.cl

R. Canales-Reyes
Universidad de Los Lagos, 5290000 Osorno, Chile
e-mail: rcanales@ulagos.cl

J. Garrido-Miranda
Pontificia Universidad Católica de Valparaíso, 2374631 Valparaíso, Chile
e-mail: jose.garrido@pucv.cl

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either. The insertion of digital technologies (DT) into the educational system requires digitally competent teachers (Castañeda, Esteve, & Adell, 2018; Engen, 2019), so it is essential to encourage the development of these skills throughout teachers' training and professional career. The training of future teachers in DT relates to three groups of factors (Vaillant, 2013): Digital competence (DC), their attitude toward technologies, and their Digital Teaching Competence (DTC). For this reason, digital competence must be incorporated into the Initial Teacher Training (ITT) stage and not only because it is an important aspect of the training of every university student. Developing DC is also necessary to achieve adequate levels of Digital Teaching Competence that result in the integration of DTs into their teaching practices and in the development of their students' DCs (Silva et al., 2019b; Lazaro-Cantabrana, Usart-Rodríguez, & Gisbert-Cervera, 2019; Esteve-Mon, Cela-Ranilla, & Gisbert-Cervera, 2016).

Measuring the level of achievement of both competencies is therefore important in establishing improvements in the training of future teachers, establishing remedial actions, as well as introducing changes in the curricula. Most of the studies implement self-assessment, degree of perception, and/or self-perception instruments that measure digital competence and digital teacher competence from what is declared by students (Usart-Rodríguez, Lázaro-Cantabrana, & Gisbert-Cervera, 2021; Cabero-Almenara & Palacios-Rodríguez, 2019). Studies using effective DTC evaluation tools in ITT are scarce (Esteve, Cela-Ranilla, & Gisbert-Cervera 2016; Lazaro-Cantabrana et al., 2019). Current research proposes to go beyond self-perception-based studies and advance toward evaluation (He & Zhu, 2017), and both instruments can also complement each other (Rosman, Mayer, & Krampen, 2015).

This chapter presents an in-depth review of the research published on the evaluation of digital competence and digital teaching competence. It also studies the presence of both in the curricula of the training of future teachers in the Chilean context, systematizing articles on the subject published in WoS, Scopus, and SciELO bibliographic bases.[1]

9.2 Theoretical Framework

In Chile, future teachers are trained in higher education institutions (HEI) that are autonomous, in programs whose average duration is five years. Teacher training programs establish their formative itineraries, entry and graduation profiles, and curricular activity programs in an institutional framework issued by the Ministry of Education (Mineduc) that considers the Teaching Professional Development System (Law 20 903), Standards for the Teaching Profession, Framework for Good Teaching,

[1] Scientific Electronic Library Online (SciELO) is an indexed base for the dissemination of publications created in 1997, made up of 12 Latin American countries participate, in addition to Portugal, Spain, and South Africa. SciELO is the third most prestigious database in Chile, after WoS and Scopus.

Curricular Bases, and Study Programs according to educational level and specialization. In this context, in terms of technology, the ICT Standards for Initial Teacher Training (Mineduc, 2008) and the ICT Competencies and Standards for the Teaching Profession (MINEDUC, 2011) are guidelines, in addition to the requirements applied by the Chilean National Commission on Accreditation CNA-Chile for the mandatory accreditation processes of teaching degrees.

Digital Competence (DC) involves "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (European Commission, 2018, p.4). This definition considers the development of different skills and attitudes for the use of DTs by citizens in their social development (Krumsvik, 2012). DC can therefore be understood as a set of skills, knowledge, and attitudes in technological, informational, multimedia, and communicative aspects that converge in multiple literacy (Ferrari, 2012). In the Chilean case, Mineduc uses the term ICT skills for learning (HTPA) understood as "the ability to solve problems of information, communication, and knowledge, as well as legal, social, and ethical dilemmas in a digital environment" (MINEDUC, 2013, p.17).

Digital Teaching Competence adds the pedagogical-didactic criterion for the effective integration of digital technologies into the teaching and learning processes (Krumsvik, 2012). Therefore, the DTC refers to the skills, attitudes, and knowledge required to promote learning in a context enriched by digital technology, thereby fostering the transformation of classroom practices and teacher professional development (Fraser et al., 2013; Lazaro-Cantabrana et al., 2019).

For the Chilean Ministry of Education "teachers must take ownership of digital technology know-how to accompany the pedagogical, relational, and communicational processes, as well as those of personal and social development. In doing so, they foster comprehensive professional performance in the knowledge society and make it easier for students to do the same" (MINEDUC, 2008, p.6). In 2008, together with UNESCO, they published *ICT standards for Initial Teaching Training: A proposal in the Chilean context* (MINEDUC, 2008), which was later joined by the publication of *ICT Competencies and Standards in the Teaching Profession* (MINEDUC, 2011) for practicing teachers. Both proposals consider five dimensions of competences: pedagogical, technical, management, social, ethical, and legal, and professional responsibility, and development. These competencies are applied and are available as references by the Higher Education Institutions (HEI) that train teachers.

In Chile, there are no ICT policies for the ITT, only guidelines (Brun, 2011). The few studies on the subject show that higher education institutions offer a variety of ICT subjects distributed in different semesters of the curricula, focused on digital literacy rather than on the pedagogical use of ICTs (Rodríguez & Silva, 2006). However, DCs and DTCs are not yet a relevant axis in the curricula of most universities. However, there are initiatives generated by some universities to guide the development of DTC according to some national and/or international references (Canales & Silva, 2019; Cerda, Huete-Nahuel, Molina-Sandoval, Ruminot-Martel, & Saiz, 2017).

9.3 Research Methodology

9.3.1 *Objective of the Study*

The general objective of the study is to review and analyze the research that has evaluated digital competence, digital teaching competence, and the development of these competences in the curricula of pedagogy programs in the Chilean context.

9.3.2 *Type of Study*

The study is a documentary meta-synthesis of the content of published scientific articles on digital competency development and evaluation in the initial training of teachers in Chile. The study is done through a systematic bibliographic review based on the seven steps proposed by Fink (2014) and used in other similar studies (Liyanagunawardena, Adams, & Williams, 2013; Nabi, Liñán, Fayolle, Krueger, & Walmsley, 2016; Salleh, Mendes, & Grundy, 2011; Vega-Angulo, Rozo-García, & Dávila-Gilede, 2021): Selection of a research question, selection of the bibliography, selection of terms or keywords, application of formal selection criteria, application of methodological selection criteria, inferential revision of the texts, and synthesis of results.

9.3.3 *Procedure*

To conduct a systematic and reliable review process and bibliographic analysis consistent with the strategy selected, the procedure considered as criteria the contextual and temporal delimitation of the development of digital competences in the initial training of teachers in Chile, the definitions established by the Chilean National Research Agency (ANID) to acknowledge and assess scientific publications in Chile, the selection of terms that are commonly used in Spanish and English research on ICT development in education and on initial teacher training, applying for the search, various combinations among them, the incorporation of keywords emerging from the articles found and the use of some Boolean language functions. Other criteria considered are the selection of articles that report evaluations and analyzes based on quantitative, qualitative, or mixed empirical research in contexts of initial teacher, as well as the joint review of the articles by the research team as a criterion of rigor for the selection, classification, and analysis of the information. This is summarized in Table 9.1.

Table 9.1 Application of steps for documentary meta-synthesis

Steps	Elements
Research question	How has the assessment of digital competencies been studied in the initial teacher training programs in Chile?
Bibliographic bases	WoS, Scopus, and SciELO
Main terms used	Area of Digital Competence in Education: "digital competenc*," "digital skill*," "digital literacy," "teach*; "teacher competenc*," "digital teaching competence," "educational technology," "information and communication technologies" "ICT competences" "ICT," "computer and information literacy" Scope of Initial Teacher Training: "training teacher," "teacher training," "preserve teachers," "pre-service teachers," "initial teachers training," "initial training" Contextual Scope: Chile, Chilean, Chilean*
Formal selection criteria	Journal articles published in English or Spanish since 2011
Methodological selection criteria	Scientific articles, empirical studies/evaluations applied in the context of the initial teacher training in Chile in terms of digital competences, digital teaching competences, and curricula
Text revision	Reading of abstracts for selection and grouping according to formal and methodological criteria. Complete reading of the article for the process of content analysis
Summary of results	Elaboration of a summary table with five fields to be completed by the researchers: size and context of the participants in the study, purpose and instrument used, theoretical reference used, areas of evaluation, and results

9.4 Results

The systematic literature review (SLR) covered the 2011–2021 period in the WoS, Scopus, and SciELO databases. The period was considered from 2011 onwards, recognizing the most recent ministerial publication on the subject, ICT competencies, and standards for the Teaching Profession (MINEDUC, 2011), as a milestone. The study included the analysis of twenty-three papers, eight in the area of digital competence, ten in digital teaching competence, and five on curricula. The breakdown of these categories into the three databases analyzed is shown in the following (Table 9.2).

The predominance of publications in journals indexed in Scopus (43%) and SciELO (31%) over WoS (26%) is observed. The writing languages of the texts are Spanish (78%) and English (22%). Regarding the country in which the journals are publishes, seven are from Chile (30%) and Spain (30%), the rest is distributed in publications in Uruguay, Brazil, Argentina, Venezuela, Mexico, USA, and England. Although the search covers the last decade, the articles are mainly concentrated in the last 4 years. Thus, only six (26%) of the articles are from 2011–2015 and the

Table 9.2 Number and classification of bibliographic references used

Study area	WoS	Scopus	SciELO	Total
Digital competence	3	3	2	8
Teaching digital competence	2	6	2	10
Curricula	1	1	3	5
Total	6	10	7	23

other seventeen (74%) are from 2016–2021. This shows an increase in publications on the evaluation of DCs and DTCs.

The research is carried out in various research centers, distributed in different regions of the country and in public and private universities, with greater productivity in the former. Regarding authorship, they fluctuate between one and five articles per author and some authors cover the three subjects under study (digital competence, digital teacher competence, and curricula) while others concentrate on only one of them. The articles are mostly written collaboratively between authors of Chilean institutions or with authors from other countries. In this last aspect the collaboration with Spain is predominant. These collaborations take place in the framework of projects financed by external sources, internal sources at national or institutional levels, or in the context of doctoral theses of Chilean and foreign scholars.

9.4.1 Digital Competencies

As shown in Table 9.3, eight articles report the results of evaluations of digital skills in pedagogy programs, during the period 2010–2021, representing 43% of the systematized articles.

These articles allow us to verify, first of all, the contexts and types of students involved. In this regard, evaluations have been applied in 5 universities involving three regions of the country, Metropolitan Santiago, Araucanía, and Valparaíso (Silva, 2017; Ayala-Pérez and Joo-Nagata, 2019; Leiva-Nuñez et al., 2018; Cerda et al., 2017; Ayala, 2013; and Cerda et al., 2018). Only two studies carry out applications involving several universities, although they are not individualized (Ayala, 2015; De la Cerna et al., 2019). Considering the existence of several teaching programs in the Chilean system, the evaluations have involved students of 15 programs: Spanish, History and Geography, English, Primary Education, Mathematics, Philosophy, Physical Education, Early Childhood Education, Music Education, Art Education, Special Needs Education, Biology, Physics, and Chemistry; however, students of the teaching programs in History, Spanish, and English who have been evaluated the most (Silva, 2017; Ayala-Pérez and Joo-Nagata, 2019; Leiva-Nuñez et al., 2018; Ayala, 2013; Ayala, 2015). Only one of the studies (Leiva-Nuñez et al., 2018) incorporates a high number of programs in its evaluation and two (Cerda et al., 2018; De

Table 9.3 Summary of publications on digital competencies

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement areas	Results
Silva (2017)	110 Students of teaching programs in English, History, Spanish and Primary Education of a university in the city of Santiago, Chile	ACUTIC instrument (Mirete, García, & Heréndez, 2015), which considers the frequency of use and pedagogical integration of technological resources in their activities	Not specified	Perception of pedagogy students of the level and frequency of use of technological resources for personal and academic activities	Students state that their ITT subjects enable them to learn how to use ICTs instrumentally, but not how to teach them, so they are not models of new training practices
Ayala-Pérez and Joo-Nagata (2019)	118 Students of teaching programs in History, Spanish, English and German of a university in the city of Santiago, Chile	Self-perception questionnaire of 46 closed, dichotomous and Likert scale question items. Validated by experts with a Cronbach Alpha of 0.7555 applied to a non-probabilistic sample of students	From the 5 keys to educational technology proposed by Aziz (2010)	General aspects, cyberculture, software usage level, device usage, and digital skills	Students show average to advanced rates. They show no significant differences by program or sex
De la Garza, Peña, and Recuero (2019)	1058 Chilean university students of several programs, including pedagogies	Two-dimensional questionnaire comparable across countries. Instrument reliability is based on the use of items used in pre-existing instruments	From the revised bibliography	Media consumption and political participation	Students do not trust the digital media they use, but they have an important ability to form to their own judgment, which is necessary to exercise as digital citizens

(continued)

Table 9.3 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement areas	Results
Leiva-Núñez et al., (2018)	422 students of 15 pedagogy programs at a university in the region of Valparaíso	Measurement based on the implementation of 3 modules for the development of ICT skills associated with the use of the TPACK model There are no further specifications of the measurement or monitoring process	ICT-ITT Standards (MINEDUC, 2008) ISTE Standards	Search for the necessary information, efficient analysis, and selection of information, Effective, ethical, and legal organization, use and communication of the information	Results obtained with the first application of ICT modules (2015) demonstrate the development of an interest in using technologies and thinking about them as an important tool for professional life
Cerda et al. (2017)	149 students (85 men and 64 women) in the second semester of 2015 in the program of Math Education at a public university of the region of Araucanía	Questionnaire elaborated by the author that collects information on access, frequency of autonomous use, and level of academic use of digital videos in support of self-learning It uses descriptive, correlational, and factorial analysis	ICT-ITT Standards (MINEDUC, 2008) ISTE Standards	Frequency of use of technologies Academic uses of videos Efficient analysis and selection of the necessary information Organization of the information Effective, ethical, and legal use and communication of the information	There is evidence of a development of computational management skills linked to office automation and not processes where technologies are used to support autonomous learning

(continued)

Table 9.3 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement areas	Results
Ayala (2013)	Students of Primary and Spanish Education at a university in the city of Santiago, Chile	Study of the digital competences of the students of pedagogy based on their computer habits, through closed and open questions prepared jointly with the students	ICT-ITT Standards (MINEDUC, 2008) ISTE Standards	Use of devices and browsers; social networks; computers, and programs Digital activities Multimedia presentations Technology and Teaching Practice	Results show that students of pedagogy consider themselves to be basic or intermediate users of ICT, despite having a high percentage of internet access and their own devices
Ayala (2015)	600 students (259 men and 341 women) of teaching programs in Philosophy, History, Spanish, and English of 8 universities in the city of Santiago, Chile	Descriptive study based on three-dimensional surveys applied to a non-probabilistic sample of students of pedagogy. Instruments incorporate closed dichotomous, categorized dichotomous, and Likert scale questions. In addition, Group Focus are applied	Not identified	Use of programs, applications, and the Internet: web use; online activities; social networks	Students perceive technologies more as a source of entertainment and communication than as a pedagogical tool

(continued)

Table 9.3 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement areas	Results
Cerda et al., (2018)	546 students (291 men and 255 women) from six programs in education at a Chilean public university	Short scale questionnaire elaborated by the author about self-directed learning scale, to a non-probabilistic sample for the convenience of students of pedagogy in the analyzed university	Not identified	Access, time, and purposes for academic, recreational, and social use of digital technologies. Self-management, desire to learn, and self-control	Results show high levels of access to digital devices and resources. Women achieve better results in academic uses, self-learning, ICT than men

La Garza et al., 2019) did not indicate the programs evaluated, although it is stated that there are several.

In terms of the number of participating students, the samples are of varying sizes, ranging from 110 (Silva, 2017) to 600 (Ayala, 2015) students of pedagogy. In studies such as Ayala (2013), the sample of participants is not indicated and in De La Garza et al. (2019) a sample of 1058 university students including programs in pedagogy is established, but without specifying the number. The largest number of students come from teaching programs for secondary education. Only 3 studies incorporate gender-differentiated samples (Ayala, 2015; Cerda et al., 2017, 2018).

Secondly, with regard to the type of measuring instrument used, seven of the eight articles use questionnaires to declaratively measure digital competences. Five of them are instruments developed by author team of the study (Ayala-Pérez and Joo-Nagata, 2019; De La Garza et al., 2019; Cerda et al., 2017, 2018; Ayala, 2013, 2015), and the one by Silva (2017) uses an international instrument ACUTIC (Mirete et al., 2015). In spite of this diversity of instruments, only some of them provide information on their psychometric characteristics and validation processes. Thus, questionnaires based on closed, dichotomous and Likert scale questions have been used (Ayala, 2015; Ayala-Pérez and Joo-Nagata, 2019), items already validated have been incorporated into other instruments for reliability of the one used.

La Garza et al., 2019), or open and closed questions have been developed jointly between researchers and the students themselves (Ayala, 2013). Two of the studies strengthened their questionnaires with complementary tools or methods, such as Cerda et al. (2018), which added the application of a short self-directed learning scale or that of Ayala (2015), which used focus groups. Finally, one of the studies (Leiva-Nuñez et al., 2018) does not provide further information on the evaluation process or monitoring applied to the implementation of the competence development modules.

Thirdly, it is noted that three articles do not specify the reference used (Ayala, 2015; Cerda et al., 2018; Silva, 2017) and three others (Ayala, 2013; Cerda et al., 2017; Leiva-Nuñez et al., 2018) use the ICT standards for ITT as reference and basis for evaluation (Mineduc, 2008). Two of the studies use the result of other studies and bibliographical revisions made as reference (De la Garza et al., 2019), or the selection of an innovative proposal such as The Five Keys to Educational Technology proposed by Aziz in 2010 (Ayala-Pérez and Joo-Nagata, 2019).

Fourthly, the areas of measurement of the assessments prioritize declarative aspects related to the types of technology, types of uses, and levels of frequency used in the activities of students of pedagogy (5), skills to search, select, analyze, and digitally communicate information (3), cyberculture (1), media consumption and political participation (1); purpose of use and self-management (1).

Finally, the reported results are grouped as follows. On the one hand, information on the development of some skills and practices that pedagogy students can perform with ICTs. In this regard, it is concluded that students declare high levels of access and achieve high levels or means of skills to search for and select information in various formats and multiple digital sources, use productivity and communication tools, and perform in social networks and virtual platforms (Ayala, 2013; Cerda et al., 2018; Silva, 2017; Ayala-Pérez and Joo-Nagata, 2019, Cerda et al., 2017). On the other hand, the few studies that include the gender variable present different results regarding the impact of this variable on the development of digital skills; Ayala-Pérez and Joo-Nagata, (2019) claim that they do not find significant differences by sex in cyberculture, while the work of Cerda et al. (2018) concludes that women achieve better results in academic uses, self-learning, ICT than men.

A second group of results of the evaluations analyzed relates to the differences and limitations that arise between the level of use and the willingness to use ICT in an academic way for by students of pedagogy and the low level of use of ICTs by university faculty in class and the limits for incorporating ICT into the school system where future teachers are later inserted (Ayala, 2015; Silva, 2017). Finally, a third set of results relate to the conclusions reached by these evaluations. In this regard, it is stated that (i) initial teacher training favors the instrumental learning of ICTs and the valuation of ICTs as a professional opportunity, but not how to teach with them (Leiva-Nuñez et al., 2018; Silva, 2017), (ii) Students demonstrate modes and patterns of digital use that permeate their activities within and outside their university education, although the levels reached differ according to the studies, but that they need to be formatively strengthened from within the initial training of teachers (Ayala, 2015; Ayala-Pérez and Joo-Nagata, 2019; Cerda et al., 2017; De La Garza et al., 2019).

9.4.2 Digital Teaching Competence

As there are ten studies of DTC, which represent 43.5% of the total twenty-three selected articles. Details of each are presented in the following Table 9.4.

Sample sizes range from 54 to 699 students. It is observed that most studies evaluate TDC for primary and secondary education students, some include Early Childhood and Special needs education; therefore no specificity is observed. More recent studies have included an article focusing on a specific area such as special needs education (Bastías & Marcelo, 2021). An article is presented that studies a variable that could have some difference in the development of the TDC, such as gender (Flores-Lueg & Roig-Vila, 2017). A comparative study was observed between two Latin American countries, Chile and Uruguay (Silva, 2019a). Although there are several studies involving two or more institutions, there is no comparison between the results. The studies involve from one to thirteen universities.

Empirical articles measuring DC are scarce, with only two publications derived from the same international project. This work includes an evaluation instrument in which problem situations that a novel teacher may face during their professional exercise are presented (Silva et al., 2019a, 2019b). The rest of the articles is quantitative studies based on instruments on Likert scales of self-perception, one that mixes quantitative and qualitative aspects (Bastias & Marcelo, 2021), and another, only qualitative aspects (Flores-Lueg & Roig-Vila, 2016). Half of the articles present psychometric parameters, one is only validated by expert judgment (Badilla-Quintanilla et al.,

Table 9.4 Summary of publications on digital teaching competencies

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurment areas	Results
Silva et al. (2019a)	Final year students of Primary and Secondary Education from public universities in Chile (273) and Uruguay (295). Implemented in 2016	Evaluation instrument, with 40 items, internal consistency of the Cronbach alpha instrument $\alpha = 0.60$	ICT Competencies and Standards for the Teaching Profession, (MINEDUC, 2011) and Lázaro-Cantabrana Gisbert-Cervera (2015)	Didactics, curriculum; planning, organization of digital resources; ethical, legal and security aspects; professional development	Basic development for all four dimensions. There are differences in the gender and level variables of pedagogies in some dimensions
Silva et al. (2019b)	Final year students of Primary and Secondary Education from public universities in Chile (273) and Uruguay (295). Implemented in 2016	Evaluation instrument, with 40 items, internal consistency of the Cronbach alpha instrument $\alpha = 0.60$	ICT Competencies and Standards for the Teaching Profession, (MINEDUC, 2011) and Arget Lázaro and Gisbert rubric (2015)	Didactics, curriculum; planning, organization of digital resources; ethical, legal and security aspects; professional development	The results show a level of achievement of 56.3% for Chile and 54.9 for Uruguay, 56.28%
Badilla-Quintanilla and Careaga-Butter (2013)	Students of pedagogy in Primary Education, Early Childhood Education, Special needs Education, Secondary Education 681 students. Implemented in 2011	Self-perception instrument and focus group. The instrument does not have psychometric values, it was validated by expert judgment, and has 73 questions with Likert type answers	ICT Standards for ITT (MINEDUC, 2008)	Pedagogical; technical; management; social, ethical, and legal; professional development	Students have an adequate level of ICT skills, and the pedagogical and management dimensions show greater weaknesses

(continued)

Table 9.4 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurment areas	Results
Ascencio et al. (2016)	58 students of 8 teaching programs, of Early Childhood, Primary and Secondary Education	Self-perception instrument, 30 general data items and performance questions. Validated by experts with a content validity index of 0.78	ICT Competences and Standards for the Teaching Profession (MINEDUC, 2011)	Pedagogical; technical; management; social, ethical, and legal; professional development	The best evaluated areas are technical and professional development, those with least appropriation are pedagogical and management
Flores-Lueg and Roig-Vila (2019)	175 students of teaching programs in Early Childhood, Primary and Secondary Education	Self-perception instrument for the pedagogical dimension contains 28 indicators measured on a Likert scale, Cronbach's alpha 0.951	ICT Standards for ITT (MINEDUC, 2008), pedagogical dimension	Pedagogical dimension	Future teachers perceive themselves as competent in the use of ICT. Age, sex, educational level of ITT affects the assessment
Flores-Lueg and Roig-Vila (2019)	9 focus groups in which 54 students from programs in Early Childhood, Primary, and Secondary Education who were carrying out their pre-service practicum	Semi-structured interview, Representation of ICT in your personal life? -Representation of ICT in the professional development? -Preparation to integrate ICTs into their teaching practices? -Strengths and weaknesses of ICT training?	No reference	ICT skill levels Factors involved in ICT competency levels:	The results show that the use of ICT has been marked by the use of traditional applications such as Word, Excel, or Power Point, which does not occur with other software

(continued)

Table 9.4 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurment areas	Results
Bastías & Marcelo (2021)	The study is based on a mixed methodology. The sample is intentional, it is made up of 699 students and 20 teachers of Special Education from eight Chilean universities	Likert consisting of 47 self-assessment questions adapted from the TPACK instrument (technical-pedagogical knowledge of content) by Schmidt et al. (2009), presented psychometric data, were also used semi-structured interviews and focus groups	TPACK model	Knowledge and use of Digital Technology in classroom interventions; attention to resource-based special needs and DTs; use of DTs in preservice practicum	Most of the students considered that they had. Formative deficiencies in the use of DT to address special needs in their areas of specialization
Sandoval et al. (2017)	Study Quantitative, descriptive, and cross-sectional study of a population of 127 students from the 2014 cohort, belonging to four teaching programs of a university	Duly validated questionnaire (Cronbach's Alpha 0.89). With 42 reagents of different formats: Dichotomies, alternatives, and Likert scale, adapted from the Survey on Information and Communication Technologies Equipment and Use in Spain Households (INE, 2005)	No reference	Access to ICT and internet resources; frequency of computer and internet use; ICT training needs for future professional performance	Students have high access to ICT resources, present degrees of digital literacy to use resources without difficulty. They do not know or use educational software

(continued)

Table 9.4 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurment areas	Results
Garrido et al. (2013)	Mixed-type research design that initially involves an exploration of data on a sample-type of 12 students, and then deepen the analysis with a national sample of students (n = 424) from 13 universities	Semi-structured interviews with 12 students of pedagogy and questionnaire application, no psychometric data are presented	ICT Standards for ITT (MINEDUC, 2008)	Pedagogical beliefs about ICT and Provisions for incorporating them into their performance	The results show the existence of a typology with provisions that can become the basis for innovating with digital technologies in the formation of the future teachers
Flores-Lueg and Roig-Vila (2017)	Descriptive design, where 175 students of a Chilean university were administered an instrument designed ad hoc for research	Questionnaire with socio-demographic questions and 75 reagents, whose response categories are presented in a Likert format	ICT Standards for ITT (MINEDUC, 2008)	Pedagogical; technical; management; social, ethical, and legal; professional development	Future teachers obtain better results than women, mainly in the pedagogical, technical, and social, ethical and legal dimensions

2013), and the others do not report indications of the reliability and validity of the instruments.

In relation to the references, four studies (Garrido et al., 2013, Badilla-Quintanilla, 2013; Flores-Lueg & Roig-Vila, 2019, 2017) use the ICT standards in ITT (MINEDUC, 2008), three articles (Ascencio et al., 2016; Silva et al., 2019a, 2019b) use ICT competencies and standards for the teaching profession (2011), two do not present references (Flores-Lueg & Roig-Vila, 2016; Sandoval et al., 2017), one mentions the TPACK model (Bastías & Marcelo, 2021). There is little presence of international referents, the researchers prefer to use the two major national referents, although their last update was in 2011. This may be related because these referents are the guide for training in technology in curricula.

The results of these studies are that students of pedagogy present an average level of DTC (Silva et al., 2019a and 2019b). The dimensions with the lowest level of achievement are pedagogy and management (Ascencio et al., 2016; Badilla-Quintanilla et al., 2013). The student body demonstrates a high level of DC, but a low level to make educational use of digital technologies (Flores-Lueg & Roig-Vila, 2016, 2019; Sandoval et al., 2017; Garrido, 2013), one study indicates the formative deficiencies for the pedagogical use of DTs (Bastias & Marcelo, 2021) and one states that male students have better results in the TDCs than women (Flores-Lueg & Roig-Vila, 2017). The training they receive strengthens their DCs but falls short in DTC development. Therefore, there is deficit in training for future teachers to make appropriate use of digital technologies in teaching.

9.4.3 Curricula and Initial Teacher Training Programs

Five (22%) published studies report research results related to the presence or development of DCs and/or DCTs in the curricula and programs of pedagogy. The following table summarizes these publications (Table 9.5).

Of the populations and samples of the five articles, the study by Cabello et al. (2020) works as a census with 100% of the curricula and graduation profiles of the country's pedagogy programs. Tapia et al., (2020) analyzed 212 curricula and Silva and Miranda (2020) and Del Prete & Zamorano (2015) analyzed 8 and 10 programs, respectively. The work by Brun and Hinostroza (2014) covers 46 universities, referring specifically to the integration of technologies into the training of future teachers.

In general terms, qualitative and quantitative works are found that study the dimensions or categories the characteristics, foundations and quality of the programs and subjects, coverage, and consistency of the curricular structure, learning objectives, contents, and their relevance. They also investigate indicators of ICT in ITT, and vision of use, program viability indicators, infrastructure, and supporting resources.

From the perspective of the reference or standard DC used in the 5 articles analyzed, one of them, Tapia et al., (2020) are based on the ICT-ITT standards

Table 9.5 Summary of publications on ITT curricula and programs

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Results
Silva and Miranda (2020)	8 ICT subject programs of Chilean universities in 5 universities	Qualitative analysis, content analysis matrix, worked with three sampling units: Fundamentals of the subject, learning objectives and contents	MINEDUC, 2011 and Arget, 2015	Incipient presence of the TDC in teaching programs, while the "didactic, curricular, and methodological" dimension has the greatest curricular coverage, the dimension with the least coverage is that of "ethical, legal and security aspects"
Cabello et al. (2020)	Census sample of 225 curricula and graduation profiles of primary and secondary education programs in the country, taught by higher education entities	ICT integration indicators in ITT. General characteristics of programs. Feasibility, quality, and structural indicators of the institutional project	None	A high proportion of curricula do not integrate ICTs at all, not even at the introductory basic level. In the light of public ICT policy in schools, this can be interpreted as a deficient point to begin plans that require advanced ICT skills and the development of skills for classroom implementation

(continued)

Table 9.5 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Results
Brun and Hinostroza (2014)	46 universities that train teachers in Chile. Participantsdeans: 46; teacher trainers: 495; mentors: 164; students: 1675; graduates: 233; technical managers: 50	Questionnaires,Interviews,case studies(1) Institutional policies and practices for ICT integration; (2) Infrastructure, ICT resources and support; (3) Actors' confidence in the use of ICT; (4) Visions about the pedagogical use of ICT; (5) Use of ICT resources in teaching and learning activities; (6) Teaching and learning activities	None	Teachers report a fairly frequent use of some ICT resources, highlighting the importance of students' learning of ICT. However, ICT integration is limited to a few specific resources (mainly computers and projectors), mostly applied to carry out "traditional" educational activities
Tapia, Campaña, and Castillo (2020)	Analysis of 212 curricular programs of Secondary Education Teaching, taught during the day, and curricula available for review	Spreadsheet where the information collected was based on 9 fields. This consolidated file enabled the creation of a database	ICT Standards for ITT, (MINEDUC, 2008)	There is an increase, between 2012 and 2018, in the percentage of teacher training programs with at least one ICT subject. This growth, 12.4%, would be linked to an increase in the concern about the presence of ICTs
Del Prete & Zamorano (2015)	ICT study programs from 10 universities	Coverage, consistency of curricular structure, and relevance of curricular ICT content were analyzed	Professional standards suggested by Krumsvik's Digital Skills Model for Teachers (2008)	The curricular orientations followed give priority to the incorporation of specific subjects of ICT that promote of basic computer skills development anddidactic tools, with little attention to permanent learning and ethical-social dimensions

(MINEDUC, 2008); another, Silva and Miranda (2020) use the ICT teacher competencies (MINEDUC, 2011); one by Del Prete & Zamorano (2015) is based on the Krumsvik 2008 competency model, and the remaining two do not mention references.

At the level of results, different scenarios are observed. On the one hand there is an incipient presence of DTCs in the curricular programs of pedagogy and a high proportion of curricula that do not integrate ICT in the training of future teachers (Cabello et al., 2020; Silva & Miranda, 2020). On the other hand, although the importance of the use of technologies for learning is acknowledge, their integration is scarce or limited to a few resources (computers and projectors) to carry out rather traditional activities. The incorporation of ICTs in specific subjects of technology is privileged by promoting basic computational skills and didactic tools, but with little relation to lifelong learning and ethical social, legal, and security dimensions (Brun & Hinostroza, 2014; Del Prete & Zamorano 2015; Silva & Miranda, 2020). Finally, Tapia et al., (2020) comparing 2012 with 2018, show an increase by 12.4% in the presence of programs with at least one ICT subject in their curriculum.

9.5 Discussion

Given the configuration of teaching programs in Chile, the studies analyzed do not always show the program of origin of the students participating in the evaluations analyzed on DC and DTC. Considering the relationship between the disciplinary and pedagogical knowledge and technological knowledge (Mouza, 2016), this implies limits to the interpretation and usability of the results obtained. On the other hand, despite significant differences in the sizes and methodological justifications of student samples, the preeminence of assessments in secondary education programs is observed in terms of DC. This is extended to primary education, special needs education, and early education in DCT measurements. The discussion of gender variable differences in digital capacity development (Aranda et al., 2019; Mediavilla & Escardibul, 2015) is considered in only four studies, three on DC and one on DCT.

The DC, DCT, and initial teacher training curricula analyzed are mostly self-assessments or declarative measurements, which confirms the preeminence of this type of evaluation found at the international level (Lemon & Garvis, 2016; Flores-Lueg & Roig-Vila, 2016). In terms of the purposes of the assessments, those intended for DC primarily evaluate the access, type, and level of use of digital technologies by students of pedagogy in their personal and academic tasks. The same is true of studies to evaluate TDCs, which incorporate aspects related to pedagogical, technical, ethical-legal, cultural, professional development, beliefs, and provisions on the incorporation of ICT in professional teaching performance. This is in agreement with international studies that define the instrumental use of technology, development of pedagogical learning, and the positive disposition to incorporate ICT into the professional exercise as main factors (Usart-Rodríguez et al., 2021; Cabero-Almenara & Palacios-Rodríguez, 2019; Vaillant, 2013). On the other hand, evaluations of the initial teacher training programs focus on the levels of ICT presence in subjects and on the facilitators and obstacles of careers for their development. This is an aspect that is consistent with the challenges of educational programs to ensure training that will enable the potential of digital technologies to be harnessed (European Commission, 2013).

We encounter research that use the ICT standards for ITT (MINEDUC, 2008) or for the teaching profession (MINEDUC, 2011) as a reference. International references are rarely used. This is consistent with the results reported by Rozo and Prada (2012) who analyzed the insertion of ICTs in ITT in countries of the Andean region (Bolivia, Ecuador, Peru, Colombia, and Venezuela). In these cases, there are different experiences of articulating ICTs in ITT that are not aligned with international standards. This differs from other realities, where more up-to-date standard references such as the European Framework for Digital DigComp Competition, the DigCompEdu European, Competence Framework for Teachers, UNESCO's ICT Skills Framework for Teachers, or the International Society Technology Education (ISTE), among others, are used.

The studies focus on self-perception instruments; although some of them have psychometric indicators, progress needs to be made in terms of evaluation instruments. There are differences between self-perception and evaluation test results, showing a negative relationship between both aspects. That is, students perceive themselves more competent in the use of technologies than they can demonstrate (Rohatgi, Scherer, & Hatlevik, 2016). This aspect is also reflected in TDC, where studies based on self-perception (Badilla-Quintanilla & Careaga-Butter, 2013; Ascencio, Garay, & Seguic, 2016) show higher levels of achievement than evaluation studies (Silva et al., 2019). Both types of instruments are valuable; therefore, one alternative is to combine this type of instrument to mix evaluation tests with self-evaluation tests at the end of the first assessment (Rosman et al., 2015). It is desirable to consider simulated evaluation environments (Esteve et al., 2016).

The areas of measurement in the various evaluations analyzed point to the double digital challenge faced by those who are trained as teachers to learn to use ICT as part of the skills required to perform in the twenty-first century. At the same time, they learn to use them to teach and mediate learning of others (Lesgold, 2003). Thus, in the assessment of the competences for information management, the frequency of access and use to search, select, organize, and analyze information, and the measurement of perceptions and arrangements to use digital technologies in different personal, training, and professional activities have been measured. Likewise, when measurements seek to assess the use of technologies for classroom practices developed by a teacher, the areas that are usually evaluated are ICT-mediated class planning, the organization of digital resources, ethical, legal, and safety issues, and aspects of teacher professional development. These areas relate mostly to the Chilean reference of the ICT-ITT standards (MINEDUC, 2008).

On the other hand, in evaluations concerning the facilitators and obstacles in initial teacher training programs for DC and DCT development, the measurement areas sought provide information to improve the opportunities for future teachers to use ICT in their curricular activities (Uerz, Volman, & Kral, 2018). In this way, these measurements relate to the foundations, learning objectives, and contents included in the subjects that address the topic, the pedagogical-technological conditions offered by institutions themselves to develop a digital training of pedagogy students, and differences and concurrences in various universities and education programs.

Finally, there is little presence of DC in programs or graduate profiles; a similar situation occurs at the level of the DTC, where the pedagogical integration of technologies in the curriculum is key. The analysis indicates that there are pending challenges and the opinion and perception of the actors in the use and integration are valued. However, the results show a lack of concretion in practice. Therefore, it is necessary to move from the subject of technology centered on DC toward the appropriation and inclusion of the DCT in the specific didactics and classroom work to strengthen the skills necessary to face the educational challenges involved in integrating DT into teaching (Brun & Hinostroza, 2014; Del Prete & Zamorano, 2015; Silva & Miranda, 2020).

9.6 Conclusions

Although Chile pioneered the region and developed the ICT standards in ITT (Mineduc, 2018) that placed it as a reference at regional and international levels, these did not become public policy. They acted at the level of guidelines, being adopted by various institutions in various ways. This lack of policies has allowed some institutions to develop initiatives that guide the development of DC and DTC by collecting elements of national standards and integrating elements from other more current international frameworks (Cerda et al., 2017). An update of the Chilean public policy on DC and DTC is urgent, which is articulated with the rest of the policies for ITT. This would allow teacher-training universities to advance in adjusting their curricular itineraries and graduation profiles by incorporating these competencies in function of the current institutional structure. Beyond national policies, it is important for institutional policies to be available in the teacher-training HEIs that include the digital training of future teachers, so they can use digital technologies in their teaching and professional development (Escudero, Martínez-Domínguez, & Nieto, 2018; Papanikolaou, Makri, & Roussos, 2017). In view of the lack of policy and discontinuity of the guidelines given by the MINEDUC (2008, 2011), the challenge for the HEIs is to integrate the most current contributions generated by various organizations at the international level into these ministerial initiatives.

Studies are general, including future teachers of different degrees: early childhood, primary, and secondary education, and in some cases, they consider special needs education. However, the same instruments are applied to all of them. Progress is needed in the evaluation of DC and DTC by focusing on specific educational levels because while the benchmarks may be the same, the scenarios of use of digital technologies faced by these teachers are different. It would also be interesting to carry out comparative studies between national and international universities, public and private universities and between educational levels, primary, secondary, special needs, etc.

It is relevant to assess digital competencies and digital teaching competencies in ITT; the former in the first in the first years of training and the latter in the last years. Measuring DC in students of pedagogy is a critical challenge to better understand its evolution, so further developed assessment tools are required (He & Zhu, 2017). Despite the assessment experiences recorded in the research, the challenge remains of having and applying objective evaluation tools to assess the level of DTC reliably and validly of students in initial teacher training (Lazaro-Cantabrana et al., 2019). There is a growing need of assessment instruments that are not based only on the perception of the user, which measure the level of digital competence and teacher digital competence by solving situations or problems in line with the indicators to be evaluated (Villar-Sánchez & Poblete-Ruiz, 2011). Assessment tools are required that face students with specific and relevant to the national educational context.

The accreditation processes of education programs and the growing demand for incorporating and evaluating the technological competences of the pedagogy student offer the opportunity to redesign the role of technologies in current teacher training curricula. DT has the opportunity of being inserted cross-sectionally into the curricula to develop skills for learning with technology and teaching with technology, regardless of the educational levels in which they practice teaching.

Finally, the limitations of this research relate mainly to the inclusion of Scopus, WoS, and SciELO databases. This leaves out repositories like Google Scholar and other databases like DOAJ, ErihPlus, Latindex, among others, books, and book chapters. This is a limitation derived from the place where the investigation was carried out, a Chilean context. The requirements for publications in indexations such as WoS, Scopus, or SciELO have increased in universities and research agencies in recent years, which goes hand in hand with the increase in publications. It is likely that the articles that we have seen are found in the selected databases, given the combinations of keywords used. Although they were intended to be as broad, some articles in the systematic analysis of the revised bibliography may have been excluded. The challenge is to extend this work to other databases and to repeat it in about two more years to evaluate the evolution in this area of study of great interest for the training of future teachers.

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Chapter 10
Digital Literacy of Chinese Normal Students: A Literature Review

Jiafeng Gu and Rui Ding

Abstract This article reviews Chinese academic papers from the past 20 years to investigate the digital literacy of normal students of pedagogical faculties. The main body of the article concerns "student literacy, to teacher literacy, then to normal student literacy"; regarding the theme, the context is "from digital literacy, to information literacy, then to digital information teaching ability." Under the guidance of the Chinese education administration, the digital literacy of Chinese normal students has gradually taken on the Chinese characteristics of being practice-oriented and ability-oriented. The findings of this article are as follows: (1) In terms of research trends, the digital literacy of normal students has increased overall. This has depended on the gradual in-depth understanding of its value to the academic world, which promotes in-depth academic research while also focusing on clear and continuous policy planning. (2) In terms of research themes, the digital literacy of normal students is biased toward practice and training, and there is less research on the development of digital teaching ability in specific subjects. (3) In terms of research methods, qualitative research is still the mainstream method, but increasingly, quantitative research, including surveys, is used. (4) In terms of research results, based on the current survey report data, the digital practice ability of Chinese normal students still needs improvement. The current research has indicated the direction for the future academic community and also proposed requirements for policy researchers and makers.

Keywords Normal students · Digital literacy · Digital teaching ability · Training strategy · Literature review

J. Gu (✉)
Institute of Social Science Survey, Peking University, Beijing 100871, China
e-mail: isssgujf@pku.edu.cn

R. Ding
Department of Sociology, Peking University, Beijing 100871, China
e-mail: 1801212341@pku.edu.cn

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10.1 Introduction

With the leap forward in the development of information technology, human society has entered a new digital era (Han, 2012). In China, the Internet has moved forward in great strides, driving changes in all aspects of its economy and society. The sudden COVID-19 epidemic accelerated the pace of online teaching in Chinese schools, becoming the main reason for implementing "suspended classes and non-stopped schools" during the epidemic prevention and control stage. This is a test of the digital construction of China's education system; it is also a time of enlightenment in the evolution of education under the digital wave (Wu, 2020; Zhang, 2020; Zheng et al., 2020).

The digital wave has not only changed the education ecology but also directly promoted the renewal of traditional education models, concepts, and technology (Li, 2016). Learners in the digital age must acquire the knowledge and grasp of technical skills in traditional education while also expanding their innovative thinking skills, critical thinking skills, and so on (Liu et al., 2021; Zhang, 2006). In response to the challenges of the times, countries around the world have put forward talent development requirements for the twenty-first century from different perspectives, such as the young talent skills proposed by UNESCO, the 21st-century learner skills issued by the Organization for Economic Cooperation and Development (OECD), the twenty-first century talent skills framework proposed by ACTS, etc. The Chinese academic community and administrative departments have also proposed core literacy contents for Chinese students. Information literacy as the key content of core literacy has become an important starting point for transforming educational goals from China's perspective (Chu, 2016). Emphasizing the development of critical thinking, open problem-solving, and digital literacy through the creative use of technology has become the key to civic literacy education in the new era; it has also become the main task of teacher teaching practice in the information age.

As citizens of a digital society and future workers in education, normal students must receive digital literacy and ability training that aligns with the ability requirements of in-service teachers (Shi, 2003; Yan et al., 2012). The teaching standards aimed at the core literacy of students must also reflect the adjustment of the normal education system in response to social changes (Sun et al., 2014; Xiang & Zhang, 2020). Therefore, the digital literacy and information teaching abilities of normal students (also referred to as future/normal students of pedagogical faculties) have received attention from the academic community (Xiao, 2021; Zhang & Sun, 2012). At the same time, the Chinese education administration has actively responded to the changing trend in normal students' digital teaching abilities through various policy measures and established relevant standards targeting students' core literacy and digital teaching abilities (Zhang, 2019). In March 2018, the Ministry of Education and five other departments jointly issued the "Teacher Education Revitalization Action Plan (2018–2022)." They put forward ten major initiatives, including the "Internet+Teacher Education" innovation action, emphasizing that teachers should make full use of new technologies and promoting the construction and application of information-based teaching service platforms for teacher education. This plan also promotes the reform of information-based teaching methods by focusing on improving the information-based teaching abilities and information literacy of normal students.

Through the joint efforts of government planning and academic participation, China has gradually established a training system for the digital literacy of normal students in line with its national conditions, devised the concept of digital literacy that incorporates Chinese characteristics, and accumulated a certain amount of experience. It significantly promotes training and improving Chinese normal students' digital literacy (Zeng, 2014). However, there are still some problems in the development process.

10.2 Concept Definition

Western scholars first proposed the concept of digital literacy. It gradually spread to China and is valued by policy makers in the Chinese government and scholars. In the process of understanding and accepting the idea of digital literacy, Chinese education researchers have also reconstructed the subjects and themes based on their own national conditions and development planning. Under the guidance of Chinese policies, China's digital literacy reflects its national characteristics. The core framework of "ability, knowledge, and awareness" constructed by the academic community proves and reflects the practical focus on normal students' digital literacy.

10.2.1 "Practice-Oriented, Ability-Oriented" Chinese Characteristics

Originating in educational research during the last century in the West (Gilster, 1997), digital literacy includes five frameworks—visual literacy, reproduction literacy, branch literacy, information literacy, and social–emotional literacy—as well as "real-time thinking skills" (and the ability to handle multiple tasks in parallel) (Eshet-Alkalai, 2012). Digital literacy is closely related to the digital technology of natural sciences and is also widely used in various fields such as the social sciences and humanities. Education researchers regard digital literacy as a key task for teachers (including normal students) in training. They care about the literacy level of the teachers themselves while valuing the professional expectations of educators that affect students.

During its arrival period in China, Chinese scholars have been trying to understand and explain digital literacy while at the same time rebuilding it with Chinese characteristics. This embodies the process of Chinese painting and the localization of the concept of digital literacy. The digital literacy of Chinese normal students is different from that of Western society in terms of conceptual connotation. Related research also reflects certain Chinese characteristics.

In terms of research content, Chinese education scholars' research on digital literacy is limited to its concept and definition. This extends to all aspects of education and teaching, including setting the standards of digital literacy, digital literacy and subject teaching, the influencing factors and evaluation system of digital literacy, the development status of digital literacy, and improvement strategies, showing a large-scale and increasingly refined development trend in the overall research. This has expanded the understanding of the concept of digital literacy in Western society.

As for the research object, normal students in pedagogical faculties have experienced a logical path from student literacy to teacher literacy, then to normal students. Social change has promoted the reform of education in the new era. With literacy as the core element, the emphasis on developing critical, open-thinking, creative, and technical digital literacy capabilities is now the focus of student education reform. It is also a new era of education and teaching, with higher professional requirements. Normal students have the dual role of "current students and future teachers." They are both learners of digital technology and communicators of future education. Therefore, their digital literacy capabilities must align with the requirements of in-service teachers, and they must also reflect the latest educational ecology trend. As a reserve force for future teachers, normal students are also discussed by scholars under the big theme of digital literacy.

In terms of the research theme, there is an obvious evolutionary process of digital literacy in China, which comprises digital literacy to information literacy to digital teaching ability gradually focused on practice. In addition to the academic context, it directly reflects the obvious policy line for digital literacy. In the process of restructuring Chinese academics, the Chinese education administration and the Ministry of Education, in response to the development requirements for educational modernization, have carried out long-term and continuously effective planning of digital literacy education for teachers (including future teachers) to ensure that the digital literacy ability of Chinese normal students reflects the obvious Chinese characteristics of being "practice-oriented and ability-oriented" (Xiao, 2021).

In March 2012, the Ministry of Education of the People's Republic of China formally promulgated the Ten-Year Development Plan for Digital Education (2011–2020). It requested "the full depth of modern information technology and the integration of education, using information technology to lead the educational philosophy and innovative education model" as one of the working principles of promoting information technology in education. After recognizing that "teachers have basic information technology application capabilities but insufficient information technology teaching innovation capabilities, and insufficient integration of information technology and subject teaching," the Education Informationization 2.0 Action Plan directly required them to "actively adapt to digital and artificial intelligence." The Thirteenth Five-Year Plan for digital put forward a clear promotional task, including "digital teaching ability training into the normal student training curriculum

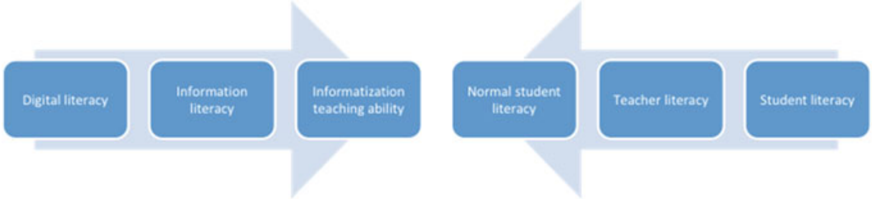

Fig. 10.1 The context of the digital literacy of normal students in Chinese discourse

system." The Teacher Education Revitalization Action Plan (2018–2022) also amplified the importance of information literacy and ability in the digital literacy of normal students, emphasizing the need to "research and formulate information technology application ability standards for normal students, and improve the information literacy and information teaching ability of normal students." Subsequently, the Ministry of Education, through "Professional Competence Standards for Teachers Majoring in Middle School Education (Trial)," "Professional Competence Standards for Teachers Majoring in Primary Education (Trial)," "Professional Ability Standards for Teachers of Teachers Majoring in Secondary Vocational Education (Trial)," "Special Education Professional Teacher Professional Competence Standards (Trial)" and other policy documents, put information literacy directly under the teaching practice ability module. It outlined a clear task definition: "Understand the new requirements for talent training in the information age. Master the common operations of information-based teaching equipment, software, platforms and other new technologies, and understand their support for primary school/middle school students/special children's learning and special education teaching. Use information and technology safely, legally and responsibly, and take the initiative. Awareness of actively and effectively carrying out education and teaching to adapt to new technological changes such as digital and artificial intelligence."

It also prompted domestic scholars to examine the digital literacy education of normal students, and the concepts of digital literacy and digital teaching for normal students are inseparable from each other. Therefore, teachers' digital literacy in Chinese academic discussions focuses on the practical ability of digital education and is biased toward the digital teaching ability, which has a clear practical orientation (Fig. 10.1).

10.2.2 Main Research Framework

Based on the information literacy guidelines set by the government, academia has conducted extensive discussions and established multiple research frameworks. Kang (2013) decomposed the digital teaching literacy of normal students into three stages: teaching design, implementation, and evaluation. On the basis of practical ability, Liu et al. (2015) expanded its structure to teaching philosophy (values, ethics, beliefs, etc.). Wang (2017) emphasized the consciousness of normal students as abilities. Yang et al. (2012) added educational technology research capabilities. Based on the aforementioned scholars, according to the educational goals in the 2017 and new curriculum standards, Zhang (2019) took into account the changes in the role of teachers in the intelligent era and supplemented the corresponding teacher abilities, including technical literacy (basic skills, moral responsibility awareness), professional development ability (learning ability, cooperation ability, and leadership ability), and digital student development ability (teaching awareness, planning and preparation, organization and implementation, and evaluation and diagnosis).

The Ministry of Education–China Mobile Scientific Research Fund project officially launched the "Empirical Research on the Standards and Training Models of Normal Students' Digital Teaching Ability" in 2015. Six normal colleges and universities set up a core research working group lasting 2 years to determine the Chinese Normal University Standards for evaluating the digital teaching abilities of students (Table 10.1). The final established standard for normal students' digital teaching abilities consisted of three dimensions: basic technical literacy, technical support learning, and technical support teaching, each divided into three sub-dimensions. The basic information literacy dimensions included awareness and attitude, technical environment, and information responsibility; the technical support learning dimensions included independent learning, communication and collaboration, and research and innovation; the technical support teaching dimensions included resource preparation, process design, and practice reserve.

On the whole, the discussion on digital literacy in Chinese academic circles has inherited the relevant discussions from Western academic circles, including the three levels of knowledge, ability, and awareness. In addition, interaction with the education planning administration highlighted the Chinese characteristics of being "practice-oriented, ability-oriented" (Ren et al., 2018).

10.3 Research Methodology

10.3.1 Objective and Subject Matter

The purpose of this research is to explore the status quo of the digital literacy research abilities of Chinese normal students; sort out the methods, technologies, and tools for measuring China's digital literacy capabilities; and provide an organized literature perspective for the next step of related research, with special attention to digital literacy and teaching science. The required combination of skills and knowledge emphasizes the practical orientation of education.

The object of analysis in this paper is a Chinese article published on China National Knowledge Infrastructure (CNKI, the world's largest Chinese academic website). The research object was selected mainly by specifying keywords and the publication date of the document. Since China's pre-service teacher system and the normal

Table 10.1 Comparison of main research frameworks

Researcher	Theoretical framework	
Kang (2013)	Digital teaching design, teaching implementation, and teaching evaluation	 1. At the level of ability, emphasizing practical digital literacy, such as using ICT to carry out teaching and design 2. At the level of knowledge, emphasizing conceptual digital literacy, such as the knowledge of ICT and the digital era 3. At the level of consciousness, emphasizing the digital literacy of thinking, such as values and ethics of information literacy China's digital literacy is biased toward practical ability
Yang et al. (2012)	General technical literacy, subject teaching design and implementation ability of technology integration, educational technology research ability	
Liu et al. (2015)	Digital teaching concepts (values, ethics, beliefs, etc.), teaching skills, and teaching ability (design ability, implementation ability, evaluation ability)	
Wang (2017)	Ability awareness, technical skills, design ability, application ability, and ethical responsibility	
Zhang (2019)	The technical literacy of digital teaching, the ability for digital professional development, and the ability for digital student development	
Standards for digital teaching ability of Chinese normal students	Three dimensions of basic technical literacy, technical support learning, and technical support teaching 1. The basic information literacy dimension includes three sub-dimensions: awareness and attitude, technological environment, and information responsibility 2. The dimension of technical support learning includes three sub-dimensions: independent learning, communication and collaboration, and research and innovation 3. The technical support teaching dimension includes three sub-dimensions: resource preparation, process design, and practice reserve	

teacher–student system are not completely equivalent, this paper only focused on the normal students in pedagogical faculties. Thus, the research focused on the Chinese teacher–student group.

10.3.2 Test Procedure and Literature Description

We used the following methods to search the literature. In order to ensure the accuracy of the screening, the selection criteria included: paying attention to the digital literacy/media literacy/digital teaching ability of Chinese normal students; excluding the literature that separately introduced foreign situations; including literature that provided one or more perspectives related to the subject; and being only available in Chinese.

Keywords used to search on the China Knowledge Network were “digital ability of normal students/digital literacy of normal students/digital literacy of normal students/information literacy of normal students/teaching of normal students.“ By reading the abstract, we judged whether the literature met the theme of the digital literacy of normal students and other filters; finally, the documents that met the conditions were determined.

Because of the small number of initial documents (Step 1), the selection of documents was not limited to the Chinese Social Sciences Citation Index (CSSCI), mainly to investigate their representativeness (Table 10.2).

10.3.3 Research Technique

There were also a variety of available literature research methods. Petticrew (2001) divided literature reviews into “narrative reviews” and “systematic reviews.“ Among them are two types of narrative literature reviews: one is a descriptive review that describes the literature; the other is a critical descriptive review that evaluates the literature based on the description. In addition, there are traditional narrative reviews (Traditional Narrative Reviews) (Ahmad & Omar, 2016; Jesson et al., 2011). Since there were only 12 direct documents on the digital literacy of normal students, we systematically sorted out the 12 documents, and then 555 documents with the theme of information literacy for normal students and 503 with the theme of digital teaching for normal students. We performed a narrative review and used the systematic literature review and narrative literature review comprehensively.

Table 10.2 Literature selection process

Step 1	Retrieved based on “digital literacy/digital ability of normal students,” the retrieval results comprised 12 articles in total
Step 2	Read the full text of the 12 articles
Step 3	Found the literature that focused on information literacy/ digital teaching for normal students
Step 4	Retrieved 555 results based on “information literacy of normal students”
Step 5	Retrieved 503 results based on “information teaching of normal students”
Step 6	Read the summary, selected representative literature, read the full text

10.4 Research Findings

10.4.1 Trend: The Digital Literacy of Normal Students Research Presents an Overall Rise

Overall, the research on topics related to the digital teaching ability of normal students in Chinese academia has shown an upward trend year by year. The first related article was published in 2002, and the number has steadily increased since then, rising rapidly in 2012 and 2018. In 2021, there were about 50 academic articles on this topic.

From the perspective of development trends, the related research trend in digital teaching ability was the same as China's information technology development. From the rise of the Internet in China in 2000 to the mobile Internet era in 2007 and 2008, the explosion of the mobile Internet in 2013, and the rise of artificial intelligence in 2016, the great progress of China's Internet has also promoted its education reform. The beginning of the twenty-first century was the official start of digital education, and it has developed rapidly in the first 10 years, promoting the rise of online education. In 2010, China entered a period of in-depth development of digital education. The related research on digital teaching ability occurred later than the development of information technology. Technology developed first, then promoted the development of teachers' digital teaching ability accordingly. Developing digital teaching ability is an important guarantee for the realization of digital education (Zhang, 2019).

Notably, on the one hand, the overall rising trend stemmed from the objective needs of educators in the digital age; on the other hand, it also reflected the advanced planning and promotion capabilities of Chinese administrative departments. Since the beginning of this century, China's education administration has been paying attention to the information age. The transformation of the role of teachers initiated long-term planning. The number of information-based teaching publications for Chinese normal school students rapidly increased in 2012 and 2018–2019, mainly owing to the spillover effect of two documents in the education sector. In March 2012, the Ministry of Education issued the Ten-Year Development Plan for Educational Digital (2011–2020). In April 2018, the Ministry of Education issued the Education Digital 2.0 Action Plan. Both documents mentioned the promotion of the digital capabilities of teachers (including normal students in pedagogical faculties), making it a hot topic in the academic community. The academic community has also paid increasing attention to its importance.

Naturally, the government's planning and deployment and objective education development requirements promoted the development of normal students' literacy. However, progress moves in stages, and the fluctuations in the number of publications indicated a certain resistance acknowledging to the digital literacy and information teaching needs of Chinese normal students. With the joint efforts of the academic community and the government, however, interest has continued to rise (Table 10.3).

Table 10.3 Annual trend in the number of publications

Information teaching for normal students		Information literacy of normal students	
Year	Number	Year	Number
2001	0	2001	4
2002	1	2002	11
2003	1	2003	10
2004	6	2004	19
2005	2	2005	17
2006	6	2006	19
2007	10	2007	39
2008	11	2008	30
2009	12	2009	32
2010	14	2010	38
2011	9	2011	31
2012	35	2012	39
2013	26	2013	33
2014	34	2014	37
2015	22	2015	16
2016	33	2016	17
2017	48	2017	20
2018	37	2018	31
2019	80	2019	47
2020	83	2020	44
2021 (Until August)	33	2021 (Until August)	21

10.4.2 Theme: The Practice and Training of Normal Students Receives More Attention

After analyzing the themes and keywords of all selected documents, we found that compared with that on in-service teachers, the research on the information teaching ability of normal students was not large. In the analysis of the keyword co-occurrence knowledge network graph under this topic, Zhang (2019) found that the keyword "teacher student" was also at the edge of the network; the overall research has not been given much attention. Closely related to the keywords "teacher students" were "educational technology public courses," "cultivation," "training strategies," and "TPACK," indicating that the research related to the digital teaching ability of normal students has mainly focused on the public education technology courses. In terms of training and TPACK, there was a lack of research on other training strategies, and the keywords "influencing factors" were far away from "teacher students." The connection line was not close, indicating less research related to the factors influencing normal students' digital teaching ability. Training strategies including TPACK have become the most researched content.

In the research on training strategy, domestic research has focused on the micro and curriculum levels, often focusing on whether normal students have improved their ability to use a certain information technology after learning a certain course. One example was whether modern information technology courses have improved the capacity for courseware production and micro course production rather than the ability to support the development of students' core literacy in addition to knowledge presentation and transmission through digital teaching.

In addition, there was little research on the development of digital teaching ability for specific subjects. Compared with the total, there remained a lack of high-quality research on information teaching ability combined with specific subjects. The research focused on the micro-level, and there was little research on the meso-macro-level. From the perspective of keywords, they were concentrated at the micro-level; the stakeholders involved were teachers and courses at the micro-level, and keywords at the meso-macro-level were relatively lacking. When analyzed, on the one hand, the digital literacy of Chinese normal students already existed in the guidance documents of the education department at the macro-level, and the academic circle was more inclined to refine based on the policy direction. On the other hand, it reflected the academic research. The status quo needs improvement at the level.

Although the perspectives and theoretical frameworks were different, academic research generally paid attention to effectively using means to improve digital practice, thereby improving digital literacy. Different models, including TPACK, provided scientific tools to explain the current training situation and improve training effectiveness. This phenomenon proved the obvious characteristics of China's digital literacy, which is biased toward practice and teaching (Table 10.4).

Table 10.4 Document subject/title frequency

Information teaching for normal students		Information literacy of normal students	
Subject/title	Frequency	Subject/title	Frequency
Normal student	105	Normal student	247
Digital teaching ability	99	Information literacy	204
Teacher information teaching ability	25	Teacher information literacy	29
Digital teaching design ability	22	Normal students education	27
TPACK	22	Training strategy	26
Improvement strategy	16	Information literacy education	23
Information teaching	15	Digital teaching ability	23
Training research	12	Educational technology ability	23
Training strategy	11	Information literacy training	22
Digital teaching design	9	Strategy research	15

10.4.3 Methodology: Qualitative Research is the Mainstream, and Quantitative Research is Growing Rapidly

From the perspective of research methods, qualitative research was the mainstream method for this theme, and the number of articles using quantitative research was relatively small. These quantitative studies included a questionnaire survey on digital literacy, digital teaching ability, and the information capability of normal students (Li & Xia, 2017). The samples mainly included a limited number of normal students in a specific school. Large-scale and large sample surveys were relatively scarce.

From a development point of view, there was an increase in articles related to quantitative research. Take the ten latest pieces of literature in reverse chronological order as an example. Five of them used quantitative research methods, including sampling surveys and construction of an indicator system, reflecting the gradual increase in quantitative research on this topic. In addition, many scholars have also developed a series of questionnaire indicator systems to effectively measure ICT technology when surveying the status quo of the information teaching ability of normal students. Some studies on the teaching abilities of normal students have also included questionnaire surveys (Liu et al., 2015; Wang & Wang, 2017; Zhou et al., 2017). The indicator system included not only concepts but also skills, influencing factors, and training aspects.

This change was closely related to Chinese academic circles' understanding of the digital literacy of normal students and the requirements of Chinese social development for the digital literacy of teachers (Zhang, 2014). It reflects the stage of research on digital literacy and information literacy topics. When scholars deal with concepts such as digital literacy, they first need to determine its connotation and extension under the Chinese discourse system so that they can form a Chinese interpretation. At this time, qualitative methods have more theoretical explanations. When the academic community forms a preliminary explanation and objectively requires a more accurate and quantitative view of the digital literacy of normal students, quantitative methods using surveys and other methods develop gradually. The construction of specific survey indicators and influencing factors became the key content discussed by academic circles and added to the government's decision-making basis (Table 10.5).

Table 10.5 Quantitative literature ratio

Information teaching for normal students		Information literacy of normal students	
The first 20 articles (2002–2005)		The first 20 articles (2001–2002)	
Qualitative	17	Qualitative	17
Quantitative	3	Quantitative	3
The latest 20 articles (2021)		The latest 20 articles (2021)	
Qualitative	14	Qualitative	11
Quantitative	6	Quantitative	9

10.4.4 Performance: Normal Students' Digital Practice Abilities Are Insufficient

At present, representative quantitative surveys mainly take the form of self-reported reports of normal students to collect information. Based on the survey results of multiple scholars, there were obvious differences in the information literacy of normal students in terms of knowledge, awareness, and practical ability.

Specifically, at the level of awareness, many of the surveyed normal students had enlightened information responsibilities and consciousness. They all believed that digital teaching ability is crucial and that they need information literacy to improve their digital literacy. At the knowledge level, the surveyed normal students tended to display relatively high self-confidence in their "traditional" knowledge and abilities required for informatized instructional design, such as basic theories and methods of instructional design and teaching process design. In modern teaching and learning theories, new teaching models, informatization teaching design processes, etc., the informatization teaching design abilities include higher-level teaching resource development, target design, learner analysis, task design, and teaching method design capabilities. For information technology and curriculum integration, information teaching evaluation ability, etc., as well, the self-evaluation of normal students was not ideal. Most students said they were unclear about the connotations, theoretical basis, and development frontiers of digital teaching ability and lacked in-depth understanding (Liu & Sun, 2019).

At the practical ability level, there were obvious deficiencies in the self-reports of normal students about the design of digital teaching, the recording and analysis of the digital teaching process, and the organization and implementation of digital teaching activities. Technical support for normal students' learning and teaching skills and evaluation of their digital teaching ability satisfaction was also low, far from satisfactory. In addition, there were significant differences in the satisfaction, basic technical literacy, technical support learning, and digital teaching evaluation abilities of normal students in different majors. Specifically, the basic technical literacy of students majoring in science was higher than that of students in liberal arts, arts, and sports. The scores of liberal arts majors in technical support learning, digital teaching assessment ability, and digital teaching satisfaction were lower than science, arts, and sports majors. Students with teaching experience scored higher in information-based teaching satisfaction than students without teaching experience. There were also obvious gaps in the digital capabilities of normal students in different regions. The group capabilities of normal students in remote and rural areas generally lagged behind economically developed and advanced education areas (Li, 2020a, b; Liu, 2021; Luo et al., 2021; Wang et al., 2021).

Based on interviews, it was found that although the school provided a basic environment for cultivating digital teaching ability and digital teaching resources, it lacked a systematic curriculum system for developing normal students' digital teaching abilities. In terms of curriculum content, it lacked a set of systematic training standards to apply to the information technology abilities of students, and the theory and practice system of the integration of information technology and subject curriculum were used as teaching guidance. It will be necessary to improve the information literacy curriculum system at a later stage and emphasize the connection between teaching knowledge and teaching practice (Liu, 2021; Shen & Yang, 2020).

Objectively, this lack in the normal students' level of teaching not only reflects the lack of progress in the normal students' training system but also explains the reason for the emphasis on the research themes of cultural strategies: academia increasingly recognizes the importance of normal students' digital literacy and takes competence and practice as the starting points for overall development. Second, it also indicates that implementation of the Chinese government's planning still suffers from a degree of running-in and lag. The specific curriculum system needs to be more objectively optimized based on the literacy specified by the government (Table 10.6).

10.5 Discussion

10.5.1 Evaluation of Existing Research

As the core literacy of future educators, digital literacy has gradually received attention from academic circles in developing and innovating educational concepts. The essence of China's teacher literacy context is "from student literacy to teacher literacy, then to normal teacher literacy." Regarding the subject, the context is from "digital literacy to information literacy, then to digital information teaching ability." Under the planning of the Chinese education administration, the Chinese characteristics of being "practice-oriented and ability-oriented" have gradually emerged.

In terms of research trends, research on the digital literacy of normal students has increased overall. On the one hand, the research depends on the academic community's gradual appreciation of the subject, which will promote in-depth academic research; on the other hand, it is also on the result of clear policy planning. In terms of research topics, the digital literacy of normal students is more biased toward practice and training, and there is less research on the development of digital teaching ability for specific subjects. In terms of research methods, qualitative research is still the mainstream method, but more and more quantitative research, including surveys, is being conducted. In terms of research results, the current survey report data suggest the digital practice abilities of Chinese normal students still need improvement.

10.5.2 Research Limitations and Future Research Direction

Looking back at the existing research on the information literacy of normal students in China, although academic circles have expounded its concept and focused on exploring its practical aspects, there are still obvious deficiencies. These include the

Table 10.6 2019–2021 representative quantitative article (portion)

Researcher	Valid samples/Total samples	Survey object and method	Questionnaire structure	Analytical method
Wang et al. (2021)	16,439/	20 normal graduates from all over the country, not specified	PT-ICT is a set of dependent variables, divided into basic technical literacy, technical support learning, and technical support teaching; Factors as independent variables set, including five supporting areas of personnel, facilities, programs, mechanisms, and environment	Descriptive statistics
Li (2020a, b)	300/	Normal students from five normal colleges in Gansu, online questionnaire	Three dimensions of information technology literacy, information learning ability, and technology teaching integration	Descriptive analysis and analysis of variance
Luo et al. (2021)	556/	Normal students at the Normal College in Qinghai Province, online questionnaire	Three dimensions of basic technical literacy, technical support learning, and technical support teaching	/
Li (2021)	392/400	Normal School students in Inner Mongolia, paper questionnaires and online questionnaire	Including information awareness, information capability, information security, moral awareness, etc	/

(continued)

Table 10.6 (continued)

Researcher	Valid samples/Total samples	Survey object and method	Questionnaire structure	Analytical method
Li (2020a, b)	570/577	Normal students of a local undergraduate college in Anhui Province, not specified	The three dimensions of basic technical literacy, technical support learning, and technical support teaching. In the questionnaire, basic technical literacy includes awareness and attitude, technical environment, and information responsibility. Technical support learning includes independent learning, communication and collaboration, and research and innovation; technical support teaching includes resource preparation, process design, and practical preparation	/
Shen and Yang (2020)	229/300	Normal students in three normal colleges in two provinces, not specified	Including basic technology literacy, technology-supported learning, technology-supported teaching, and information-based teaching evaluation capabilities	Principal Component Analysis
Liu et al. (2021)	111/121	Normal students at a pedagogical university in Tianjin, not specified	Two dimensions of digital teaching concept training and skill training	Factor analysis
Liu and Sun (2019)	1101/	Fourth-grade normal students of Shaanxi Normal College, online questionnaire	Including basic technical literacy, technical support learning, and technical support teaching	/

following concerns: (1) From the perspective of research subjects, the emphasis is on in-service teacher research, and far from enough attention is paid to normal students in pedagogical faculties; they remain in a marginal position in the knowledge system. (2) On the basis of research, the standards of ability for in-service teachers are often used as the basis for studying the corresponding abilities of normal students, ignoring the difference between them. Therefore, it is necessary to develop a proprietary standard for normal students, which will be of great significance in standardizing and guiding the cultivation of Chinese normal students' digital teaching ability. (3) Regarding the research focus, emphasis is now placed on practice and application, and attention to other aspects of normal students' abilities, such as innovative thinking ability, critical thinking ability, autonomous learning ability, collaborative communication ability, problem-solving ability, etc., should increase. Therefore, when constructing a digital teaching ability model for normal students, it is necessary to fully consider the professional changes for teachers in the digital age, highlighting the improvement of core literacy and the all-around development of people supported by information technology. (4) From a research perspective, domestic research on the information teaching ability of cadres and normal students often originates in a static and isolated perspective. It lacks the comprehensive perspective necessary to examine the interests of normal students, teacher educators, and management to learn how the subject factors ultimately shape the training results of information and digital literacy through interaction. Although the research has found some influencing factors, it has not systematically explored the connections among the various stakeholders. Therefore, it must proceed from a dynamic research perspective to investigate the relationships of the participants at the micro and the macro levels.

At the same time, the inequality of digital education for normal students in China also needs attention. However, because of the uneven development of teaching equipment and education levels across the country, there are still restrictions on hardware resources and teachers in rural and poor areas, which imposes restrictions on normal students. Educational inequality has also created obstacles to the improvement of digital teaching ability.

Based on the limitation mentioned above, different scholars have provided different suggestions for different levels such as top-level design, middle-level strategy, and micro-level curriculum implementation, curriculum construction at the meso-level, construction of teaching facilities, and teacher development at the macro-level. The core content, such as policy planning, training strategy improvement, and educational transformation, indicated the direction for the academic community and also suggested the requirements for future scholars, policy researchers, and policy makers. In addition, more empirical research is needed on the digital literacy of normal students. The spatial distribution of the digital literacy of normal students is also an important future research field. The comparative study of the concept and meaning of digital literacy of Chinese normal students with that of foreign countries also needs to be further investigated.

10.6 Conclusion

Normal students in pedagogical faculties are both citizens of the digital society and future workers in education. Their digital literacy represents the potential ability of teachers to improve the core literacy of students while reflecting the adjustment direction of the normal education system in response to social changes. We conducted a semi-systematic literature review of Chinese academic papers from the past 20 years with the theme of teacher-training students' information teaching ability. Based on a summary of the existing literature, this article proposes several directions and key points for future research on the digital literacy of normal students.

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Chapter 11
Digital Competencies of Czech Pre-service Teachers: Review Study

Milan Kubiatko

Abstract The aim of this chapter is to explore the level of digital competency (DC) among students of the faculties of education in Czech Republic based on previous research. For this purpose, a systematic analysis of the literature (peer-reviewed articles, proceedings from conferences) indexed in repositories and scientific databases such as Google Scholar, EBSCO, Scopus, and Web of Science was used. Based on data from 2001–2021 on Czech students, these being future educators, it was noted that (1) the occurrence of studies regarding to digital competence is very rare in Czech Republic; (2) there is problem in core definition in this region of digital competency concept. The concept of digital literacy is often used as synonym of digital competence; (3) the authors published not only in scientific journals but also in proceedings of conferences; (4) the part of studies is regarding to analysis of text; (5) studies are conducted in different institutions; (6) the level of digital competence is most often described as good; and (7) part of the studies had got comparative character, mainly with neighbored countries and the level of DC is similar.

Keywords Czech Republic · Digital competence · Digital literacy · Faculties of education students · Pre-service teachers · Systematic literature analysis

11.1 Introduction

The last decade is the period of the huge changes in the requirements for people. Rapid development of information and communication technologies (ICT) caused change of habits in personal and also in the work life of people. ICT brings new challenges in the teaching and learning process. On the basis of these facts the new abilities, how to work and how to learn are required for the students and all people. And how the digital competence is developing, how the students and people are able to use ICT in their learning and working activities, so they are success in the study time and also in the work process. In this chapter, there is the effort to analyze

M. Kubiatko (✉)
J. E. Purkyne University, Usti and Labem 40096, Czech Republic
e-mail: mkubiatko@gmail.com

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published studies for the last 20 years. The aim of this article is to explore the level of digital competency (DC) among students of the faculties of education in Czech Republic based on previous research.

11.2 Theoretical Framework

The concepts of digital competence and digital literacy are in many cases considered for synonymous, so below are presented both concepts, how they are perceived in scientific world. First at all, it is important to define the concept competence, which was for the first time introduced into work of White (1959). Competence is in general view defined as the ability to do well some special things; the knowledge, skills, values and attitudes needed to make some activity significant to success in professional life (Butler, 1978). The number of studies regarding to concept "competence" is huge; however, there is possibility to find many of discrepancies among them and this small problem is long lasting. However, there is a possibility to find out some similar signs, which creates the non-problematic definition of this concept (e.g., Blomeke et al., 2015). One notice toward the definitions of concept in British and in American world, competence in Britain and competency in America according to Mitchelmore and Rowley (2010): The concept "competence" is regarding to behavior a person should be able to demonstrate (e.g. Moore et al., 2002), and the concept "competency" is defined as a set of personal characteristics that facilitate performance (e.g. Boyatzis, 2008). As it was written above, the disconcordance in the terminology of the concept competence is a problem. However, it is important to mention the effort of scientific society to create and build rigorous theoretical framework. On the basis of these activities, it is possible to find and read conceptual analysis regarding to this concept (Norris, 1991; Stoof et al., 2002). For the purpose of the study the perception of digital competence from the British view is correct. Yet one kind of information, the concept of digital competence should also be developing from socio-cultural perspective. And in the educational environment the teacher is the person, who has got the responsibility for the acquisition of adequate abilities to use information and communication technologies for everyday life of pupils. According to this, the teacher becomes a key element for the development of students' digital competence (Passey et al., 2018; Søby, 2013).

The concept "digital literacy" is needed to mention on this place because it is in narrow relationship with the "digital competence". The United Nations Educational, Scientific and Cultural Organization characterized literacy as being a fundamental human right (UNESCO, 2008). UNESCO (2008) defined this concept, that person is literate, if she/he is able to read and write a short simple statement on his (her) everyday life. The concepts "digital competence" and "digital literacy" were used in many scientific literature, also in the policy documents as synonymous (see e.g. Iordache et al., 2017; Martin & Grudziecki, 2006). The concept of digital literacy was possible to find out also in the economic literature, where authors provided kinds of information about the correlation between the level of digital literacy and poverty (e.g. Chetty et al., 2018). So, it is possible to define the concept of "digital literacy" as the ability to understand and also use different kinds of information in multiple formats from a variety of sources when it is presented through information and communication technologies (Gilster, 1997). Through the years this concept was became more and more complex. The reasons are in the developing of many disciplines and ICT had got more a more influence on the different aspect of human life like education, business and others. Ba et al. (2002) offered a broad definition of digital literacy. They described digital literacy as a set of habits through which people use information technologies for learning, work, and fun.

At this point it is appropriate to mention small conflict between the terms used above. As it was noticed, in the scientific world there are many opinion currently, some of them suggested that these concepts are synonyms. And other scientists considered these two terms as different. However, there is many unclearness in the concepts of digital literacy and digital competence, so for the purposes of this chapter the term digital competence will be used, because from the authors point of view is digital literacy something different.

11.3 Brief Report About Training for Future Teachers

In the Czech Republic is the program "Digital education strategy", which includes the development of digital competency among all type of schools. With the respect to purpose of this chapter, the kinds of information regarding to preparation of future teachers will be presented below in the brief form. Activities regarding to future teachers' education were following:

- preparation of digital standard teacher competencies;
- systematic integration of the standard digital teacher competencies to undergraduate teacher training, its inclusion in the graduate profile and in educational programs submitted for accreditation;
- creation of complex teaching resources, methodological recommendations and online materials suitable for teacher education in didactics digital literacy development and pupils' computer thinking;
- extension of educational faculty programs teachers about the issue modernized educational areas, including ICT education, developing digital literacy and pupils' computer thinking;
- preparation available nationwide in-service teacher training offers in areas of digital development competences and IT pupils' thinking, including creation massive open online courses (MOOC) with the option of certified termination (certificate of completion).

The Ministry of Education, Youth and Sport of Czech Republic declared that all points, which are presented above, are fulfilled. And also, other statement of Ministry was, that all activities will continue, because digital competencies of teachers are important and integral part of teachers' abilities. The detailed kinds of information about activities and (partial) results of them is possible to find on the web page of Ministry (MSMT, 2021).

11.4 Research Methodology

11.4.1 Objective and Subject Matter

The aim of the research is to explore the level of digital competence (DC) in Czech Republic among students of faculties of education. The man of this study was focused on the previous research studies regarding to digital competence among future teachers. The author of the chapter presented text in the form that only published results are showed in the results part of this chapter. Secondary aims were to present the methods, techniques, and research tools in which digital competence in above mentioned country were measured. Due to unclear terminology, where the terms digital competency and digital literacy are in many studies considered for synonyms, the author determined to include studies with both objects of research like digital competence and also digital literacy.

The subjects of the analysis are scientific articles, which went through the review process and were published in domestic (Czech) and foreign scientific journals. The object of research has been selected by assigning key words and the date of publication of the document. The subject of the research focused only on the students' educational faculties.

11.4.2 Test Procedure

The subject matter of the research was selected by using the following keywords: digital competence (and the following synonyms—digital skills, media competence), students, education, Czech Republic, and Czech. The keywords in Czech language were translated into English in order to broaden the literature selection due to the fact that Czech researchers also publish their texts in congress languages (with a special focus on English). The term pre-service teacher was also added to the key words in English, which is very often used in the foreign literature as a term clearly indicating a group of students of education faculties.

The research procedure was performed twice, once for each of the two language variants, Czech and English. The selection of the object of research, i.e., scientific articles, was carried out using search engines of scientific texts: SCOPUS and Web of Science databases. These databases were chosen according their acceptance of scientific community all over the world. The selection of the research subject was narrowed down to the period 2001–2021 due to the technological changes that have influenced the development of digital competences in that time (e.g., the intensive incorporation of new media in school and academic didactics in pedagogical faculties).

Based on the procedure of text selection within the systematic discourse analysis, a total of several thousand scientific articles containing the indicated key words were analyzed. The specific number of texts covered by the analyses, i.e., that met the criteria presented in previous chapters. It was important to eliminate duplicated studies, which were included into more than one database. The research studies analyzed were characterized by these criteria: the sample had to be related to students of faculties of education in Czech Republic, the measurement needed to include issues of digital competence, and the research needed to have a description of results.

11.4.3 Research Technique

The research employed a systematic literature analysis (SLA), which is focused to identify, select and to critically evaluate research due to find responses on research questions regarding to review analysis. It is a complex, transparent searching activity conducted through selected databases (on the authors criteria and selection) and selected literature that could be reproduced and rewritten by researchers interested in similar problematic. The analytic activity should be planned on the focus to find answer on questions showed before and even created through review. The review should find certain kinds of information following the rules of the review. The search concepts, strategies (like databases, or other platforms, and also dates of search) and limits should be precisely be included in the review (Okoli, 2015). Text selection was performed by checking the research methodology, focused on the sample, research technique, and also on the main results.

11.5 Results

The SLA analysis included totally twelve studies regarding to this concept, the amount was higher, but from the analysis were eliminated studies, which were focused on the similar problematic, but the research was conducted on the different faculty, like is Faculty of Education. And the second selected factor was the sample, the majority of studies had got among respondent's pupils from elementary and high schools, also teachers from practice or adult population. These factors significantly reduced the total amount of studies.

The studies are dispersed among different universities and different authors, part of studies had got research character and part of them had got theoretical character. The theoretical studies were focused on the analysis of documents, and empirical studies were focused on the identification of digital competency level by the using of questionnaires.

The source, where were published, is divided into two basic groups. The first one is regarding to studies published in journals, and the second one is group of studies published in proceedings of conferences. Other findings from analysis are the time of publishing, and the studies were published in the last decade.

11.6 Discussion

The analysis of literary sources regarding to digital competency was according common used scientific method called systematic literature analysis (SLA). The compliance of criteria aimed to choosing of the literary sources, which filled conditions regarding to correct key words like digital competence, Czech Republic, students, and education. The other criteria was, that the research sample should be from faculties of education, but as it is below discussed the amount of these kinds of literary sources was little bit low, so the other variable came inside in the analytical process. As it was mentioned above, the chosen key words were given into analyzed databases like Web of Science, SCOPUS, and Google Scholar. The main key word was "digital competence", but after the using terms like digital skills or something similar, the identical results of literary sources were found out. The concept digital literacy was not used because in some nuances they are different concepts. However, this concept has got according scientific literature a longer tradition than digital competence (Erstad, 2010), and there are studies about digital literacy related, e.g., to education (Sefton-Green et al., 2009). This term is regarding to traditional perception of literacy but also to media studies. The main and significant difference between these two concepts (education and literacy) is that literacy is connected with a person's ability to read and write, while education refers to the systematic process of obtaining knowledge, attitudes, skills, values, beliefs, and other abilities of persons. Literacy is one of the many steps to acquire appropriate form of education (Kim, 2019; Kim & Lee, 2013; Nikolajeva, 2010).

The other variable was time period, and it was from 2001 till 2021, but all studies, which are presented in Table 11.1 were published in last ten years. It is obvious also form the scientific literature. By analyzing the scientific literature on digital competence development models, this developing process is possible to observe (Carretero et al., 2017; Ferrari, 2012; Redecker, 2017). From the first moment, where significance of digital competence was included on the training process of future teachers to present, where the positive development of teachers' level of digital competence is expected through their real practice in educational institutions, it is awaited the transfer from teachers to their pupils or students. On the basis of this fact, it is possible to think that majority of researches were done in the last decade.

The core sample was created by university students, concretely from the students of educational faculties. However, the original idea was good, but the number of published articles in indexed journals was very low. The important number of articles or in this case, the better term is study, was published in scientific conferences, like an empirical studies or theoretical reviews. Because, the number of these studies

Table 11.1 Summary of results of systematic literature analysis

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Javorsky and Horvath (2014)	Theoretical research	Text analysis	Definition of the concept digital literacy from the international context	The comparison of the findings to the national curricula from different countries and to compare each other with regards to its subjects and grade specification
Eger et al. (2018)	University of West Bohemia; Palacky University in Olomouc (n = 205, together)	Self-report questionnaire (probably Likert scale type items)	ICT competence, then definition of digital competence and at the end of the theoretical background is presented research studies	The study was focused on the finding out future type of teachers regarding to digital competence. The application of cluster analysis found four different user groups according to their use of ICT in their life
Chmura et al. (2019)	Institution—not specified (n = 150)	Likert type items questionnaire	Digital competence—main definitions from the view of different authors	Findings can be considered to be “prodigious” attitudes of academics and students, and these should be transported into evaluation tools for the assessment of higher education and learning

(continued)

Table 11.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Duffek et al. (2019)	West Bohemia University (n = 10)	Evaluation of presentation created on the basis of experience with virtual reality. Also questionnaires after work with virtual reality	Virtual reality and its application—definitions from many perspectives	The presentation of individual students in a virtual classroom is a good way to open both subject and didactic topics in teaching didactics. It turned out that pre-service teachers very often focus their training and self-learning on the professional (disciplinary) accuracy of the presented curriculum, and are less concerned with the didactic aspects of the topics taught—how to explain and motivate pupils to learn

(continued)

Table 11.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Cernochova (2019)	Theoretical research	Text analysis	Computational thinking as theoretical concept and it is defined from the different points of view	In order to be ready for the planned curricular changes in schools, compulsory courses for student teachers of pre-primary, primary and secondary schools were designed. The author summarises her experience with development of computational thinking of primary school student teachers at the Faculty of Education, Charles University
Cerny (2020)	Masaryk University (n = 372)	Web analytics tools, testing and self-evaluation tools, and a questionnaire	Definitions of digital competencies to connectedness with learning behavior	Response on the questions, how students self-evaluated themselves as digital competence persons
Cernochova and Novotna (2020)	Theoretical research	Text analysis	The report about ICT in the Czech republic comparing with other countries like Austria, Slovakia, Poland and Germany	The main results were focused on the documents related TO ICT education in the countries mentioned in the theoretical framework

(continued)

Table 11.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Casas Moreno et al. (2020)	University of West Bohemia and Ostravska univerzita (n = 132)	Likert type items questionnaire	Need of new skills of students due to huge development of ICT	Students use educational applications once a week. They are self-taught and use these applications in a field. On the other hand, the figures detect a lack of training in how to use the educational applications for learning or complementing studies such as languages, subject reinforcements, and blended learning
Haskova and Zahorec (2020)	Charles University in Prague, University oh Hradec Kralove (n = 75)	Questionnaire	Tendencies in digital competencies and the comparison between Slovakia and Czech republic	The teacher training related to the use of digital technologies was appropriate implementation of different software applications into teaching

(continued)

Table 11.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Eger et al. (2020)	University of West Bohemia; Palacky University in Olomouc (n = 583, together)	Questionnaire (Likert scale type)	ICT education in the countries, which were included in the study. The presentation of the research works focused on the similar problematic	The results showed differences in the use of ICTs according to four selected areas: ICT for leisure-time activities, social networking, ICT on mobile phones, and ICT for study purposes by students
Krelova et al. (2021)	Universities, but not specified (n = 1233)	Likert type items questionnaire	Digital competencies in the actual pandemic situation	The research has unequivocally proven that digital literacy is influenced by the study programme specialization, study level and study form It is necessary to mention, that the full article is not available, so the presented kinds of information could be not complete

(continued)

Table 11.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Svoboda and Mynarikova (2021)	Not specified university in Czech republic	Probably questionnaire	The importance of MOOC courses as a support in teacher education	The paper focuses on social science teachers who lag behind others in the use of digital technologies. It is important to create MOOC courses for the development of digital competencies and for the use of digital technologies in teaching It is necessary to mention, that the full article is not available, so the presented kinds of information could be not complete

was low, so also text analysis of documents connected with digital literacy or skills typical for future teachers, whose were studying at faculties of education. The analysis showed that the digital competencies are in good levels among students, and they are comparable with respondents in other countries. Some of studies had got comparative character. Mainly, the selected countries were neighbored and as it was mentioned above the level of digital competency was similar.

When the empirical studies were analyzed, in the majority of cases was used questionnaire with Likert type items. This type is frequently used because it produces quick and reliable findings. Only in minority of studies were used other techniques. And as it was mentioned other part of research studies were presented by text documents. The findings were mentioned in previous paragraph, so the repeating of the information is not appropriate.

11.7 Summary

The presented chapter was trying to bring some new kinds of information about digital competency among college students in Czech Republic. This kind of study belongs among the first one, which is focusing on this problematic and trying to summarize knowledge and findings about the level of digital competency among mentioned group of respondents. The possibility, why this is the first one is that the number of the studies regarding the problematic of digital competency among Czech students of educational faculties is low. On the basis of this, in the future could repeat this review publication, because the number of studies could higher that it is nowadays.

From the presented facts there are some limitations. Some of them were mentioned in the discussion and in this chapter. Other one is time period, as it is possible to see, the research studies were published in the last decade, on the beginning of century the number of studies was zero. In the era, the beginning of implementation of ICT into educational process was starting, so only the studies focused on the basic work with ICT and attitudes toward ICT were published, but the main sample was pupils from high schools. And the direct effect of ICT on the skills of pupils, students and teachers were studied later in the second decade of the millennium, so when the research studies about digital competencies started. However, the aim was not only university students but also pupils of elementary and high school and also teachers on every grade of the school.

The presented chapter is divided into typical parts for this kind of study. In the first part, the basic definitions of main concept, mainly on digital competence. In this region is small problem with the clear expression of this concept, so it is common phenomenon to use in different synonyms, the most often is concept "digital literacy", in the theoretical background are in brief form presented basic kinds of information. Except of this the information about history of digital competence and development of this concept is presented.

In the practical part are presented methodological information about the choosing of studies regarding to digital competence. The results part includes presentation of studies regarding to main aim of the chapter. The discussion part discussed about main problems of the result parts.

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Chapter 12
The Dominican Republic and the Digital Competencies of Future Teachers in the Digital Age

Darwin Munoz, Rita L. Cruz, Leipzig Guzmán, and Laura Reyes Alardo

Abstract Higher education institutions deal with many defiances as the world evolves constantly. Since the 1990s, many countries have progressively experienced several changes as they arrived at the digital age. In addition, the pace at which technology is evolving is ever increasing. Thus, future teachers in the Dominican Republic (DR) as digital natives would benefit from using technology during education. Consequently, this systematic review utilized four databases to describe the concept of digital competence in higher education and intended to identify how future teachers on the DR can use ICT. Also, to determine their digital literacy and the components frequently used to evaluate DR's future professor's competencies in these aspects. The review indicated a project from the DR government that seeks to improve education and knowledge by integrating digital technologies in schools. Teachers attribute a sufficient or suitable level of training in ICT, particularly in the technical handling of technological tools and Internet access. The extent of training decreases as the ICT content is more complex. Also, most teachers lack a research profile, basically because teachers lack a Ph.D., among other factors. It is interesting that although for decades the informality and lack of concrete plans to have teachers digitally competent to teach the future professors in the DR. Since 2015, that reality began to change with Regulation 09-2015. Then the Agenda 2030, in

D. Munoz (✉) · R. L. Cruz
Universidad Federico Henríquez y Carvajal (UFHEC), Av. Máximo Gómez Esq. César Nicolás Penson, Santo Domingo, Dominican Republic
e-mail: dcmunozn@gmail.com

R. L. Cruz
e-mail: Licelot.cruz@gmail.com

L. Guzmán
Universidad Iberoamericana (UNIBE), Av. Francia No. 129, Gazcue, Santo Domingo, Dominican Republic
e-mail: L.guzman@unibe.edu.do

L. Reyes Alardo
Universidad Domínico Americano (UNICDA), Abraham Lincoln No. 21, Santo Domingo, Dominican Republic
e-mail: Lreyes@icda.edu.do

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2021, is perfectly complemented to establish the competencies required for future teachers in the DR.

Keywords Digital competencies · Future teachers · Digital age

12.1 Introduction

The rapid growth of knowledge must include critical situations for higher education institutions (HEIs). The scenario is challenging for them. On the one hand, technological change could be observed, and on the other hand, a rapid expansion of information (Dias & Ryland, 2017; Rychen et al., 2003). In the past, the cause of this progressive expansion of information was globalization (Dias & Ryland, 2017; Rychen et al., 2003). The 1990s represented the beginning of an era where many countries had undergone these adjustments. Thus, they went from the knowledge society throughout the industrial era and arrived at the digital society (Zhao et al., 2021). In the past, the cause of this progressive expansion of information was globalization (Dias & Ryland, 2017; Rychen et al., 2003). As the world faced transformation and rapid growth, industries required a different graduate than the one they demanded from post-secondary education; a graduate who could work in complicated scenarios (Westera, 2001). The focus on acquiring knowledge disappeared, and the dominant concern was that the graduate acquires the competencies required by the industry (Westera, 2001). Guidelines for education were established (Rychen et al., 2003). These guidelines should serve as standards or competencies that the new graduate should acquire in the twenty-first century. The main characteristic of these standards was that instead of being focused on a particular setting, such as the student or the school achievement, or meeting the labor market needs, it would serve in a permanent learning perspective contributing to an individual's fruitful life and a better society (Rychen et al., 2003). This project aimed to ground the competencies needed to face the present and the future with a solid theoretical basis and identified clear quartet fundamentals for these competencies. For them, these essential abilities had to be multifunctional, crosswise throughout social fields, reflex a high order of mental difficulty, and integrate proficiency, common-sense, critical, inventive, communication abilities, and understanding and logic to make decisions (Rychen et al., 2003). Therefore, in December 2006, the European Committee established these competencies and indicated that individuals should seek them permanently for education during their lives. Among the competencies were communication in the inborn tongue, mathematical competence, communication in a non-native dialectal, technical and industrial elementary competency, and *digital competence, a*mong others (Crick, 2008; European Commission, 2006). The European Commission created DigComp, after establishing digital competence as one of the abilities students should acquire during education (the European Digital Competence Framework). This framework indicated the standards for digital literacy and introduced a list that included several competencies and the abilities that individuals should acquire according to their academic level, serving as a basis to the European context (Zhao et al., 2021).

In 2018 the European Commission adopted the term "Digital Literacy or Digital Competency' to indicate that individuals can routinely incorporate systems and knowledge of technology as part of their daily activities (Hernández, 2018). It is also thought of as part of the critical competency individuals most exhibit in the 21st Century. However, consideration for *digital competence's* acquisition continued to grow acceptance in higher education. One of the facts considered is that students in the 21st Century experienced the development of online media. They are familiarized with the use of cyberspace, artificial intelligence, virtual reality and have social awareness regarding digital literacy (Iansiti & Richards, 2020; Zhao et al., 2021). Consequently, technophiles would benefit from ed-tech strategies as part of their instruction as to future professors (Guillén-Gámez et al., 2020; Zhao et al., 2021).

Predominantly nowadays, due to the unexpected epidemic of the COVID-19, teachers, students, and overall individuals were in the middle of a generational transition, which made it possible to deal with relative success all the challenges caused by the abrupt interruption of education when the world experienced the called for COVID-19. This generational transition made it possible to quickly change from a face-to-face model and integrate technologies supporting remote learning, thus saving the school year. Thus, now more than ever, is it urgent that such future teachers acquire the digital skills required in this century.

Another fact is that Generation Y questions the order of the status quo. Thus, they are different, and as millennials, they approach their rights differently. They honestly challenge the typical model of obtaining and owning goods, and they will have a lasting impact on the future (Niewiadomski & Anderson, 2015). Despite what was previously stated, the reality, already denounced by many, that this digital transition is still a pending matter in society, and what was evidenced is the importance of providing inclusive and impartial education and support education permanently, as a right for all (Murillo & Duk, 2017). However, social and economic inequality brings a considerable difference between countries in the digital divide, which cannot be refuted. School administrators and governments should consider implementing measures to solve the digital divide and allow all individuals in every country to receive the same quality education.

Another critical situation for the evolution of technology was in 2014 when the United Nations Fellow Nations acquired national websites in all their 193 country members. Despite this, not all these countries have developed in the same way in terms of technology. Thus, even in the case of countries with very sophisticated **data processing** infrastructures, it has not been easy to develop an electronic model for the government. Hence, the reality is that many countries are not prepared to move forward and adopt connected services. It is also known that many countries need strong systems to secure their data, incorporate digital payment procedures, and safeguard information sharing across leadership organizations (United Nations, 2014). There are other equally important aspects such as achieving high-level political management, the state salary, social responsibility, strengthened institutional capacity, and public accountability (United Nations, 2014). It is also vital to count on an adequate electronic government, an adequate technological platform, and the proper preparation for its use (United Nations, 2014).

Although there are different terms to discuss the relationship between digital technologies and teachers, they all refer to ICT used for teaching. This chapter accepts one of those classifications of *digital competence*, by this means attaining a familiar notion when talking of *digital competence*. In practice, we discuss the proper management of those tools that allow teachers to effectively develop their online teaching and learning activities. These tools have gained particular importance and an extraordinary development, accelerating the process towards a digital society, especially including the education sector, due to their strong influence on constructing the future we all want to have.

However, like most developing countries, the DR has a historical situation of teachers with inadequate academic instruction, which adds little training in digital skills. This situation is evident at pre-university education and the undergraduate level because teachers show less preparation in digital skills. However, it should not be undervalued that the knowledge curve for the effective use of computers in higher-distance education is very sharp and demands external assistance in technology and education (Giannini, 2020). Despite reality, the COVID-19 pandemic also forced an extraordinary acceleration in the training of professors to integrate digital technologies into education in the DR, as happened in other countries. Distinct levels of preparation and education were found. However, it allowed us to bear our reality as a country and brought the opportunity to leave behind the ostracism that characterizes DR teachers allowing them to change their behavior towards integrating technology into education. Furthermore, COVID-19 set the foundations in the DR for the future generation of teachers to establish the digital skills such teachers will need to be digitally competent.

In this publication, we thoroughly explored the definition of computer literacy in higher education and explained how future teachers in the DR are prepared to use ICT. We also investigated the components regularly used to evaluate the digital literacy of future professors in the DR. Finally, this publication aimed to outline the significance and growth of digital competency of future professors in the DR in a methodical approach. The research questions that conducted this review were:

1. How higher education defines digital competency/literacy?
2. In what manner are future teachers in the DR able to use ICT?
3. What are the digital skills of future educators' undergraduates in the DR?
4. What are the components frequently used to evaluate the computer literacy of future professors in the DR?

12.1.1 Materials and Methods

We conducted a systematic analysis to define the concept of "computer literacy or digital literacy" in higher education (European Commission, 2018) and precisely to understand how our future professors on the DR prepared to use ICT. Also, this review aimed to explore and determine the digital competence of future teachers in the DR. Also, theoretical frameworks and elements are frequently used to evaluate the digital literacy of future professors in the DR.

We posed four research questions to understand well the target population and the research conducted in the DR regarding the digital competence of future teachers to provide an unbiased summarization and explanation of the findings (Borrego et al., 2014). To conduct this review, we inspected several studies (Keele, 2007; Kitchenham et al., 2009), such as a study that dealt with issues of the preparation of teachers in technology and a comparative pilot study carried out in teachers in several countries, including the Caribbean, Latin America, and Europe (Starkey, 2020; Tatnall, 2021; Tomczyk et al., 2019). This review is divided into several stages: (a) four research questions were clearly shown to be responded to, (b) we indicated the databases that we are going to be assessed, (c) we indicated the method to develop literature searches, (d) we specified the elements that should be used for the selection and assessment of studies, and (e) we indicated the publications that were analyzed. The process is organized into three main phases: (a) choosing, (b) categorizing, and (c) synthesizing (Gough et al., 2012).

12.1.2 Literature Review and Search

The search method consisted of journal papers, articles, reports, books, and dissertations seen in Table 12.1. The information was selected because it included either study, such as dissertations or literature surveys. They were used as sources for

Table 12.1 Indicators used to include or exclude a study

Indicators used to include a study	Indicators used to exclude a study
Research paper on college students' or professors' digital competence or digital literacy in the DR	Studies not on higher education students' or professors' digital competence in the DR
The article comprises digital competence proficiency among students and teachers or digital literacy in the Dominican Republic	The article does not involve usable digital competence or digital literacy in the Dominican Republic
They were published after 2010	They were not published after 2010
The studies were written in English or Spanish	The articles explored were not written in Spanish or English
The full version of the publication has open access through the following two: 1. Google Scholar 2. Subscription of our institutions 3. Science (WOS) 4. SCOPUS 5. Wiley online library	The full version of the publication does not have open access through the following two: 1. Google Scholar 2. Subscription of our institutions 3. Science (WOS) 4. SCOPUS 5. Wiley online library

other systematic literature reviews related to digital competencies, precisely, studies, articles, dissertations, or reports conducted explicitly in the DR.

The Web of Science (WOS), SCOPUS, Google Scholar, and Wiley online library electronic information service was selected to conduct this systematic analysis. Four types of databases were searched for publications in Digital Competency Research, and the terms were selected. The keyword search that was explored in the selected electronic information services were:

- Web of Science: TS= ((“digital literacy*” OR “digital competency*” OR “digital proficiency*”) AND (“future teachers” OR “higher education*” OR “college*” OR “Dominican Republic*”))
- Scopus: ((“digital natives*” OR “digital literacy*” OR “digital skills*”) AND (“higher education” OR “college*” OR “Dominican Republic*”))

Google Scholar: allintitle: “digital skills*” OR “digital literacy*” OR “digital competence*” AND “future teachers” OR “school*” OR “institution*” OR “Dominican Republic*”.

Wiley online library in “digital competence Article Titles” OR “digital competence” in Abstract OR “digital competence” in Keywords OR “future teachers” in Article Titles OR “universe” in Abstract OR “Dominican Republic” in Keywords.

12.1.3 Inclusion and Exclusion Criteria

In this systematic analysis, papers were selected of reported studies in the DR regarding teaching technology, digital competencies of teachers and future teachers, application of ITC in teaching, student’s attitudes regarding ITC in schooling, concerning scope, sample, and complexity. Also, we examined literature about the dimensions regularly used to evaluate the computer literacy of future professors in the DR.

Each article that met the search criteria was evaluated using various methods, techniques, and research tools for the research variables. Other systematic reviews on this topic were assessed (Zhao et al., 2021). We compared 62 articles, and after this analysis, 54 studies were selected because eight papers were repeated. The following table (No. 1) presents the criteria used in this review.

12.1.4 Quality Criteria

A thorough revision was conducted to decide which articles, papers, dissertations explored fulfill quality criteria and determine if they met the standards set. The quality criteria are listed in Fig. 12.1. The complete list (62 articles) was assessed, from which eight were eliminated. Only 54 articles were chosen.

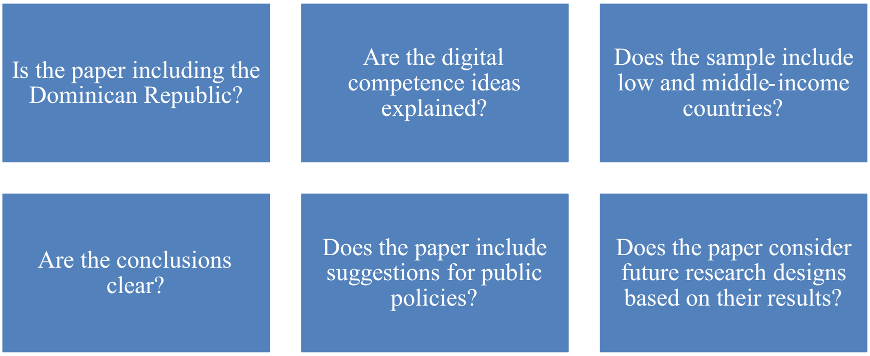

Fig. 12.1 Quality criteria

Table 12.2 Data extraction process

Description	Numbers of papers
Articles found on Google Scholar and WMU library	62
Removal of duplicated	−8
Exclusion and Inclusion criteria application	0
Quality criteria application	0
Total of papers	62

Papers included in the review should have a value of at least three points to be selected. We used questions that had only at least three alternatives. The answers were encrypted as affirmative (1 point), negative (0 points), and restricted (0.5 points). Table 12.2 shows the literature reviewed to write this paper.

12.1.5 Theoretical Framework

The intensive use of technology in everyday life, productivity, and continuous development such as personal, professional, government, and academic level invites us to educate ourselves in its creative and safe use, and with an examining eye. In our digital era, this conscientious use of technology is essential to maximize inclusion, employability, learning, in short, our daily lives. Furthermore, the European Commission (2018) explains digital literacy as the positive and critical use of digital tools, including the competencies that all individuals should demonstrate in the digital era, such as understanding, abilities, and feelings. Due to the evolution of the conceptualization of digital competence, there is still no unanimous consensus regarding its definition. Since the beginning of this concept, it has been in constant development, and many authors refer to it differently, although they coincide in several aspects. Gisbert and Esteve (2011) indicated that digital literacy is referred to the understanding and opinions in the scientific, communicative, media, and informational fields that make up complex and numerous literacies. Similarly, Krumsvik (2008) explains that digital literacy looks like the general term used in an international environment. He also explains that digital competence is the most generally used concept in the educational context in Scandinavian countries. Also, digital literacy was used as an alternative expression. Thus, we used digital competence and literacy as synonyms for this study.

Due to the evolution of the conceptualization of digital competence, there is still no unanimous consensus regarding its definition. Since the beginning of this concept, it has been in constant development, and many authors refer to it differently, although they coincide in several aspects. The DR does not escape the unfortunate Latin American context of a lack of appreciation for education in a general sense, which has impacted the quality of the training of DR teachers through the history of Dominican education. Schools, organizations, and countries end up with the teachers they ought to have. It is how much each society encourages and values its teachers and what it does to build and develop the teaching profession (Hargreaves & Fullan, 1997). One of the region's biggest problems is the lack of a family culture of obsession with education, which contrasts with Asia and other countries where education and preparation are appreciated (Oppenheimer, 2021). International and national research affirm that countries want to overcome the lack of learning of students who travel throughout the educational system that they have structured. Thus, to achieve students learn, an essential condition is a teaching team in each school with the highest possible professional level, despite knowledge of contents. Furthermore, with the pedagogical competencies to design and elaborate the teaching strategies that result in the students' expected learning (Mejía, 2021).

The law 09-2015 enacted by the MESCyT (Dominican Ministry of Higher Education, Technology, and Science) laid the basis for renovating teachers' instruction with a quality vision through a competency model. It was an important step for education's development in the DR. All the universities that train teachers were forced to transform their curricular plans, resulting in only some universities having managed to be authorized to return to teaching their careers. In essence, the policy determined that new teachers should be trained with an emphasis or mastery in the content and skills development, teachers should have an excellent professional profile, and applicants should reach a minimum value in an entrance test. These provisions sought a significant change in the conventional way of doing things, undermined already given interests, and altered well-established practices (Guzmán, 2021).

Regarding ICTs and the digital divide, the DR government made significant progress in closing them. The Digital Agenda 2030 initiative has been established. The purpose of this Digital Agenda 2030 is to ensure that the DR by 2030 becomes the nation that exhibits high connectivity, which will have to be affordable and accessible. To have a population endowed with the digital skills and competencies to use technology productivity (Cabinet of Digital Transformation of the Dominican Republic. 2022. Digital Agenda 2030). To achieve these objectives, one of the bases within this agenda is to strengthen digital skills in teachers of the national education system (Cabinet of Digital Transformation of the Dominican Republic. 2022. Digital Agenda 2030, objective 4.2.2). Thus, the new generation of teachers, who also are digital natives, will be one of the great beneficiaries of this initiative. They will achieve the technical skills necessary for their future responsibility as teachers. Thus, with better preparation, the Dominicans should have access to better jobs (Cabinet of Digital Transformation of the Dominican Republic. 2022. Digital Agenda 2030).

12.2 Results and Discussion

The methodology chosen was a systematic analysis to guide this revision. In the following paragraphs, results are presented.

12.2.1 How Higher Education Defines Digital Competency/Literacy?

To explain the meaning of digital literacy, we explored 33 studies that defined digital literacy from several lenses. For example, 21 of these articles dealt with EU documents and research that portray the intent of digital literacy. Whereas seven of these articles identify digital literacy using information related to EU policy registers. However, five publications in this review explained digital literacy by referring only to selected research publications and partially described digital literacy or competency. It was interesting that several publications defined digital literacy in terms of teachers, precisely ten; however, four indicated that this concept was developed among higher education undergraduates.

Despite these definitions, this systematic analysis defines digital literacy by referring to policy documents from the EU that were comparatively universal. Nine publications referred to the term long-lasting learning and used by the European Commission as "lifelong learning." In these publications, digital competence is referred to as using ICTs for several facilities such as amusement communication and the work environment. Also, it included the use of technical devices such as computers. Others indicated that it is the capacity to collaborate with others, use the World Wide Web, among other services related to the use of computer networks (European Commission, 2006, 2018).

In this revision, we found several reports by Ferrari (2012, 2013) indicating the importance of ICT use in education both for enhancing and improving it. For him, digital competence includes experience in ICT and solving problems; transmitting; handling information; cooperating; generating and communicating content; and creating knowledge productively, efficiently with flexibility, and correctly, both for relaxation and work.

12.2.2 In What Manner Are Future Teachers in the DR Able to Use ICT?

The DR is a middle-income country where less than 10% of its adult population is illiterate (CEPAL, 2016). The same publication also highlights an attendance ratio in junior-high-school of 73.68% for 2020. In 2015, there were 26 students per teacher in graduate schools. In 2019, while the need to stay home increased, learning institutions in the DR had to adjust to the change to endure the COVID-19 crisis.

As a result, technologies usage expanded in other aspects of life, such as teaching and learning. While other countries, even in the same region, have gradually implemented Technology to their teaching and learning practices, the DR fully embarked on that path as necessary for survival (Tomczak et al., 2021). Also, Tomczyk et al. (2021) evaluated 873 teachers from eight countries, including the DR. The study sought to know their attitude towards the new digital technologies used to teach and learn. Four main variables were included in the surveys: (a) teachers' opinions regarding new media; (b) use or implementation of ICT's; (c) their e-learning experiences; and (d) a self-assessment of their digital skills. This study was conducted in several countries from Latin America, such as Brazil, Ecuador, and Uruguay. Also, it included other regions, such as the Caribbean, the DR, and finally, the case of Turkey. Results indicated that professors preferred to integrate new technologies and highlight their decisive effect on educational processes and enthusiasm over teachers from other countries. Nevertheless, the reality is that the Caribbean and other countries of the Latin American region require a new type of professors with new competencies in Technology, specifically with digital literacy, that can integrate it as part of their educational activities as teachers (Tomczyk et al., 2021).

12.2.3 What Are the Digital Skills of Future Educators' Undergraduates in the DR?

In the context of the DR, there are at least two main elements to consider before mentioning the digital competencies needed for future teachers in DR. First, the constantly evolving nature of ICT requires a set of skills to be in place to master those new technologies. Besides, it is essential to consider that DR higher education teachers often do not possess the basic skills required. Such reality hinders the ability of DR teachers to stay up to date with the upcoming technologies. The Framework for Citizens' Digital Competence (DIGCOMP) outlines the competence areas listed below: "(a) information processing; (b) communication; (c) creator or content designer; (d) safety/security; and (e) systematic thinking capacity" (Redecker, 2017).

Second, a higher education teacher is often employed locally, and teaching is their second job. As a result, teacher practices often rely on the extra time that professionals that decided to join teaching decided to invest for these purposes. Caena and Redecker (2019) explained that according to the European Commission

(2013), a teacher competence framework would consider: (a) Underlying educational beliefs; (b) Teachers' professional practice; (c) The constant improvement nature of teaching; (d) Learner outcomes; and (e) Crucial features as constancy, durability, and flexibility.

Finally, the DR does not comprehensively assess future teachers' present technologies skills. The idea of such a document will be discussed in future research on this topic.

12.2.4 Which Are the Components Frequently Used to Evaluate the Digital Skills of Future Professors in the DR?

Until 2015, with the regulation 09-2015 mentioned previously, there was no specific instrument to evaluate the digital skills of applicants to study pedagogy in the DR.

General admission tests were used for all students. After 2015, all pedagogy students or future teachers must undergo a series of tests to meet the competencies of this profession. The admission exam for each student who applies to professions related to teacher training is established as mandatory and without exception, which must measure whether students possess the required competencies to begin studies at a higher level in teacher training or not. This test contains two components: (1) orientation and Academic Measurement Test (POMA) and (2) Internationally recognized standardized test in student selection processes to enter higher-level studies, validated for application at the national level (Regulation 09-2015 for Quality Educator's Instruction in the Dominican Republic, 2015). In the internationally recognized standardized test, the College Board test is used.

Although we reviewed several papers and studies conducted in DR, few research studies have been conducted regarding the situation of digital skills of teachers. However, it is known that at the beginning of the Century, ITLA (Instituto Tecnológico de Las Américas [Las Americas Technology Institute]) created the initiative of the Connected Professor, which sought to provide teachers with the minimum skills for the use of essential office automation tools and Internet access.

By 2004 the ITLA had trained more than 40,000 people, including 25,000 teachers (Grullón, 2004).

Public and private Dominican colleges are supplied with innovative technological equipment. Five articles approach the subject from different perspectives. Several deficiencies were observed, especially in the instruction and learning processes, such as the absence of ICT instruction for professors and their use and application in the classroom (Coronado et al., 2014).

However, these have not been translated into a generalized application of diverse teaching strategies used to educate and prepare future teachers in the DR (Contreras, 2005, cited by Coronado et al., 2014). Another initiative was the República Digital Education Program, which was an idea of the Dominican authorities.

República Digital Education program seeks the enhancement and renovation of the student's teaching and learning, aiming quality through the incorporation of multimedia and computers in schools and the administration of the methodology and procedures used by educational institutions to teach (García, 2018; Instituto Superior de Formación Docente Salomé Ureña, 2021; Ministerio de Educacion Superior Ciencia y Tecnologia, 2021).

A teacher who starts in the classroom must know and communicate their limitations to receive the help they need (Jáspez & Sánchez-Moreno, 2019). A study shows that the teachers attribute a sufficient or suitable level of ICT training, particularly in the technical handling of technological tools and Internet access. The level of training decreases as the ICT content is more complex.

Most teachers lack a research profile, a fact that is related, among other factors, to not having a doctoral degree (Pérez Díaz, 2019a, b). Finally, several newspaper articles were checked to understand and enhance the answers to this question.

Once completed the assessment, we classified the literature into the following categories: (a) research concerning definitions of digital competency or digital proficiency in the context of undergraduate education; (b) issues that could impact teachers and future teachers' technological proficiency or literacy in the DR, and publications in this category explored the circumstances that affected and made variations in digital literacy within our country; (c) future 'teachers' levels of preparedness to use ICT, mainly focusing on the impact of digital literacy on 'participants' success, (d) articles, dissertations, reports in this category were evaluated and explored the impact of technological competencies on 'students' achievement; and (e) we tried to understand the dimensions commonly used to assess the digital competence of Future Professors in the DR. Articles in this category were reviewed.

12.3 Limitations

After inspecting and reviewing validated studies, this analysis offers the latest information to answer the research questions posed. It describes research included in four types of databases searched for publications in Digital Competency Research. They were used as sources for other systematic literature reviews related to digital competencies, precisely, studies, articles, dissertations, or reports conducted explicitly in the DR. The Web of Science (WOS), SCOPUS, Google Scholar, and Wiley online library electronic archives were carefully chosen to accomplish this systematic analysis of the literature. We explored the terms used in the paper's title, keywords, and abstract (2011–2021).

The steps followed first began with publications from the designated databases. Thus, we did not include all the current publications in the review. Another fact was that we had restricted the years of the articles to be reviewed. The dates were from 2011 to 2021. Also, we focus on recent publications on the field studied, basically in the DR. In addition, we focused on the publications written both in Spanish and or in English. We inspected papers about digital proficiency, digital skills, or digital literacy relayed to higher education. Papers regarding junior-grade school were not represented. Finally, it must be noted that despite using several studies regarding the use of ICT in the DR. Specifically, regarding the competencies of future teachers, there is little information on the subject. However, we could understand the research questions asked.

Regarding the dimensions commonly used to evaluate the digital proficiency or digital literacy of Future Professors in the DR. It must be noted that the DR does not have a comprehensive assessment of future teachers' present technologies skills. The idea of such a document will be discussed in future research on this topic.

12.4 Conclusions

After exploring the data collected, it is essential to point out that many research results introduce the definition of higher education, delivering a general idea. Regarding the definition of digital literacy, the framework presented in Europe is the most accepted. Despite this, some publications have expanded these concepts.

Regarding ICTs' evolution in DR over past years and the level of preparedness of future professors in the DR to use ICT, few studies explored this situation for this question. Therefore, it is necessary to develop a consistent, up-to-date, and professionally relevant theoretical framework that can be used to understand these two facts in the DR.

Regarding components frequently used to evaluate future professors' digital proficiency or literacy in the DR., we also found few studies exploring this situation for this question. Even though the Dominican government's initiative aims to renovate and enhance the quality of teaching and student learning through the integration of digital technologies in schools, Jáspez and Moreno, in 2019, indicated that teachers who start in the classroom must know and communicate their limitations to receive the help they need. Furthermore, a study showed that the results highlighted those teachers attribute a sufficient or suitable level of ICT training, particularly regarding internet access and handling of technological devices. The level of training decreases as the ICT content is more complex. Finally, most teachers lack a research profile, a fact that is related, among other factors, to not having a Ph.D. (Pérez Díaz, 2019a, b). Accordingly, it is crucial to develop a relevant theoretical framework as the basis for a universal research tool to assess the digital competence of Future Professors in the DR.

Regarding acquiring competencies of ICTs in the future professors in the DR, it is just the beginning in laying the foundations. Data indicates the agenda 2030, in 2021 in the DR, is perfectly complemented to establish the competencies required for future teachers in the DR. Though, the lack of competencies represents a challenge for teaching and education development in the DR. This situation prevents many Dominican students receive a quality education which is a social right. Accordingly, it is crucial to establish these competencies to allow all Dominican students receive quality instruction.

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Chapter 13
Digital Competence Among Students of Pedagogy and EFL Teacher–Students in Ecuador: A Review of the Existing Literature

Magali Arteaga and Esteban Valdiviezo

Abstract This research aims at reviewing the existing literature regarding digital competence or literacy in Ecuador. Digital literacy is a new term, which in Ecuador, was converted into a subject taught in the schools of pedagogy in a mandatory way in colleges all over the country in the pursue of a sound educational program. For this reason, this research sought to analyze systematically articles and research papers that pertained to the field of digital competences in pedagogy by using databases such as EBSCO, Google Scholar, Scopus, and Hinari. The data obtained showed a lack of investigations in the field. Therefore, a search that included a broader use of keywords was applied. The results showed that the field of study and research for digital competences or digital literacy at any level is scarce in Ecuador and that the use of ICTs in general is linked to pre-service and in-service teachers, social inclusion, and EFL pedagogy.

Keywords Digital literacy · Digital competence in Ecuador · Pedagogy · Teaching EFL · Incorporation of ICTs

13.1 Introduction

Digital competence is a skill that has brought a lot of fuzz these days. In today's world, where technology surrounds human beings in every corner of their lives, developing an attitude about the skills, values, and knowledge regarding the use of digital technology is a must. Developing a critical awareness on digital competence is relevant for work, leisure and communication as people should think critically about sources of information, and the information itself. Thus, mastering these skills may help individuals understand complex contexts in an accurate way so that they use the information in a safe and efficient manner.

M. Arteaga (✉) · E. Valdiviezo
Universidad del Azuay, Av. 24 de Mayo 7-77, Cuenca, Ecuador
e-mail: marteaga@uazuay.edu.ec

E. Valdiviezo
e-mail: evaldiviezo@uazuay.edu.ec

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For these reasons, Costas and Blanco (2020) in their chapter explain that every curriculum should include certain training in digital literacy. Additionally, Potyrała and Tomczyk (2021) state that education in digital literacy is not a fad that responds to a temporary situation, but an undeniable need for twenty-first century teachers and students. The increased number of reports regarding the misuse that students give to new technologies have created the need to prepare this generation of pupils in digital literacy an urgent matter. However, thinking about digital literacy as a standardized process is a failure that should be avoided, as context plays a crucial role. Many aspects such as educational policies, law, school type (whether it is rural or urban), and university policies for preservice teachers should come to mind when developing a plan for digital literacy. One key objective that should be kept in mind, however, is that the purpose of training students, teachers, and teacher–students in digital literacy is to take advantage of the benefits that internet brings to their lives. Thus, it is important to understand the different contributions provided by investigations carried out on digital literacy. This will help define a route to integrate different perspectives on digital literacy in different dimensions and how transversal this matter has become to everyone's daily life.

13.2 Theoretical Framework of Digital Competence

In this new ICTs and internet environment the development of digital skills is necessary to broaden the boundaries of learning and communication. "The creation of the Internet has expanded the boundaries of digitization, and the combination of the Internet with individual conditions for access to information" (Milenkova & Lendzhova, 2019). This change has resulted in a new computer-based education form through technology feedback, classes, quizzes, and information and also it can be achieved in manners that were though impossible before.

The internet and ICTs have opened space to a wide range of information and forms of communication. For this reason, access to knowledge is broad today. No wonder why contemporary communities are known as knowledge societies. However, this term is blurred in the different international contexts (Ramírez & García-Peñalvo, 2015). In the Ecuadorian one, for instance, where the country struggles to transform its economy from a primary resource export economy to a knowledge economy (Von Sigsfeld, 2020), ICTs and internet represent an opportunity to attain this goal.

Although the internet and ICTs represent a great opportunity for developing countries to gain space and continue with their growth, there are risks that should be taken into consideration. According to García-Ruiz and Pérez (2021), there are two main risks linked to the use of internet and ICT for both teachers and students. The first is the need to carry out a monitoring process to help students from cyber-crimes. The second corresponds to "health issue, as ICT users can be seen as addicts controlled by the need of cyber connection" (p. 60). Such risks represent also an opportunity to teach our students, teachers, and future teachers certain skills and abilities to overcome and foresee the problems that may happen when deepening in the digital world.

As education is a communicational process per se, ICTs have turned instruction into a dynamic and demanding practice. That is, learning and acquiring knowledge has become a lifelong process at school, at home, in the workplace, and in the social field. This brings us back to the knowledge society where it seems there is a saturation of information in messages, books, comics, television, computers, and many other forms.

For this reason, developing digital skills is an important process in the knowledge society, not only in the moral area but also in the field of evaluation, efficiency, but in values such as cooperative learning, experience learning, problem solving, and legal citizenship.

Digital competency is an evolving process, defined as "technology related skills" (Ilomäki et al., 2011), which enable people to acquire competences in other areas such as language, criticism, cultural awareness, social, and emotional aspects. For this reason, the terms digital competence or digital literacy are more widely used than digital skills.

What should be clearly stated is that digital literacy should not be considered as a new type of literacy as there is no new language being created. Instead, digital literacy refers to a new construction of forms and languages that represent communication (Sánchez et al., 2019).

Digital literacy represents the ability to carry out things in the digital environment. That is, through digital literacy, an individual reads and interprets data from the media. In the past, literacy was directly connected with the printed-paper or books as the only way of acquiring knowledge. With the invention of the internet, the term literacy has evolved into learning in the digital area. Although skills such as reading and writing are still important, in the digital society, other skills are also needed. Skills such as multitasking, trans-media navigation, negotiation, problem-solving, source finding, critical thinking, and autonomy. For this reason, preparing students to invent, generate, and contribute to the knowledge society and a lifelong learning process is necessary at all levels of education (Santos & Serpa, 2017).

It is undeniably true, however, that this represented a revolution in the educational field because teachers may consider they are at disadvantage compared to their students who are digital natives. For this reason, it was suggested that teachers start their training from the early stages in colleges so that they learn to adapt technologies and pedagogy to perform their duties digitally (López et al., 2020).

In 2005, the European Commission encouraged its members to include in their educational systems mechanisms to enhance in their students the development of key competencies for a life-long learning process (Fraile et al., 2018). This proposal created great concern in teachers. They defined digital literacy as

> involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet (p. 13).

According to Esteve-Mon et al. (2016), there are many skills involved in digital literacy. On the one hand, Ferrari (2013) suggests that digital literacy involves not only having skills but knowing when learning environments, tools, fields, ways, and purposes in using ICTs should be put into action. Likewise, there are many different standard models to guide digital trainings for pre-service teachers, like the one offered by UNESCO, which combines three factors: technological literacy, knowledge deepening, and knowledge generation. All of them joined by policy, curriculum, pedagogy, ICTS, organization, study plans, and teacher professional development. Another standard model is the one offered by the USA through its International Society for Technology in Education, which stated that digital literacy should be based on students learning and creativity, experiences in learning, ability to include creative activities in a digital era, teacher's capacity to promote responsibly and ethically in their professions, and leadership through the use of ICTS. All of them followed by rubrics that can truly assess the teacher's level of digital literacy at a level that varies from beginner, intermediate, expert, and transformer. The Norwegian model, on the other hand, states three levels of digital literacy to access information, basic digital skills to teach in a different way so that new knowledge is generated through rethinking the process of traditional teaching, didactic competence with ICTs and learning strategies so that students become aware of ways to keep learning permanently. The Chilean model considers five stages in the process of training future teachers, pedagogy centered in learning experiences, technique, centered in the use of ICTs, management, focused in the modernization of the institution, social and ethical principles, and finally professional development.

In Ecuador, where this study took place, the Ministry of Education does not count with a standardization process in detail as the ones offered above. However, it counts with a Digital Education Agenda to be developed between 2017 and 2021. The aim is to encourage a digital culture and new forms of learning and teaching in the Ecuadorian context in the knowledge society. With this plan, the country pretends to enhance the development of digital skills, digital literacy, educational resources, innovative teaching and learning methods for both teachers, students, and teacher–students. Although the country does not count with a standard measure process, the plan Estrategia Ecuador Digital 2.0 pretends to encourage among the Ecuadorian citizens' proper access and generation of information and knowledge through the use of ICTs (Ministry of Education, 2017). This program started in 2011 by the Ministry of Telecommunications (Mintel) and was linked to the National Plan of Well Being. This model is made up of four main parts: regulatory policy, universal access, digital isolation, applications, and e-gob. Three main policies involve this plan: universal access, online governance plan, and the national plan of broadband.

The aim of the program is mainly to ensure that the Ecuadorian population get access to internet, teach future teachers new forms of teaching through ICTs, and improve the quality of education.

Regarding the second aspect, the teaching plan consists of four components:

- Curriculum: a new subject was added to the schools' curriculum, computers, with the purpose of analyzing and solving complex problems through the application

of strategies and tools in a contextualized manner. This subject was implemented in a two-stage process. First, the visualization of digital tools as a transversal axis and the implementation of the subject itself in schools. Secondly, the development of an online system to administer the curriculum so that teachers work in a virtual environment through planning, use of resources and intercultural adaptations.
- Pedagogy: Pedagogy involves edu-communication. It is not enough to know how to use technology. What it counts is to write in these new languages.
- Content: To reflect on the specific content that can be worked through ICTs.
- Digital resources.

To ensure the accomplishment of the second aspect, two dimensions are taken into account, the training of teachers and the training of teacher–students. To do this, the Ecuadorian government based the instruction on the UNESCO model. The plan consists of the following stages, rise, apply, integrate, and transform. The first one is developed in the first stages of the teacher–students career. The others are developed slowly through the teaching years with workshops and relies exclusively on colleges and universities. Thus, all colleges now teach a subject called education and technology.

13.3 Research Methodology

Initially, the purpose of this research was to diagnose the level of digital competence in Ecuador among students of pedagogical faculties, including the EFL (English as a Foreign Language) pedagogy school, as the teaching of English go hand in hand with technology due to the methodology of teaching that this subject demands (Texidor et al., 2017). Additionally, it was intended to investigate the impact of the workshops offered in colleges regarding the use of ICTS with pedagogical aims. It was also intended to find out how these studies were carried out. However, not much information was found regarding the impact of workshops nor the way the studies were carried out. For this reason, the research was expanded to pedagogy and ICTs in different areas of education, not only in pedagogical schools in colleges, but with a broader stance, like primary schools, high schools both in the rural and urban areas, public and private.

13.3.1 Procedure

The following search words were used for the databases, where the term indicated between the parentheses describes to which parts of the database the search words were directed, also the period was narrowed down from 2001 to 2021.

English Keywords:
Digital Literacy in Ecuador (all text)

Digital competence in Ecuador (all text)
Pedagogy + Digital Literacy in Ecuador (all text)
Pedagogy + Digital Literacy in Ecuador + teaching EFL (all text)
Incorporation of ICTs in Ecuador in pedagogy (all text)
Spanish keywords:
Competencia digital (all text)
Incorporación de TICS en pedagogía (all text)
Pedagogía + Competencia digital (all text)
Engines:
EBSCO
Google Scholar
Scopus
Hinari (Research 4 life)

The terms pre-service teachers, pedagogy and ICT in Ecuador, were also used in all data bases giving as a result duplicates but no new material to be used.

Getting this lack of results, the researchers decided to include in this chapter some fragments of a short interview carried out with two professors who were interviewed to know about ICT and pedagogy in two universities of Ecuador, one of a private university and the other of a public college. Although the sample was very short, it served to confirmed that there is absolute no information regarding the impact of teaching future teachers on the use of ICTs in education, including EFL majors, nor about the development of digital literacy in colleges.

The professors were asked three questions. Have you taught about ICTs in the school of pedagogy? If so, what and how you taught them, and what skills were developed? What studies have been made on the impact of teaching ICTs in college? And what skills should be taught. Both professors informed that they had taught that subject. One in the school of EFL pedagogy and the other in the school of Basic Education and other schools of pedagogy.

Both professors agreed that there were no studies carried out to see the level of competence that future teachers reached once they finished with their majors. Both professors agreed colleges indeed teach a subject called ICTs and education and that the skills developed in the subject aimed mainly at developing resources, materials and to make the classes more dynamic. A bunch of tools, applications and platforms and their use were covered in classes. Both professors shared the syllabus they use to teach and some commonalities were found:

- The main objective of the subject is to understand and reflect on the importance of ICTs in education and to know the tools that enrich the learning processes.
- Specific objectives involve the proper use of ICTs, learn how to use different tools and select appropriate resources for the different educational levels.
- None of the syllabus emphasize on skills such critical thinking, emotional skills, photo-visual skills, or others.

With this lack of research in mind, the researchers decided to investigate on studies carried out about digital literacy in the country, whether or not they belonged to future

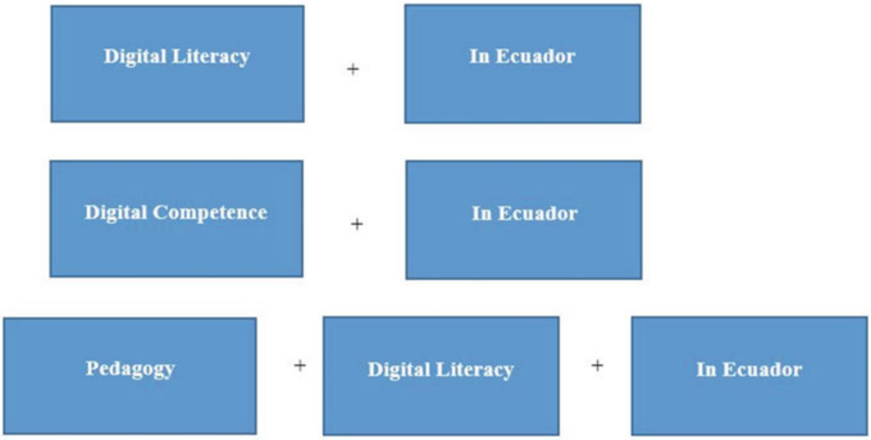

Fig. 13.1 Strings used for the research

teachers, students, in-service teachers, so that this investigation could work as the basis for future research.

To identify relevant papers, a search for peer-reviewed papers, blind reviewed papers, single blind review papers, open peer reviewed, collaborative reviewed papers, and conference papers in four databases within educational research EBSCO, Google scholar, Scopus, and Hinari. The strings used for the research can be summarized in the following Fig. 13.1.

As the results were scarce under these categories, the search was extended to other criteria such as: Digital Literacy in Ecuador and Incorporation of ICTs in Ecuador in pedagogy (all text). Having identified the papers under these categories, the guidelines described by Lassersson et al. (2019), which states Review teams must include expertise in the topic area under review. Topic expertise should not be overly narrow, to ensure that all relevant perspectives are considered.

Perspectives from different disciplines can help to avoid assumptions or terminology stemming from an over-reliance on a single discipline. Review teams should also include expertise in systematic review methodology, including statistical expertise. (p. 5)

As part of the procedures suggested by Higgins et al. (2019) the search merged search results, examined titles, abstracts, downloading full papers, reviewing conclusions and making the final decision of including the paper or not in the investigation for the data analysis.

Papers that did not include information about pedagogy and ICTs were initially discarded. However, the lack of research in the field pushed the researchers to extend the research to other categories and to include the term EFL specifically in the search. After analyzing these other categories, papers that did not include digital literacy or competence were excluded. Also papers, which did not include information about ICTs in education in general were also excluded. Papers in which digital literacy played a minor role or did not include deep information were also discarded. However, it is worth mentioning that papers that included relevant information about education in primary education and high school were included due to the lack of research at university level. See the PRISMA Flow chart for reference (Fig. 13.2).

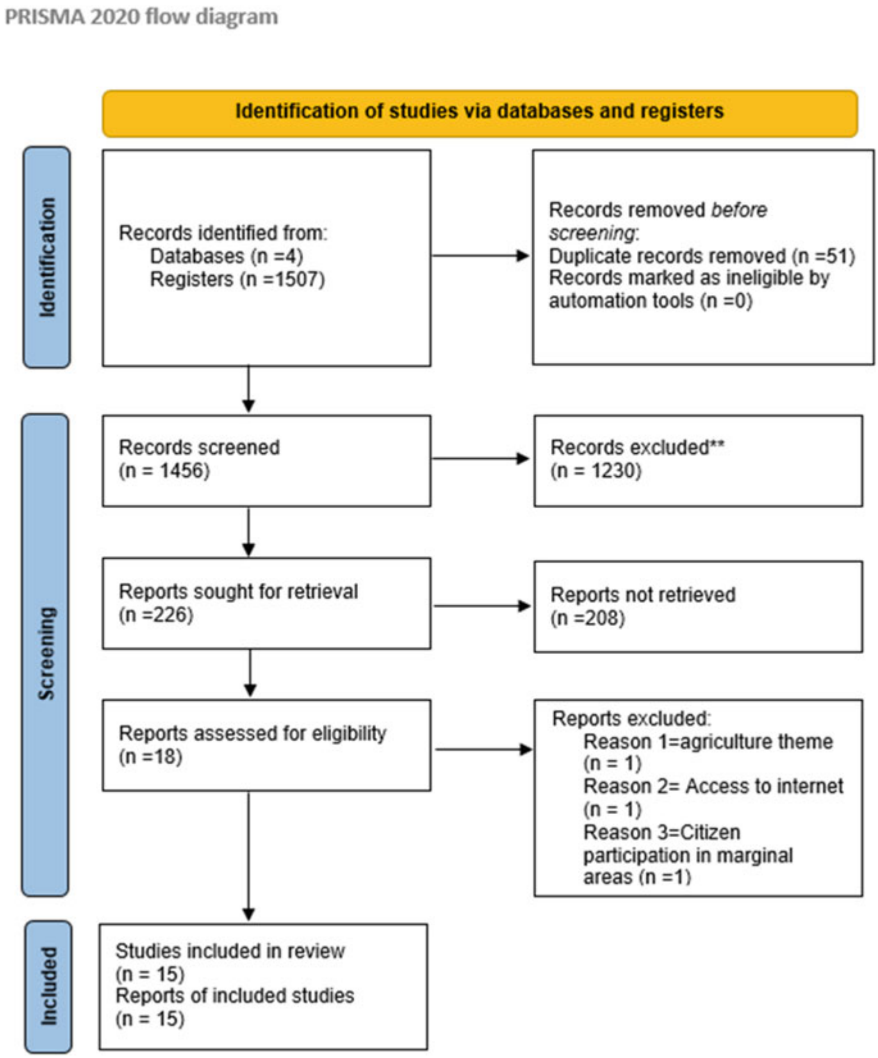

Fig. 13.2 Prisma flow chart

13.3.2 Limitations of the Study

The main limitation of this systematic review research is the limited number of databases to spot eligible studies. Another hot issue was the lack of investigations in the area of preparing future teachers on developing digital skills on the use of ICTs in their classes.

Although the research was carried out in English, it was also searched in Spanish to ample the research. The researchers strongly consider this as another limitation of the study as there are many publications done in Brazilian journals in Portuguese, which could have been left aside some valuable research.

Additionally, the databases used for the research are common, but there are other indexed journals with no high impact but included in indexing systems like Latindex that was not included because of the language. This may also have left aside relevant information.

13.4 Results

Through this review of literature, 1507 papers were found under the topic of ICTs in the databases mentioned in the methodological section. After screening the databases and articles, the relevant and eligible papers summed up a total of 18 manuscripts of which three were also excluded because they did not comply with the inclusion criteria set by the researchers.

The results show that investigations in Ecuador mainly deal with digital competence developed by in-service teachers and pre-service teachers. Other topics also include inclusion ICTs in society and the enhancing of autonomous work among EFL students by using ICTs. Just a few studies analyze that the perceptions teachers have on the pedagogical use of ICTs in their classrooms.

Regarding the samples stated in the studies, they do not represent a large sample so as to generalize the study in a broadened scope. Most of the research is quantitative measuring the use of ICTs. However, there is a lack of research in the area of how digital competence was developed nor what skills teachers possess regarding the use of ICTS. Most of the research covers the use of Web 2.0 and its tools. However, there is a gap in the literature that seeks for the skills on how to use the information both future teachers and students work with the information they have access to, so they use this information in a wise manner. The following tables summarize the papers found and report its main findings (Table 13.1).

Table 13.1 Research results

Main theme: In service teachers and the use of ICTs
Authors/Year: Javier Jorge-Vázquez 1,*, Sergio Luis Náñez Alonso 1,*, Washington Raúl Fierro Saltos 2,* and Silvia Pacheco Mendoza 3 (Article 2021)
Region/place/number of respondents: Sample of 216 university teachers from different regions of Ecuador
Research tools used/areas of measurement: An ex post facto survey design was used. Information is collected in a standardized way using a questionnaire that allows the intra-group analysis of the sample. SPSS statistical software non-parametric Chi-square test was used
Theoretical framework: Definition of the concept of digital competence by several authors
Results: University faculty has a mostly intermediate level of digital skills, which is independent of gender, but dependent on the generational cohort
Main theme: In service teachers use of ICTs through virtual field trips
Authors/Year: Stacy Delacruz (Paper, 2018)
Region/place/number of respondents: Convenience sampling was used to select participants across the globe. The three participants came from Ecuador, Costa Rica, and Ohio, USA
Research tools used/areas of measurement: Over a 5 month period in 2015, data was collected in the form of VFT artifacts and Skype interview sessions with teachers. The researcher used semi-structured interviews and checklists during the Skype sessions with each teacher. Checklists were used to ensure the research questions were discussed. Interviews were 1 h in length, audio recorded and transcribed
Theoretical framework: Concepts of global education, definitions of cross-cultural collaboration in schools, definition of VTFs (virtual field trips)
Results: A student–teacher in Ecuador created a VFT with her kindergarten classroom. Her class consisted of 16 English Language Learners, all of whom were from Ecuador and were native Spanish speakers
Main theme: ICT inclusion to society
Authors/Year: Jorge Cristopher Delgado, Jorge Washington Valarezo Castro, Asisclo Alfonso Avila Carvajal (Conference paper 2020)
Region/place/number of respondents: N = 60 participants from the Jambelí community in the Machala canton, El Oro province, Ecuador
Research tools used/areas of measurement: A survey based on a Likert scale was applied to find out what skills and abilities were obtained, as well as the equitable application on entertainment, communication, work and education activities
Theoretical framework: Lack of clear framework
Results: The conclusion is that this type of conference is feasible for the use, dissemination and awareness of the good use of technologies, and it is important to be replicated to reach more communities
Main theme: Digital competence for teachers and students
Authors/Year: Juan Cobos-Velasco, Lilian Mercedes Jaramillo-Naranjo, Santiago Vinueza-Vinueza (Article, 2018)
Region/place/number of respondents: N = population of 40,000 students from Universidad Central del Ecuador, an optimal sample of 1,799 was extracted, as well as 300 teachers

(continued)

Table 13.1 (continued)

Main theme: Digital competence for teachers and students
Research tools used/areas of measurement: A questionnaire on knowledge perception, application and assessment of digital competences was elaborated based on the competencies and ICT standards of UNESCO, which was validated by the international panel of research in educational technology-PI2TE, it was answered voluntarily by 300 teachers from 2015–2016 and similarly by 1799 students
Theoretical framework: Exploration of ICTs concepts as well as how they change society. Digital Literacy. Use of media and technology in education for both teachers and students
Results: According to the results, most of the future professionals have a high level of digital competence (especially in basic digital skills), in the same way, certain significant contrasts were obtained with respect to age, in the area of basic digital skills. For teachers, it was determined that the use of web 2.0 tools causes difficulty to its incorporation into the teaching process, whereas students have an attachment to use them
Main theme: Digital literacy in students during Covid-19 crisis
Authors/Year: Santiago Tejedor 1, Laura Cervi 1,*, Ana Pérez-Escoda 2 and Fernanda Tusa Jumbo 3 (Article, 2020)
Region/place/number of respondents: Comparative study of three countries' higher education institutions (Spain, Italy, and Ecuador) During the lockdown globally imposed for the COVID-19 pandemic, N = 376 students
Research tools used/areas of measurement: The methodological approach followed was quantitative with an exploratory-correlational scope using a questionnaire designed ad hoc and applied to students
Theoretical framework: Digital literacy concepts and gaps between generations. Exploring different dimensions for the promotion of digital literacy for Europe countries and for Ecuador in particular
Results: necessity of enhancing the main aspects such as the teacher's digital skills, sources for learning that may be adapted, communication between universities and students, and teaching methodologies that should be appropriate to the current context
Main theme: Digital competence for students of 5 countries
Authors/Year: Jorge Ángel Martínez Navarro. (Article, 2019)
Region/place/number of respondents: Study of self-perceived digital competence of Latin American students with a broad sample of 5 countries in the region (Ecuador, Colombia, Perú, Chile y Venezuela)
Research tools used/areas of measurement: The collection of data used was INCOTIC instrument adapted to the Latin American context, obtaining data by age and sex on Information Literacy (DAI). Technological literacy (DAT), multimedia literacy (DAM) and communicative literacy (DAC)
Theoretical framework: Literature review on ICTs and challenges for the educational system Furthermore, exploration of concepts such as digital native vs digital immigrant
Results: The country with the lowest score obtained in the analyzed literacies was Ecuador, with Chile and Colombia being the countries with the highest score. In addition, interesting differences are observed when deepening by gender and age in each literacy
Main theme: Digital competence for In-service school teachers
Authors/Year: Tania Salome Valdivieso Guerrero 1, María Ángeles Gonzáles Galán 2 (2016)
Region/place/number of respondents: Measure the digital competence of elementary school teachers in the district of Loja (Ecuador) N = sample of 420 teachers

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Table 13.1 (continued)

Main theme: Digital competence for In-service school teachers
Research tools used/areas of measurement: Ad hoc instrument (Cuestionario de diagnóstico de competencia digital docente) was designed, and a stratified non probability sampling technique was applied to public and private educational establishments
Theoretical framework: Literature review on Digital competences and ITC inclusion for teachers
Results: The level of digital competence is low, but not null, there is evidence of a trend towards curricular integration of ICT, especially, teachers who are younger than 30 years old and those who have graduated from pedagogical institutes
Main theme: ICT inclusion to society
Authors/Year: Maria-Jose Barros, Gabriel Barros-Gavilanes (Book chapter, 2019)
Region/place/number of respondents: Ecuador. N = sample of 114,086 people
Research tools used / areas of measurement: This study used ENEMDU 2017 (INEC 2017b) data to analyze economic, cultural, social and personal characteristics of digital illiterate individuals
Theoretical framework: Literature review from Ecuadorian context and government documents were used as well as digital literacy review
Results: Although according to INEC's report (2017a), digital literacy has increased from 78.6% in 2012 to 89.5% in 2017, this study shows that this increment may still not be a reflection of the inclusion of historically underrepresented groups. In spite of government efforts to increase ICT inclusion people in rural areas still report lower rates of ICT access, especially women
Main theme: Pre-service teachers and the use of ICTs
Authors/Year: J. I. Mora-Fernández, A. X. Castaño-Sánchez (Conference paper, 2018)
Region/place/number of respondents: Student–teachers in formation in the careers of Basic (Middle School) and Intercultural Bilingual Education of the National University of Education UNAE, and to Social Communication students at the UNACH, University of Chimborazo, in Ecuador (exact number not included)
Research tools used/areas of measurement: A methodology integration was developed and implemented, through cycles of observation, exploration, evaluation and project-based learning, designing ICTs projects for students
Theoretical framework: Literature review based on integrative methodologies such as Action research, Lesson Study and Flipped Classroom
Results: The future teachers involved, developed their professional skills related to the media convergence, information and communication technologies (ICT) in the classroom. The educational tools and productions were evidenced and classified during the learning process. Promoting the reuse, remixing, adaptation, dissemination of these materials by the national and international communities
Main theme: EFL students and ICTs to encourage autonomous listening comprehension
Authors/Year: Roger EDWARDS, María Daniela HOLGUÍN-BARRERA, Ana Cristina ORTIZ, Mariela PÉREZ (Article, 2019)
Region/place/number of respondents: This action research took place at a University language center in Ambato, Ecuador. N = sample of 154 EFL students of lower advanced levels who engaged in a 5 week intervention addressed at encouraging autonomous listening comprehension practice through videos

(continued)

Table 13.1 (continued)

Main theme: EFL students and ICTs to encourage autonomous listening comprehension
Research tools used/areas of measurement: Quantitative and qualitative parameters were used to assess the achievement of two objectives: the extent of the development of autonomous behavior; and the extent of the motivational impact of student collaboration on encouraging autonomous behavior. Quantifiable data came from weekly questionnaires; Qualitative data came from two sources: Open-ended written feedback, and interviews carried out with two randomly selected students per class
Theoretical framework: Literature review on ICTs, learner autonomy, the stages of autonomy namely reactive and proactive
Results: Results showed a degree of development of student autonomy classifiable as "proactive" (Littlewood, 1999); therefore, the first objective was met, albeit with deficiencies
Main theme: In service EFL teachers perceptions using technological pedagogical content knowledge TPCK
Authors/Year: Rodrigo Tovar Viera 1, Diego Ismael Velasco Sánchez 2 (Article, 2020)
Region/place/number of respondents: The assessment instruments were administrated to EFL language instructors, who work in the Language Center at the Technical University of Cotopaxi. N = 16 EFL instructors who constitute the English teaching staff of the Language Center, were surveyed
Research tools used/areas of measurement: The study is an extension of previous research carried out by Tovar et at. (2019), and Tovar (2019). It applied a survey-based questionnaire, an unstructured interview, and classroom observations for data collection. The area measured was teachers' beliefs and competencies of using the Technological Pedagogical Content Knowledge (TPCK) in teaching English as a foreign language
Theoretical framework: Brief literature review on Technological competency and integration, TPCK lessons (technology, pedagogy and content knowledge)
Results: Results revealed that a high percentage of the EFL language instructors are not familiar with the use of the TPCK model and its integration into their classroom practices. This support the claim that teachers probably have technological knowledge, but they are not well-prepared to combine teaching resources and appropriate pedagogical methods for language teaching and learning
Main theme: Pre-service teachers explore the use of Pixton, a program that creates comics to unleash their artistic and writing potential
Authors/Year: Paola Cabrera, Luz Castillo, Paúl González, Ana Quiñónez, César Ochoa (Article, 2018)
Region/place/number of respondents: The study examined the use of Pixton for enhancing grammar and vocabulary teaching in a public high school in the South region of Ecuador. N = 163 junior high school learners and 14 pre-service English teachers participated during a period of 4 months
Research tools used / areas of measurement: The data was obtained by gathering information from pre and postquestionnaires, pre and post-tests, and observation sheets. Students were divided into control and experimental groups. The control group (78 students) received English lessons without using Pixton, while the experimental group (85 students) used Pixton

(continued)

Table 13.1 (continued)

Main theme: Pre-service teachers explore the use of Pixton, a program that creates comics to unleash their artistic and writing potential
Theoretical framework: Literature review on teaching EFL grammar as well as understanding the origin and use of Pixton
Results: After analyzing the data quantitatively and qualitatively, the results showed that Pixton is an effective teaching tool that motivates students to learn grammar and vocabulary in an enjoyable way
Main theme: In-service teachers perceptions using technological pedagogical content knowledge TPCK
Authors/Year: Łukasz Tomczyk 1, Vladimir Costas Jáuregui 2, Cibelle Albuquerque de La Higuera Amato 3, Darwin Muñoz 4, Magali Arteaga 5, Solomon Sunday Oyelere 6, Özgür Yaşar Akyar 7, Mariana Porta 8. (Article, 2020)
Region/place/number of respondents: Implementation of new technologies in education from the perspective, opinions, and experiences of educators from Bolivia, Brazil, the Dominican Republic, Ecuador, Finland, Poland, Turkey, and Uruguay. N = sample of 873 teachers representing eight countries
Research tools used/areas of measurement: A survey was conducted using a standardized survey questionnaire translated into the relevant national languages in the first half of 2019. This article was the result of pilot studies conducted within the framework of the SMART ECOSYSTEM FOR LEARNING AND INCLUSION
Theoretical framework: Literature review in reference to technology, pedagogy and content knowledge, techno-optimist, techno-realist, techno-pessimist, and techno-ignorant
Results: It was concluded that the vast majority of teachers in each country like to use new technologies. Teachers from Ecuador are most likely to want to ban the use of smartphones in schools
Main theme: In-service teachers and Digital Competences
Authors/Year: Dra. Adiela Ruiz-Cabezas 1, Dra. Mª del Castañar Medina Domínguez 2, Dr. Eufrasio Pérez Navío 3, Dr. Antonio Medina Rivilla 1 (Article, 2020)
Region/place/number of respondents: Teachers' training at the Catholic University of Santiago de Guayaquil, Ecuador, on digital competence knowledge, command and projection to help in their own professional development and in the improvement of teaching–learning processes, especially for first-year university students. N = sample of 30 teachers
Research tools used/areas of measurement: The methodology used was mixed quantitative and qualitative, it used the design and application of a questionnaire favoring open-ended questions, and two discussion groups
Theoretical framework: Literature review on digital competence and its impact on university teachers is explored and supported by the work and research of several authors providing a sound theoretical framework
Results: It was evidenced the interest of the teaching staff in understanding and integrating digital competences, as well as the importance and meaning of improving the teaching–learning processes to generate a culture of professional development among teachers. The lack of digital command and assessment is common to all teachers interviewed
Main theme: In-service teachers and the use of ICTs
Authors/Year: Nory Andreina Sornoza Pico 1, Marcos Alejandro Yánez Rodríguez 2 (Article, 2021)

(continued)

Table 13.1 (continued)

Main theme: In-service teachers and the use of ICTs
Region/place/number of respondents: A particular educational unit in Ecuador. N = sample was taken from 40 teachers who are part of the same institution, to acquire information that is linked to ICT
Research tools used/areas of measurement: The type of research used was documentary with a qualitative–quantitative approach. A survey was applied to teachers of a particular educational unit in Ecuador for the 2021–2022 school period
Theoretical framework: Literature review on Information and Communication Technologies (ICT)
Results: It is concluded that the use of technology advances greatly, it is outstanding to enlighten the teachers and be able to provide relevant data to promote the benefits of using them in instruction

13.5 Discussion

Due to the short time available to carry out this literature review, it was not possible to review all the existing studies in Ecuador, under other categories, but the ones mentioned in the methodology of the research. It was intended to show the most relevant investigations carried out in our country regarding ICT in education and the EFL classroom.

Such studies included the impact of ICT in education, the risks students face when using technology. Other studies focused on the positive side of ICT in the EFL classroom, how pre-service and in-service teachers develop lesson plan, how competence teachers and future teachers are regarding the use of technology to teach by means of technology, and the lack of real evaluation regarding the policy set by the government many years ago.

As teachers and researchers, we believe that it is hard to measure the effects of ICT in education and the EFL classroom without taking into consideration the actual use of ICTs and the risks that they represent for the student. For this reason, we recommend further studies regarding a review of the literature that include key words that cover not only the impact of ICTs, but a broader spectrum to confirm the findings presented here.

We strongly believe that future investigation in the field of specific uses of ICT and how the plan developed by the government is instructed in universities deserves an extended body of research.

13.6 Conclusions

After conducting this research, it becomes relevant to emphasize the fact that the studies and research carried out in the area of Digital Literacy and Digital Competence are still in its infancy in Ecuador compared to other countries; this was evidenced in the lack of studies that the search for papers yielded. Therefore, as evidenced in the data collected, in the case of Ecuador, the fields that involved digital literacy or digital competence are linked to other areas besides ICTs, namely EFL and social inclusion to the community. This leads us to believe that this area of research is under developed and it is advisable that researches continue to explore the fields of digital literacy and digital competence both for pre-service and in-service teachers.

Additionally, the lack of research in ICTs during COVID-19 has arisen certain concern in the researchers as only one comparative study was found in relation to digital literacy and competence in our country. As COVID-19 pushed everyone to work remotely, concerns about how teachers decide on content, methodology and the use of ICTs deserve further study. Additionally, it is important to do research on how students have reacted to the use of ICTs in their studies.

It is worth noting that digital literacy and/or competence should not only be aimed at learning, understanding, and using ICTs as tools that the teacher can use within the classroom but also they should include a broader view that considers developing necessary soft skills like critical thinking, decision making, team work, communication, and problem solving, to name a few, especially in the area of EFL teaching, where teachers should be aware of certain linguistic errors that could be prevented by using and understanding ICTs properly.

On a final note, it should be mentioned from the results obtained in the research articles that there is great acceptance of learning and incorporating ICTs by students, teachers, and even society. This finding shows that the era of technology has come to stay and become the new norm, and also, that people in general are aware of its importance, and thus, by adopting new technologies, we will be able to shape the future, not only for students and teachers in the field of pedagogy, but in general, for society as we know it.

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Chapter 14
A Multidimensional Perspective on Digital Competence, Curriculum and Teacher Training in Italy. A Scoping Review on Prospective and Novice Teachers

Laura Fedeli

Abstract The study, here described, approaches the analysis of selected sources in a scoping review for mapping the key aspects related to digital competence, at national level, in the chosen research area and target audience, that is, pre-service teachers, including novice faculty members. The review process is supported by providing a brief overview of the Italian initiatives in the lens of European reference frameworks and a focus on training paths and profiles of prospective teachers in Italy. The specificities of the above-mentioned aspects can, in fact, facilitate the discussion of data and the collection of inputs for future research. The review highlights some of the existing gaps in the literature due to the difficulty in selecting a broad range of studies focussed specifically on assessment and shows that a common trend, in the selected studies, is the clear connection both theoretically and empirically to a cross analysis with European initiatives and tools, including for self-assessment inclination.

Keywords Digital competence · Italy · Teacher training · Novice teachers

14.1 Introduction

When addressing digital competence and teacher assessment, it is necessary to attribute to the process a set of frames to get significant inputs. On a conceptual level, any research effort should move in the direction of a specific perspective and should be modulated for application to a target population who inhabits a specific context. Because the object of this study is characterized by a broad interest area—that is, the assessment of digital competence among prospective/novice teachers—we need to clarify first the direction we assume on a theoretical and empirical level to enable an interpretation of data that can be easily understood in its research context and possibly become an object of comparison with similar studies.

L. Fedeli (✉)
University of Macerata, P.le Bertelli, 1, 62100 Macerata, Italy
e-mail: laura.fedeli@unimc.it

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This chapter focuses on the concept of digital competence by taking into account the main European frameworks, which were chosen as reference documentation for the Italian national ministerial initiatives for digital innovation in school and teacher training actions. Approaches in this direction include research lines on specific areas such as digital and media literacy (Buckingham, 2007; Calvani et al., 2009), but also digital scholarship (Fedeli, 2017a) when we widen the target population to analyse and assess teaching competences among faculties and early career researchers.

Another relevant step in understanding how to run an assessment process in this area is to identify the teacher training paths in the specific country of analysis to get supporting inputs when analysing the data. Training opportunities can vary from initial/induction processes to lifelong actions during the whole professional life and are strictly connected to national guidelines aimed at organizing and structuring the school curriculum at each grade/level of instruction. Clarifying the focus and available space for digital competence in the curriculum can guide the selection of criteria and tools to run assessment processes and activate empirical studies. This chapter will, then, approach the analysis of selected sources in a scoping review by providing a brief overview of the above-mentioned aspects to facilitate the discussion of data and the collection of inputs for future research.

14.2 Digital Competence: An Overview of the Italian Initiatives in the Lens of EU

A first reference to "digital competence" at the European level is the "Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning" (EU 2006/962/EC), where it appears among the eight key competences of the Reference Framework, which is the tool identified to pursue "the development of quality, future-oriented education and training tailored to the needs of European society" (L 394/10). Digital competence has its roots in a wide literature discussing the advent of the digitalization, however, and its implications for education branch out in conceptualizations synthesized by different phrases such as "Digital Literacy", firstly discussed by Gilster in 1997, stressed the dimension of critical analysis and reflection in the digital world (as cited in Calvani et al., 2009); "Media literacy" (Buckingham, 2007), "Computer literacy" (Martin, 2001; Williams, 2002) and "Information literacy" (ACRL, 2000; Kurbanoglu et al., 2014; Tomczyk, 2020; Zurkowski, 1974). In the EU recommendation, digital competence is defined as follows: "Digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet" (L 394/10). The document underlines the complex nature underpinning the phrase "digital competence" by addressing the knowledge, skills and attitudes needed to be able to acquire a "critical and reflective attitude" when using technology.

The Italian National Plan for Digital Education (Piano Nazionale Scuola Digitale, PNSD) created by the Ministry of Education, University and Research is a comprehensive framework to set key actions to enable an innovation strategy process in the Italian school system in the digital age. The PNSD represents a milestone of "La Buona Scuola" school reform (Law 107/2015). The vision of innovation proposed in the document is accompanied by a cultural and holistic approach in which the school and its actors are not isolated in their formal contexts but are immersed in an augmented system of relations which extend to the whole territory and its dimensions (formal, informal, non-formal). In this approach, the document embraces the EU guidelines and such that "technologies become enablers, they are daily, ordinary and support the educational activity, first of all the activities directed to training and learning, but also administration by joining all school's environments: classrooms, common spaces, labs, individual spaces and informal ones" (MIUR, 2015, p. 8). The variety of actions and projects listed in the plan shows the connotations within the umbrella phrase "digital competence"; those initiatives are, in fact, connected to different competences that highlight strong connections with the EU framework, DIGCOMPEDU[1] and tools used, at the European level, to attest proficiency in the areas of the model. The EPICT Certification Syllabus (for the European Pedagogical ICT Licence) is an example of this alignment in Italy, which started in 2005 when the University of Genoa began organizing courses and certification, and a team of experts is in charge of updating the materials (Adorni et al., 2018). Another example of commitment in the direction of embracing EU initiatives is the Italian piloting of the SELFIE project[2] (2016–2018), which included the participation of 201 schools and a total of 31,912 respondents, and was recognized as one of the ten best in experimentation (Bocconi & Panesi, 2018).

[1] The European DIGCOMP frameworks related to digital competence were developed thanks to a synergy with the Joint Research centre (JRC) and include different outcomes: the European Framework for Digitally Competent Educational Organisations (DigCompOrg: 2015); the Digital Competence Framework for Citizens (DigComp 2.0: 2016; DigComp 2.1: 2017); the European Framework for the Digital Competence of Educators (DigCompEdu: 2017) and the Digital Competence Framework for Citizens: Call for contributions (DigComp 2.2: revision started in January 2021 to be concluded in 2022).

[2] SELFIE—Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies—is one of the 11 actions (*Digital Education Action Plan*) promoted by the European Commission in 2018. It is meant as a monitoring tool and self-assessment device for schools to check teaching/learning practices in terms of digital integration and didactic innovation. The tool can be used by all school actors (manager, teachers, students) from the primary level to secondary school in European countries through simple registration with the project portal. SelfieforTeachers is a further step of the initiative, and starting from 7 April 2021, the Italian piloting has started on this project (http://digcompedu.cnr.it/news.html) to optimize the tool that will be made available to all teachers in Europe (in 24 different languages) in 2021–2022 (primary and secondary schools).

14.3 The Target: The Training Paths and Profiles of Prospective Teachers in Italy

Prospective teachers in Italy are required to follow different learning paths (depending on school level) at different stages of their study process (during the degree course and after) to be able to take on a teaching role. That role is not exclusively reserved for full-time teachers hired permanently at schools but can also be temporarily covered by different profiles (e.g. educators, subject matter experts) if there is a specific need in the school to promote either an extra-curricular project or to reinforce the supporting action for classes with students with special needs.

In 2015, the Italian PSND established the presence of a trained teacher, the so-called "digital animator" by formally institutionalizing a function that had in the past been played without a dedicated budget and resources. The digital animator is currently present in every school to design and develop actions of didactic innovation in line with the PSND and the specific requirements set by the school manager. The training initiatives promoted by the PNSD are directed to digital animators and the innovation team of the school, such that each school can count on a number of reference teachers, as well internal training for colleagues.

The degree courses at university useful for becoming a teacher are divided into two paths: (a) the course for pre-school and primary school teachers, in which the technology integrated into didactics and digital competence is already a core content in the degree curriculum and (b) the disciplinary 5 year degree to become secondary school teachers. For the latter, graduates are required to follow specific courses (during their degree or after it) dealing with technology and didactics covering 6 of the 24 credits required to complete the profile (PF24). Teachers who wish to specialize in special needs and be hired as a "supporting teacher" for classes with one or more students with disabilities should follow a specific teacher training programme (60 ECDS), which includes an Information and Communication Technology course that covers 75 h of instruction. Technology and digital and media literacy are of paramount importance to create inclusive classes based on Universal Design for Learning (UDL): "UDL principles and guidelines offer a unique way for educators in digital and media literacy fields to ensure that their work will benefit the widest range of learners, including those with learning challenges and disabilities" (Dalton, 2017, p. 17).

Teachers are, however, offered the opportunity to deepen their knowledge and practice of technologies during their whole professional life, from induction programmes for newly appointed teachers to refresher courses promoted yearly through the online platform SOFIA (operative system for teacher training and continuing education) that has been active since 2017 as part of the National Plan that established compulsory, lifelong and structured education for teachers according to "La Buona Scuola" school reform (Law 107/2015). The specific content addressed in training dedicated to digital competence and new learning environments includes the use of personal devices at school (Bring your Own Device, BYOD); the use and production of open resources (Open Educational Resources, OER); information literacy; technologies for inclusion and digital citizenship.

14.4 Curriculum and Digital Competences

Technology and the development of digital competences to be integrated in the teaching/learning process (at macro- and micro-level) can be considered a connection link in the overall school curriculum (Fedeli, 2017b). Studies and initiatives on the integration of media education, technologies and digital competence in the curriculum for teachers of different levels of instruction (from primary to secondary school) have travelled in two directions: either disciplinary or transversal (Rivoltella et al., 2019). In Italy, the curriculum at the macro-level (the PTOF, or 3 year plan for the learning offer) is remanded to the autonomy[3] of each school institution where teachers and all profiles involved in the educational actions negotiate the teaching–learning design for all disciplines, the supporting action for inclusion and the connections between school levels (e.g. orientation processes for students who pass from primary to middle school) and subject matters within the same class level (e.g. the cross-content in different disciplines to be managed by different teachers in the first class of the middle school).

In Italy, unlike many other countries, digital education is not expressed in a specific disciplinary curriculum but is instead spread transversally throughout different curricula from the perspective that aspects like digital citizenship, for example, cannot be confined in a single discipline but should be a focus in all teachers' educational actions. In line with this rationale, a major effort should be made to provide all teachers with the due competences in the digital area and to establish a profile for a resource who could play a reference role in the school (e.g. the digital animator). Currently, digital themes are addressed at all school levels and "teachers don't need to force their curriculum to include technology since technology is already embedded in the students' background and expectations" (Fedeli, 2017b, p. 46). The big challenge is enabling teachers to use the students' available background, interests and skills productively for critical use of technology that could support their learning path, wellness and social abilities in a safe, appropriate way.

14.5 Pre-service and Novice Teachers' Digital Competence: A Scoping Review at National Level

Because the object of the analysis is heterogeneous in nature, the literature was not amenable to a systematic review based on the criteria of Munn et al. (2018); indeed, "Scoping reviews are useful for examining emerging evidence when it is still

[3] Law no. 59/97 recognizes the autonomy of scholastic institutions, and DPR. no. 275/99 regulates it. Schools establish their POF (plan of the learning offer that was later replaced by PTOF with law 107/2015) and the didactic curriculum, which focusses on the school systemic design process at different levels: organizational, educational, didactic, research and innovation. School autonomy should support a deep and full valorization and development of human beings with their relational skills.

unclear what other, more specific questions can be posed and valuably addressed by a more precise systematic review" (p. 2). The scoping review was therefore identified as the methodological approach most suitable for mapping the key aspects related to digital competence in the chosen research area and target audience, that is, pre-service teachers (degree course and PhD students), including novice faculty members (newly appointed). The aim of the review is to analyse and describe the last 10 years of research on the assessment of digital competence in the identified target population. The analysis was aimed at satisfying the following research questions:

- What dimensions of digital competence were taken into consideration?
- How is the assessment of digital competence connected to different contexts (e.g. formal/informal)?
- What are the differences in studies run in different contexts (e.g. formal/informal; school/university)?

The scoping review was carried out in July 2021 by searching through the Google Scholar, Scopus and Web of Science databases, as well as the archives of selected national scientific journals in the field directly. The search included works published in both English and Italian. Figure 14.1 illustrates the process followed to select contributions where the exclusion criteria were strictly related to

1. Subject: Digital competence is a broad topic, so research and studies should adhere to a focus on assessment and clearly describe the conceptual framework, the variables identified to run the assessment process and the methodology used; studies that did not match the requirement were not considered.

2. Target: The educational actions related to digital competence have a wide range because learning is a lifelong, multifaceted process and a primary goal of Italian Ministry of Education and Research. Assessment appears to be a common practice and the object of a huge number of scientific contributions when related to in-service teachers; studies that did not address novice or pre-service teachers specifically were not included.

Step 2 (Title and abstract screening) led to the major exclusion of studies due to lack of consistency with subject and target requirements, as well as reference to the target country, Italy; step 3 (full text availability) was a necessary selection action that let the researcher deepen the analysis to verify the appropriateness of the source.

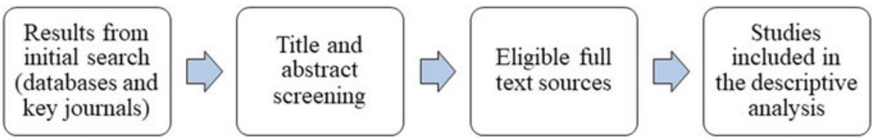

Fig. 14.1 Selection process for the scoping review (breakdown of search results)

14.6 Data and Discussion

The review was carried out with nine selected contributions published from 2013 to 2021 (Table 14.1). The target of the reviews included faculties (with a focus on newly appointed ones and early career researchers), student teachers, prospective/novice teachers (pre-school to secondary school) and PhD candidates within the university context, as well as newly appointed school teachers and school teachers on short-term contracts.

To discuss the orientation of the selected sources, the review presents an overview of the main emerging issues by addressing: (a) the level and kind of digital competences forming the object of analysis, (b) the tools used to assess digital competence and (c) the value and connotation of the context.

14.6.1 Digital Competence Ecosystem

As well underlined by Volungeviciene and Szűcs (2018) the "European Union initiatives emphasize solutions to emerging needs and seek to improve competitiveness and professional development; enhance cross-sectional skills; and fuel the engines of social innovation—creativity, entrepreneurship, critical thinking and problem solving" (p. iii). The review shows consistency with this perspective by highlighting the effort of the national instructional system to focus on a holistic view of digital competence, where integrated skills and metacognitive awareness appear to play a relevant role in the construction of a "digital culture". It worth noting, first of that, there has been a focus on the cognitive dimension of digital competences (Calvani et al., 2010) where the assessment tools used aimed at disclosing the presence and level of awareness of critical use of technologies to be applied in the educational context. The selection of tools reported in the selected sources (e.g. TPACK, DIGICOMP) reinforces the tendency towards a metacognitive level.

Starting from the most recent article, in which newly appointed faculty members were investigated (La Marca et al., 2021), the authors underlined the objective of their analysis in digital competence as "representations of didactics, postures towards didactics and assessment, metacognitive competence, didactical strategies" (p. 167) from the perspective of integrated learning. The faculty members' reflexive approach and applied self-regulated strategies were considered relevant, and their impact resulted in significant activation of innovative methodologies in didactics, including the use of digital technologies. Participants who showed higher results in the Metacognitive Awareness Inventory (MAI) test and TPACK scale were those who stated they applied a variety of didactic strategies, including those reliant on digital competences. Metacognition also remained a critical aspect in other sources in the review: "participants can be supported in metacognition processes to gain awareness about the meaning they build on the several digital culture dimensions, the way they

Table 14.1 Selected sources

Year of publication	Author	Title of publication	Target of the study	Context of the study	Methodology
2021	La Marca, Longo, Martino	Digital skills e consapevolezza metacognitiva: prospettive di sviluppo professionale dei docenti universitari neoassunti	Newly appointed faculty	University: in-service	TPACK scale (Mishra & Koehler, 2006); MAI test (Schraw & Dennison, 1994)
2019	Petrucco	La valutazione delle competenze digitali in ambiti informali online: una esperienza trasformativa con Wikipedia	Student teachers	University: students enrolled in degree courses	Authentic assessment crossed with DigComp 2.1 (Carretero et al., 2017)
2018	Calzone, Di Gioia, Pappalardo	Initial teacher training and the national plan for digital education (NOP-ESP)	Newly appointed school teachers	National institute INDIRE	Questionnaire (consistent with the framework of Call for Projects 6076/2016—addressed to the Italian Local Training Hubs); Skill Assessment tool (http://neoassunti.indire.it/2018/toolkit.html)
2018	Loperfido, Caposeno, Dipace, Scarinci, Viteli	Teachers' digital culture: the horizon of Italian participants in a TFA course	Prospective/novice Teachers (pre-school to secondary school)	University: TFA teacher training programmes	Questionnaire adapted from Opeka project (Viteli et al., 2013)

(continued)

Table 14.1 (continued)

Year of publication	Author	Title of publication	Target of the study	Context of the study	Methodology
2017	Manca, Ranieri	Exploring Digital Scholarship. A Study on Use of Social Media for Scholarly Communication among Italian Academics	Faculty	University: faculty	survey from a questionnaire annually administered by Pearson and the Babson Survey Research Group (adapted and translated from Moran et al., 2012)
2015	Muscarà, Messina	Perceived competency, perceived ICT usefulness in classroom and teachers training models	High school Teachers on a short-term contract	University: PAS teacher training programmes	ITIS scale (Niederhauser & Perkmen, 2008); (adapted, Benigno et al., 2013)
2015	Petrucco, Grion	Insegnanti in formazione e integrazione delle tecnologie in classe: futuri docenti ancora poco "social"?	Prospective/novice middle and secondary school teachers	University: TFA and PAS teacher training programmes	Questionnaire adapted from PEW Report (Purcell et al., 2013)
2013	Esposito	Neither digital or open. Just researchers: Views on digital/open scholarship practices in an Italian university	PhD candidates, early career researchers	University	Face-to-face, semi-structured, individual interviews
2013	Messina, Tabone	Technology proficiency, TPACK and beliefs about technology: A survey with primary school student teachers	Student teachers (primary school curriculum)	University: pre-service training	TPACK (Mishra & Koehler, 2006, 2008)

position themselves in respect to the components, the feelings they have about the group they belong to, and so on" (Loperfido et al., 2018, p. 770).

A second focus was on motivation and self-confidence; Calzone et al. (2018) showed the connections among the achievement of a deeper level of engagement in digital competence, development of professional autonomy and motivation as a driver to reach a satisfying management of technology in the teaching context. These findings are in line with the tool used by Loperfido et al. (2018) to collect data, an assessment tool (Opeka project, Viteli et al., 2013) based on the following areas: (a) leadership and management, (b) resources and access to resources, (c) confidence and competence and (d) motivation and time. The stress on professional development, motivation and confidence let prospective teachers both to unveil their perceived barriers in reaching a digital awareness and to uncover their strengths as a community. In fact, the authors reported that teachers rely on their colleagues and the context in which they live to find valuable and reliable support, which makes the value of relational skills clear.

The concept of community gains an additional connotation when addressing the target of academics. In the study by Manca and Ranieri (2017), the motivations for using social media tools were investigated among faculty members of different ages and profiles; they found that digital tools, even though not common in daily professional and personal routines, are actually used for scholarly communication to "keep in touch with colleagues", "extend the professional network" and "be part of a professional community". The social impact is also present in open answer to the interviews run by Esposito (2013), who reported that "there is also awareness that the networked environment is becoming a condition that significantly creates one's own approach to social inquiry".

A similar object of inquiry was proposed targeting prospective/novice middle and secondary school teachers (Petrucco & Grion, 2015) and highlighted that attention to the potentialities of technologies was limited to the "quantitative" level of information access, but almost totally ignored the relational aspects and qualitative effects the collaborative and interactive opportunities can have on the construction of a learning community and the co-construction of knowledge. A similar attitude was found in the study by Esposito (2013) in which faculty members and doctoral students showed an approach to technologies that was "pragmatic and efficiency-driven".

Motivation and engagement in digital competence (training and application) in instructional and professional dimensions also appeared to be strictly connected with the concept of "Technology Acceptance" (Venkatesh et al., 2003) and the Social Cognitive Career Theory (Muscarà & Messina, 2015). In teachers' professional development, the variables that can be taken into account in reference to ICTs and digital competences are the "Outcome Expectations" (perceived advantages in using digital technology for instructional processes), "Performance Outcome Expectations" (perceived advantages of using a specific technology for one's own professional performance) and "Self-Efficacy" (being confident in using digital technology). All of these aspects were more productive in disciplines that had already integrated technology into the curriculum. Muscarà and Messina (2015) suggested the need for further exploration of the motivational aspect, mostly at the intrinsic level, to determine how to design and implement training courses that could help teachers develop an integrated vision of technology application in the classroom to demonstrate their competence in the digital area.

14.6.2 Context

This review unveils that the context variable, when associated with digital competence and assessment, needs to be seen as a connotation of formal and informal dimensions in which assessment appears to make use of different tools. Regarding the relationship between formal and informal contexts, it is necessary to clarify that because formal contexts in both schools and universities tend in fact to mean an informal dimension, because of the shift in focus to authentic assessment (Petrucco, 2019) rather than tests, questionnaires and scales. This is possible when the trainees are actually performing in a real context (not just as in simulations at school/university) and assessed throughout the whole process as being active participants in so-called *knowledge-building environments* (Scardamalia et al., 2012).

Assessing digital competences through the authentic assessment approach lets the researcher achieve a complex vision where transversal skills (e.g. collaborative ones) can be observed in action and, thus, be fully integrated in the assessment process for different digital competence areas. As underlined by Petrucco (2019), there have been some attempts to design and develop tests that could satisfy this complexity, such as the Digital Competence Assessment (DCA), "which addresses students aged 15 to 16, and which consists of three sections: the first section is based on instant quantitative tests with automatic feedback (Instant DCA); the second one focuses on situated and complex tests (Situated DCA); the last one consists of projective tests (Projective DCA)" (Calvani et al., 2008, p. 184). Authentic tasks and modelling are also a core methodology in the open model for the integration of technology in teacher training (Messina & Tabone, 2013), where problem-solving is meant as a challenging strategy to apply digital competence in context-based didactical actions: "The faculty modeling role in integrating content, pedagogy and technology was investigated, as modeling appears to be a powerful strategy to support teacher students in deciding to try to integrate technology in their teaching practices" (p. 22). Concreteness regarding the teaching actions required by teachers in the study by Calzone et al. (2018), which referred to the Italian National Plan for Digital Education training courses, is said to accompany those authentic assessment and authentic tasks to improve digital competence and make it work in action.

14.7 Conclusion

This scoping review highlights some of the existing gaps in the literature due to the difficulty in selecting a broad range of studies focussed specifically on assessment. Digital competence is an umbrella phrase used to refer to studies that explore the topic from an extremely wide range of approaches and objectives. But, when searching for targeted research on the assessment of digital competence, one faces a highly heterogeneous landscape in terms of significant sample populations investigated, diverse analysis aims, tools used (quantitative and qualitative) and, finally, discussion of data. The discussion reported here had to narrow the number of studies for analysis to focus on a more specific branch of research and to select existing trends/directions that could suggest research paths and direct future research efforts. The discussion reports reasoning that could reply to the first two research questions on the dimensions of digital competence taken into consideration and how assessment of digital competence is contextualized. The current review could not provide any significant structured result about the differences present in studies run by different entities (e.g. school, university, research centre). In the studies considered, a common trend is the clear connection both theoretically and empirically to a cross analysis with European initiatives and tools (e.g. DIGICOMP), including for self-assessment trends (e.g. SELFIE). Assessment in digital competence appears to be a systemic and multidimensional process in which researchers need to isolate variables tied to teaching practices that should include "evidence-informed" approaches to teaching and authentic tasks for appropriate investigation.

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Chapter 15
The Digital Competence of Future Teachers in Kosovo

Hasan Saliu and Arberore Bicaj

Abstract The aim of this chapter is to identify the level of preparation of university students in using information and communication technology (ICT) in their work as future teachers in Kosovo. The collected data are based on desk research analyzing the scientific publications of authors from Kosovo relating to ICT and the digital competences of teachers. Considering that only a modest number of studies have been obtained regarding digital competence, all curricula of programs that lead to the qualification of pre-university teachers have also been analyzed. These data have been analyzed through content analysis, determining whether the courses offered manage to develop digital competences according to these three groupings: (a) competence in the generic use of computers, (b) digital teaching competence, and (c) professional digital competence. The findings indicate an average level of competence in the generic use of computers and general digital teaching competence. However, this level is higher in the faculties of education. On the other hand, professional digital competence is developed in programs at the Faculty of Mathematical and Natural Sciences.

Keywords Pre-service teachers · Digital competences · Pedagogical faculties · Kosovo

15.1 Introduction

Critical knowledge and the creative use of information and communication technology (ICT) have become necessary today more than ever before. Today's world is built as an information society (Buckland, 2017) and a networked society (Castells, 2009), i.e., we live in the infosphere (Floridi, 2014). The digitalization of the world in recent decades has transformed societies, including the education sector and its

H. Saliu
Faculty of Mass Communication, AAB College, Pristina, Kosovo

A. Bicaj (✉)
Faculty of Social Sciences, AAB College, Pristina, Kosovo
e-mail: arberore.bicaj@aab-edu.net

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members (Farias-Gaytan et al., 2021), and is constantly challenging our way of life, work, and teaching in schools (Engeness, 2021). Educators are currently faced with numerous online resources, which can be used for more effective teaching.

The use of digital technologies and the Internet, including equipment, applications, and the support infrastructure, has been widely introduced into school systems globally, affecting teachers' performance (Starkey, 2020). Recent reports confirm that knowledge and the use of technology for teachers have become a very important tool in their daily classroom work (Potyrała & Tomczyk, 2021). There is a broad consensus that digitalization can promote the quality of education by increasing professionalism, student activity, and improving digital skills, thus increasing the quality of education in general (Engeness, 2021, p. 97). But as schools evolve with the introduction of ICT in teaching, the work of the educator changes, too.

However, teachers themselves must first have the critical knowledge and practical skills to implement them in teaching. They are expected to be profound users of educational technologies, to engage in the design of digital learning environments and to be able to manage learning through online applications as well (Engeness, 2021, p. 96). Teachers entering the profession need to develop knowledge and skills to teach in schools of the present and the future by having digital technologies introduced into the functions of administration, communication, and teaching (Starkey & Yates, 2021). For this reason, many countries have classified digitalization as a specific high-priority strategy to increase the use of digital technology in schools and to include it in the curriculum. A key element of this strategy is the development of teachers' skills and knowledge in the use of digital technologies (McGarr & McDonagh, 2021). Via the European Commission, the EU has taken several initiatives towards creating 'well-trained, motivated and entrepreneurial' teachers, such as: 'Europe 2020', 'Rethinking Education', 'Opening Education', 'DigComp' (Fernández-Batanero et al., 2020; Redecker, 2017; Ferrari, 2013). Frameworks for teachers' digital competences have also been proposed by UNESCO (2011, 2018).

As a country that is not a member of the EU and is not yet part of UNESCO, but aspires to join, Kosovo has undertaken several initiatives and strategic plans to introduce the use of technologies in teaching and in teacher training curricula. These include the Pre-University Education Strategy 2007–2017 (2007), the Kosovo Education Strategic Plan 2011–2016 (2011), the Strategic Education Plan 2017–2021 (2016), and other strategies involving digitalization in schools and teaching. The purpose of this chapter is to analyze the lessons that teaching students receive in relation to the digital competences that they will exercise during their future work as teachers. To achieve this goal, a bibliographic review of the studies so far on this issue has been made, and all the university curricula of the pedagogical programs in Kosovo have been analyzed. Until 2018, study programs for teachers for pre-university education in Kosovo were offered by the Faculty of Mathematical and Natural Sciences and the Faculty of Philology at the University of Pristina (Kosovo Curriculum Framework, 2016). From 2018 onwards, graduates must also complete an MA at the Faculty of Pedagogy at the University of Pristina to qualify as teachers of pre-university education (MEST, 2018, 2021). Meanwhile, English, German, French, and Turkish language teachers still graduate from the Faculty of Philology, as well as those of sports educated at the Faculty of Physical Education. For these reasons, this chapter does not focus only on pedagogy students.

15.2 Theoretical Framework of Digital Competence

The definition of digital competences depends on how the context of these skills is situated and how the literature explains them in different ways (Tomczyk, 2021). This complex concept is constantly changing, depending on the development of digital media (Søby, 2015). Before the digital age, television literacy was discussed. After that, in the digital age, discussions have focused on computer literacy, media literacy, internet literacy, and information literacy (Leaning, 2019). Today, we often talk about digital literacy and digital competences as synonyms. In recent decades, these two concepts have been used frequently to relate to the skills and abilities that (young) people should possess in society, as well as how to acquire them (Ilomäki et al. 2016). In analyzing 107 articles published in English between 1997 and 2017 in journals indexed in Web of Science, Scopus, and the Education Resources Information Center, Spante et al. (2018) found 28 articles addressing digital competence and 79 focusing on digital literacy.

15.2.1 Digital Literacy

The concept of digital literacy was first introduced by Gilster in 1997. He states that 'digital literacy is the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers' (Gilster, 1997, p. 1). The concept was later evaluated and today includes other concepts of media consumer education, including media education for misinformation and fake news (McDougall et al., 2019; Johnston, 2020). Buckingham (2015), in explaining digital literacy in education, states that nowadays media literacy has moved online. He emphasizes that the knowledge that the teacher has about online media is very important so that he/she can then teach it to the students. According to Buckingham (2015), this knowledge should be primarily based on web literacy, game literacy, and writing for digital media. Other studies consider digital literacy as a cognitive skill (Mishra et al., 2017), or 'the ability to use information and communication technologies to find, understand, evaluate, create, and communicate digital information, an ability that requires both cognitive and technical skills' (American Library Association, 2013). Digital literacy, which was recognized as a competence by the European Commission in 2006 as part of lifelong learning, includes the digital training of citizens, thus becoming over the years, part of national educational policies for students, teachers, and citizens in general (Perez-Escoda et al., 2019). It was only after 2006 that the ability to use digital tools became an important component of all levels of education for both students and teachers in Europe (Instefjord & Munthe, 2016).

15.2.2 Digital Competence

Based on the importance of critical knowledge today and the creative use of information technologies, the European Commission published the Digital Competence Framework in 2013, based on 21 competences which include the notion of digital literacy (Ferrari, 2013). Subsequently, the European Commission published the European Framework for Digital Competence of Educators (DigCompEdu) in 2017, which was based on 22 elementary competences organized in six areas, but mentions only digital competences and not digital literacy (Redecker, 2017).

Digital competence includes the wide range of knowledge, skills, and attitudes required when using digital technology (Instefjord & Munthe, 2017). The term covers knowledge and skills to successfully use computers, their related applications, and software in teaching and education practice (Maderick et al., 2016). Usually, these skills are included in the general category of the ability to use hardware and software (Tomczyk, 2021, p. 2). According to the European Commission (2006), 'digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication' (p. 6). Ferrari (2012) emphasizes that digital competence is 'the set of knowledge, skills, attitudes, strategies and awareness that are required when using ICT and digital media to perform tasks; solve problems; create and share content; and build knowledge effectively, critically, creatively, autonomously' (p. 30).

The term digital competence includes the agenda for innovation, education, and pedagogy (Søby, 2015, p. 4). These three dimensions include: using particular technologies as a teacher; being able to select and critique which technology to use for a specific teaching purpose; and being able to plan and teach students who are learning through and with digital tools (Starkey, 2020, p. 43). In this sense, Ilomäki et al. (2016) define digital competence as consisting of: (a) technical competence; (b) the ability to use digital technologies in a meaningful way for working, studying and in everyday life; (c) the ability to evaluate digital technologies critically; and (d) the motivation to participate in and commit to the digital culture.

While competence was mentioned frequently across the literature, there was not one universal definition and it was not clearly defined in individual articles (Starkey, 2020, p. 40). In seeking to answer the question of what has been researched in studies examining teacher preparation for the digital age, Starkey (2020) analyzed 47 journal articles on digital competence published between 2008 and 2018. He finds that the integration of ICT in teaching practices has led scholars to divide competences into three groups: (a) competence in the generic use of computers (the ability to use PowerPoint presentation software, video editing, picture editing, use of online communication platforms, web and video development, etc.); (b) digital teaching competence—the ability to integrate digital technology into teaching practice; and (c) professional digital competence, which includes the teacher's ability to use digital tools including assessment, data management, network communication and providing solutions to this nature of problems with students.

Meanwhile, the measurements that have been made for the level of digital competences of students who will become teachers are mainly focused on three competences: being a member of the profession in the digital age; how to teach them; and what to teach students (Starkey & Yates, 2021; McGarr & McDonagh, 2021). In studies dealing with students' digital competence, however, there are often differences between the stated level and the actual level of digital skills by pedagogy students who will become teachers (Tomczyk, 2021).

15.2.3 The Meaning of Digital Competence in Kosovo

Based on Kosovar authors, the importance of including information technology in the education system is acknowledged through legal documents (Beka, 2014). On the other hand, Shala and Grajcevci (2018) relate the meaning of students' digital competence as being the ability to learn and solve problems independently. In education strategy documents, the main goal is the development of ICT competences in pre-service and in-service students (Beka & Gllareva, 2016), while ICT competences are considered as key competences for students (Beka et al., 2016). According to the Kosovo Education Strategic Plan (2011) and the Curriculum Framework for Pre-University Education (2011), students should use ICT during their learning process and their school assignments, as well as use ICT and media effectively and responsibly as an important means of information, communication and interaction in the digital age. Integration in the digital age is one of the challenges faced by Kosovar society in the twenty-first century, and the Pre-University Education Curriculum Framework (2016) emphasizes that, in addition to basic knowledge gained from digital literacy, the current education system implies awareness of the development and functioning of digital competences.

15.3 Research Methodology

15.3.1 The Aim and the Method Used

The main purpose of this chapter is to describe the preparation of students in pre-university education to use ICT, which will be needed in their future careers as teachers in Kosovo. The research question derived from this purpose is: what do students learn about ICT in their study programs? Therefore, we based our research on the Kosovo Curriculum Framework (2016), which aims to outline student competences, including digital competence, as well as learning outcomes (Levin, 2008). This was accomplished through desk research of articles published on the digital competences of students in higher education, and more specifically, of students in the teaching/pedagogical faculties. The analysis also relied on examination of the legal framework and other relevant documents. Another form we used to conduct research was the implementation of existing programs in the respective faculties, focusing on courses that develop students' competences. The syllabi of ICT courses were analyzed to identify which courses best addressed these competences: (a) generic use of computers; (b) digital teaching competence, or (c) professional digital competence. These three competences were selected as according to Starkey (2020), these have dominated a considerable number of the studies conducted during the last decade. This method is based on the three stages of curriculum development according to Goodlad et al. (1979): ideological curriculum ideas (ideal and formal curriculum) towards realization in the classroom by teachers (perceived and operational) and students (experiential) (Goodlad et al., 1979; Instefjord & Munthe, 2016). This paper, however, considers only the second stage—the formal curriculum. The field of study deals with all of the programs in Kosovo that train students for qualifications to teach in pre-university education.

15.3.2 Data Collection

The data are based on the analysis of the curricula of the University of Pristina (four faculties), the University of Mitrovica (one faculty), and the University of Gjilan (one faculty). Based on these observations, qualitative data were extracted (Palsa & Mertala, 2019). Qualitative content analysis has been applied to analyze the curricula of the above-mentioned faculties (Krippendorff, 2004). Subsequently, courses within the programs that aim to develop students' digital competence were identified and are also discussed (Instefjord & Munthe, 2016) in more detail below.

15.3.3 Research Limitations

The following aspects can be considered as research limitations:

- the lack of empirical research on the situation within teaching faculties;
- the lack of observation of the learning process in schools and classrooms;
- the limited number of relevant scientific papers on the development of digital competences in Kosovo have been published in indexed journals.

15.4 The Kosovo Context

According to the Pre-University Education Strategy 2007–2017 (2007) and the Kosovo Education Strategic Plan 2011–2016 (2011), Kosovo has had to turn into a 'knowledge society integrated into the mainstream of European processes, offering equal opportunities for personal development to all individuals, who will in turn contribute to sustainable economic and social development' (Selenica, 2018, p. 9).

Formal university and pre-university education in Albanian language in Kosovo were banned by Serbia between 1990 and 1999. It was only after liberation via NATO intervention in 1999 that Kosovo resumed formal education in the Albanian language. In 2000, the education system still consisted of outdated pre-service education, lack of continuing education opportunities for teachers, teacher-centered classroom education, and lack of critical thinking (Pupovci, 2002). Other publications emphasize the role of teacher-centered learning (Kadriu & Gougeon, 2014; Ognevyuk, 2016) and this was due to the lack of an adequate system for monitoring quality requirements (Haxhikadrija, 2019). Therefore, it was necessary for the education system in Kosovo to be reformed towards achieving greater quality. The Department of Education and Science (which operated under the UN mission in Kosovo (UNMIK) until 2008), received support from international organizations to reform the higher education system based on the objectives of the Bologna Process (Tahirsylaj, 2010; Kaçaniku, 2020). In order to reform the education system, the curriculum framework had to change and to take into consideration the challenges faced by Kosovar society. Nowadays, higher education has undergone large-scale reforms (Kaçaniku, 2017, 2020). One of the challenges is its integration into the digital age/digitalization, with the aim of developing students' digital competences. Thus, students' readiness for the digital economy requires the development of their digital competences—for example, in order to have a student capable of creative and critical thinking at the end of their pre-university education, among other requirements, he/she must have developed digital competences. In addition, to have an effective and communicative student, opportunities must be provided for students to know how to use ICT for communication and public information purposes (Kosovo Curriculum Framework, 2016). Therefore, the future generation of teachers should demonstrate these skills in using digital tools in their educational activities, which shows the importance of different media and digital environments in schools (Tahirsylaj & Wahlström, 2019).

When referring to different authors from Kosovo, we see different opinions on developing students' digital competences. According to Beka and Gllareva (2016), the requirements of the education strategies of Kosovo's Ministry of Education, Science and Technology (MEST) of Kosovo are related to the building of the digital competences of pre-service and in-service teachers. Based on the Strategic Education Plan 2017–2021 and the Kosovo Curriculum Framework, Gjelaj et al. (2020) confirm that the integration of students in the digital economy depends on the digital competences they have achieved. At the same time, Gjelaj et al. (2020) emphasize the benefits and risks of using technology since early childhood. However, cooperation between parents and teachers is seen as the mechanism that will increase the benefits and reduce the risks.

On the other hand, another study offers the opportunity to observe the importance of ICT and e-learning literacy in strengthening the competence-based curriculum within the Kosovo Curriculum Framework. Thus, a school in Kosovo is not only a physical building but also a collection of digital resources; the teacher is an integral part of the virtual world (Beqiri, 2010).

Limani et al. (2019) emphasize the low level of development of methods to implement digital technologies in the public and private sector in Kosovo. Consequently, they have researched the willingness of Higher Education Institutions (HEI) in Kosovo to implement digital technologies. The results of the study consider digital technologies as the main driver and catalyst in response to the challenge of teaching in HEIs, as this process depends on digital education, professionalism in the classroom or workplace, and the challenge of recognizing values. Research conducted during the pandemic period, which was characterized by the immediate need for the use of online learning, shows that 'the education system in Kosovo has never prioritized investment in technological equipment, and teachers' continuous professional development in the field of technology' (Beka, 2021, p. 857).

15.4.1 An Analysis of the Curricula of the Teaching/Pedagogical Faculties

Nowadays, the way students access new information, adapt to the current rapid changes and develop critical thinking is of the utmost importance. In this case, the best solution is the development of technology and information (Ismajli, 2012). According to the Law on Higher Education (2011), only public providers of higher education can offer study programs, which lead to the official teacher-training qualification for schools.

Based on the importance of developing pre-service students' digital competence, we have analyzed the curricula of the education faculties within the University of Pristina, as well as the curricula of the Faculty of Education at the University of Gjilan and the University of Mitrovica (all public HEIs).

At the University of Pristina, each program has approximately one course that deals with the development of digital competence. Yet what is noteworthy is the lack of ICT-related courses within programs offered by the Philology Faculty and at the MA level at the Faculty of Education.

In the preschool and primary program offered by the Faculty of Education (2021), there is only one course that leads to the development of digital competences, whereas the pedagogy program offers two courses: 'Cyber Pedagogy' and the 'Technological basis of teaching work'. Currently, the preschool and primary programs at the Faculty of Education aim, among others, to train students in how to implement educational technology as future teachers.

The aim of the courses to develop students' digital competence in the Faculty of Education (2016) is to acquaint students with basic computer hardware and software, such as the Windows operating system and the relevant programs, and focusing on how to use these programs when working with pupils. The pedagogy program also offers opportunities for students to become acquainted with information and communication systems, as well as their content elements. This helps to develop students' skills in presenting educational topics via mass media and to link practical work with the application of technology in teaching. Students also learn how to apply technology in the contemporary society. At the MA level, not all programs offer courses in developing digital competence. The mathematics, geography, and chemistry programs offer courses with a focus on the use of technology and media in teaching according to specialization: 'The use of technology in mathematical education', 'Technology and media in teaching geography' and 'ICT in Chemistry Education'.

Based on the program of the Faculty of Philology (2021), there is a noticeable lack of courses that develop digital competences and therefore, we are faced with an unsatisfactory situation. Consequently, only the Albanian Language program and the Albanian Literature program offer courses with a focus on digital competences, such as: 'Information technology for linguistics' and 'Introduction to information science'. The 'Information technology for linguistics' course develops theoretical and practical knowledge, as well as skills for the use of information technology and language technology. The course also offers opportunities to create new ideas for natural language processing from information, communication, and multimedia technology. The second course, 'Introduction to information sciences', examines the impact of information management, the way it works and how it is managed in online environments, thus leading to discussions on how to improve current information procedures.

In the Faculty of Physical Education and Sports (2021), the teacher-training program has a single course that develops students' digital competences. The course on informatics provides students with the opportunities to gain skills for using computer applications in their future work.

In the Faculty of Mathematical and Natural Sciences (n. d.), we identified five teaching programs. Within three of the programs (biology, chemistry, and geography), no courses are offered for the development of students' digital competences. In the mathematics program, four such courses are offered, namely 'Programming I', 'Programming II', and 'Mathematics software packages', and 'Databases'. The aim of these courses is to teach students data structures and how to apply them; for example, the latter course teaches students how to compile and use databases in their professional life. The physics program offers two courses: 'Introduction to computer sciences' and 'Programming in physics', with the first offering students the opportunity to become acquainted with computer science and its importance in their field of study. Furthermore, these courses are relevant to the field of study, given that they provide opportunities for the student to acquire basic knowledge of how to use technology in their work with pupils.

In the University of Gjilan, there are two programs that prepare future teachers: the preschool education program and the primary education program. Both programs offer a course entitled ‘Education and media’ (2017), which aims to develop media education skills so that students understand the role of mass media and become able to use their skills in the implementation of media activities. However, the lack of courses that prepare students for the use of technology in the learning process is something noticeable, too.

In creating digital competence among its students, the Faculty of Education at the University of Mitrovica (n. d.) has a similar approach to the Faculty of Education at the University of Pristina. By offering the course ‘ICT in preschool and primary education’, students are taught how to use information technology, which can then be implemented in their learning activities.

15.5 Discussion

This research on students’ digital competences is based on the literature and on the review of the documentation from academic teaching units and faculties. Consequently, since there is a lack of literature in Kosovo that refers to this issue, we have tried to look into the situation directly within the faculties themselves. This has been achieved through the analysis of the programs and courses offered, and on how they prepare students to apply digital competences in their professional practice in the classroom. The research has identified and described some of the digital competences as well as areas where those competences can be developed.

Based on our observation of the programs available in the faculties, we are aware that during the basic studies/BA level, there are insufficient courses for the development of digital competences such as: (a) competence in the generic use of computers; (b) digital teaching competence; and (c) professional digital competence.

The content of all of the courses has been analyzed, with the aim of identifying which competences are dealt with in the courses offered. The Faculty of Education at the University of Pristina offers three BA programs aimed at achieving/developing the digital competences of preschool students, such as: the preschool education program; primary education; pedagogy, and some MA programs with a teaching subject. Only three of these programs offer a course for the development of students’ digital competence. Consequently, out of the three BA programs offered by the Faculty of Education at the University of Pristina, four courses are related to the development of students’ knowledge and skills in digital technologies: ‘Information technology in preschool education’, ‘Information technology in primary education’, ‘Cyber Pedagogy’, ‘Fundamentals of technology in education’; out of eight MA programs, three courses are related to the focus of the study: ‘Use of technology in mathematical education’, ‘Technology and media in teaching geography’, ‘ICT in chemistry education’.

According to the analysis of the curricula of these courses, it can be noted that students are provided with general information that is mainly related to media literacy and the development of general computer skills and professional digital competences, for example: in the use of Microsoft Windows, the Word and PowerPoint applications as well as the internet (Faculty of Education, 2016, p. 15). The continuation course 'Basics of technology in education' offers the opportunity for digital teaching competence development, with the course description reading as follows: 'the application of educational technology in daily educational practice and research and scientific work will be dealt with' (Faculty of Education, 2014). There is an obvious lack of technology courses; not every program aims to develop students' competences, except for the programs in Albanian Language and Albanian Literature.

In the Faculty of Philology, despite the lack of courses that develop digital competence, the Albanian Language program and the Albanian Literature program offer two courses as follows: 'Information technology for linguistics' and 'Introduction to information science'. The first course aims to develop digital teaching competences as well as generic computer skills, offering topics that provide knowledge about the use of information technology in the teaching process as well as knowledge of software and language technologies (Faculty of Philology, n. d.).

As noted previously, the Faculty of Physical Education and Sports (2021) offers the course entitled 'Informatics', which ensures competence in the generic use of computers, while the Faculty of Mathematical and Natural Sciences offers five programs but not all offer courses on technology. Of the five different programs offered, only the programs in mathematics and physics aim to also develop students' digital competence, as shown by each course description: 'Programming', 'Mathematics software packages', 'Databases', and 'Introduction to computer science'.

At the University of Gjilan, two programs offer the course 'Education and Media', in order to develop students' competence in the general use of computers. Based on the purpose of the course and the expected learning outcomes, students will analyze different types of media including images, videos, games, and the internet (Education and Media, 2017).

And finally, the University of Mitrovica, with two programs for pre-university teachers, offers courses similar to the BA programs of the Faculty of Education at the University of Pristina, which was discussed above.

On the other hand, we found that the preparation of teachers regarding the use of technology in their work does not end with their initial teacher-training qualification, but continues during their career in the framework of professional development activities. Since 2009, the MEST has launched an initiative to train teachers in the European Computer Driving Licence (ECDL) program, in order to enable them to use information technology in their professional careers (Zylfiu, 2013).

15.6 Conclusions

The results show that the use of technology, ICT, and digital competences does not occupy the place it deserves in the curricula of study programs that lead students toward a teaching career. The inclusion of digital competences in the skillset of education students is quite complex and at the same time necessary. Some subjects in the curricula of certain programs in Kosovo are very elementary or outdated; most of the ICT courses offered are more related to the development of generic computer skills and digital teaching competence than to professional digital competence. If these competences are supposed to be achieved with a single subject offered within these programs, then this is an issue that needs to be explored. Prospective teachers should not only know how to use technology for teaching purposes but also help students improve their capacity to use digital technologies so that we do not have cases where students have more advanced technology skills than the teacher.

According to the Kosovo Curriculum Framework (2016), in order to achieve the required teaching competences, teachers and professors will need to help students meet the challenges of the digital age. Therefore, there are dilemmas about whether the curricula of teaching faculties provide sufficient opportunities for the development of digital competences. The relationship between policy and practice should also be taken into account when considering the role of curricula in institutional education, although the inclusion of policies in the curriculum still does not guarantee the achievement of the intended outcomes (Palsa & Mertala, 2019).

The development of future teachers' digital competences does not end during pre-service studies; it continues through professional development training during their career (in-service teacher professional development).

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Chapter 16
Digital Competence and Teacher Training Overview: Is Lithuania Ready for Digitalism in Education?

Ramunė Kasperė and Vilmantė Liubinienė

Abstract The aim of this study is to research the state-of-the-art situation of digital competence of both in-service and pre-service teachers, as well as students of the Lithuanian primary and secondary education. The analysis relies on scientific literature, i.e., peer-reviewed scientific articles, employing both quantitative and qualitative research methods as well as analysis of documents, published in foreign and Lithuanian scientific journals, mainly in the past decade. The results of the systematic literature analysis reveal that the contemporary context of technology-enhanced smart pedagogy in Lithuania still seems to be insufficient to assure integration and access to smart educational environments to all children. Although the situation currently is changing to the best at a quick pace, more research is needed along with implications for policymakers and pedagogical study programme implementers for continuous development of the digital competence.

Keywords Digital competence · Digital skills · Teachers · Teacher training · Lithuania

16.1 Introduction

The Lithuanian Information Society Development Programme 2014–2020 "Digital Agenda of the Republic of Lithuania" focuses on three major areas: skills and motivation of the Lithuanian citizens to use the information and communication technologies (ICT), development of electronic content and evolvement of ICT infrastructure, including next-generation access. Lithuania's Digital Agenda give a high priority to stimulation of the demand for fast internet access as well as the digital literacy of Lithuanians. Although estimates for Lithuania relating to computer usage and computer-based activities are close to the average European levels, at the primary

R. Kasperė (✉) · V. Liubinienė
Kaunas University of Technology, A. Mickevičiaus 37, 44244 Kaunas, Lithuania
e-mail: ramune.kaspere@ktu.lt

V. Liubinienė
e-mail: vilmante.liubiniene@ktu.lt

Ł. Tomczyk and L. Fedeli (eds.), *Digital Literacy for Teachers*, Lecture Notes in Educational Technology, https://doi.org/10.1007/978-981-19-1738-7_16

level, the schools lag well behind those countries like Norway, Denmark and the Netherlands.

The challenges of developing digital competencies (DC) of both teachers and pupils as well as incorporation of information and communication technologies in the general education process are being solved by the common efforts of strategy planners, management and administration. Great investments are needed to develop the infrastructure of information technologies, to ensure the professional development of in-service teachers and to promote teacher training programmes based on the formation of digital competencies. It is also important to establish an overwhelming network of smart pedagogy, including partnership, cooperation and networking of all interested parts.

The aim of this study, which is based on the results of a systematic literature analysis, is to research the state-of-the-art situation of digital competence of both in-service teachers, future teachers and students of the Lithuanian primary and secondary education. In order to achieve the aim set, the analysis relies on scientific literature, i.e., peer-reviewed scientific articles published in foreign and Lithuanian scientific journals.

The research of the state-of-the-art situation of digital competence in the educational sector in Lithuania may be undertaken twofold: considering the results prior to the global pandemic caused by COVID-19 and after the experiences of the lockdown. Although many in-service teachers lacked sufficient skills of technologies up till the first lockdown in March 2020, the current global pandemic has forced them to adapt to the changing situations and plunge into the digital environment both developing their ICT competencies and teaching students at the same time. They have had to introduce innovative teaching methods and adapt the curricula and assessment criteria with respect to primary and secondary students' needs.

However, following the research aim, in this study, we are going to concentrate mostly on the research of the state-of-the-art situation of digital competence of in-service and future teachers as well as pupils until the changes brought by the global pandemic, since extensive research data of the post-pandemic situation are only to come in the near future.

Our study is divided into several sections. Following the introduction, the theoretical framework describes the essence of digital competencies, as well as importance of developing the skills of digital literacy and ICT both for in-service teachers, future teachers and pupils. Next, a section on research methodology seeks to clarify the procedure used to collect and analyse the data. Study results are presented followed by a table of selected articles. A discussion of results and conclusions form the final section of the study.

16.2 Theoretical Framework

Computational thinking (CT) and DC as indicated by the European Commission and supported by many education policymakers are vitally important twenty-first century skills. Lithuanian researchers agree that nowadays CT and DC are essential skills and the young generation should learn them for life (Juškevičienė & Dagienė, 2018). Digital literacy, media, information and communication technologies and other modern technology-based skills are essential requirements for the twenty-first century learner's education. Contemporary children use the Internet from an early stage of life (Chaudron et al., 2018). ICT competence and skills are important for every citizen in a modern society (Dagienė, 2011). However, to be more precise, what do we mean by digital competence and how to acquire computational thinking and digital literacy?

As defined in the Recommendation of the European Parliament and of the Council of 18 December 2006 on Key competencies for Lifelong Learning (2006/962/EC), "digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet" (European Parliament and the Council, 2006). In the later development—DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe—a list of five areas and 21 competencies that are essential in order to become media literate person are provided. Various aspects of digital competencies are described in terms of knowledge, skills, and attitudes. The areas of digital competence can be summarised as follows. (1) Information and data literacy encompass the following skills: browsing, searching filtering, evaluating, storing and retrieving information. (2) Communication and collaboration develop the skills of interacting through technologies, sharing information and content, engaging in online citizenship, collaborating through digital channels, netiquette and managing digital identity. (3) Digital content creation covers the skills of developing content, integrating and re-elaborating, copyright and licences, programming. (4) Safety advances skills of protecting devices, personal data, health and the environment. (5) Problem-solving includes solving technical problems, identifying needs and technological responses as well as digital competence gaps, innovating and creatively using technology (see Punie & Brecko, 2013).

DigComp 2.1 is a further development of the Digital Competence Framework for Citizens. Based on the reference conceptual model published in DigComp 2.0, Carretero Gomez et al. (2017) elaborate and expand the definitions, offering a more developed tool to improve the citizens' digital competence.

In order to achieve the digital competence, a teacher's qualification comes as a significant trigger on student's performance (Jasute & Dagiene, 2012). Twenty-first century teachers should be achievers who model the behaviour they expect their students to learn. Jasute and Dagiene (2012) assert that through team projects teachers are involved in professional development opportunities to keep their skills up-to-date, and collaborate with their colleagues to share the best practices. The application of ICT requires the change of teacher's role in the educational process. A teacher must be open to innovations, seek to inspire, support, facilitate, and create a learning friendly environment. A teacher must become an assistant, a partner, an assessor, combining the traditional role of an expert and the role of a facilitator in the educational process (Ignatova et al., 2015; Kalesnikienė, 2013).

Research studies—both theoretical and empirical—focusing on digital technologies within an educational context emphasise the effects of transfer from traditional teaching and learning towards technology-enhanced practices as an integral part of education on three different layers of the educational sector: the institution (i.e., the school), teachers and pupils. Parents are yet another layer to be considered. The challenges in relation to technology-enhanced teaching and learning are multifaceted. In an institution, i.e., the school, the availability and accessibility of computers, the Wi-Fi, the selection, installation and use of educational platforms, communication issues between the stakeholders inside and outside have been noted (Carrier, 2018; Reza, 2020). Technology-enhanced learning also comes with diverse challenges for pupils. Various psychological issues, social isolation, social inequality, lack of engagement, lack of feedback, virtual environment addiction, academic achievement fluctuations among other challenges of technology-based teaching in secondary schools have been discussed in the scientific literature worldwide (Pokhrel & Chhetri, 2021; Reimer et al., 2021; Reza, 2020). In all challenges and issues experienced by pupils, parent mediation becomes an important aspect, and not all of them are ready and/or willing to engage to an extent required by their child (León-Nabal et al., 2021). The transformation of the teacher's role, including the digital competence acquisition or improvement, is among the primary concerns in many countries. Although teachers may themselves lack sufficient skills of technologies or feel anxious about their computers and the Wi-Fi quality, they still have to adapt to the changing situations, like the current global pandemic, and also to reconsider the uses of innovative teaching methods, curricula, activities, assessment methods and criteria with respect to the different pupils' needs (Polydoros & Alasona, 2021; Toppin & Toppin, 2015).

In the Lithuanian context, a research study by Indrašienė et al. (2015a), aiming at the analysis of teachers' experiences with the use of ICT in the teaching process in the general education schools of Lithuania, has come to a conclusion that there are three factors determining the teachers' attitudes towards ICT use in the teaching and learning process and they are qualifications, work experience and ICT competence. Following that, all three factors—qualifications, work experience and ICT competence—relate to a smaller or greater extent to teacher training and are interlinked. General qualifications and ICT competence are acquired in a pedagogical study programme; meanwhile, work experience almost always includes a component of life-long learning. Therefore, relying on the study accomplished by Dagienė et al. (2021), informatics curriculum is becoming a central part of school education. Next to that, pedagogical programmes have been also the focus of some research studies stating the need for transformation and adaptation to the development of technologies. Therefore, in a broad sense, all these issues deserve a deeper analysis.

16.3 Methodology

The aim of this study is to research the state-of-the-art situation of digital competence of both teachers and students including the level of ICT competencies among future teachers of the Lithuanian primary and secondary education. Thus, the objectives also include digital competence and its measurement among would-be teachers of the Lithuanian primary and secondary education, namely, how teacher training, qualification raising and requalification programmes encompass the digital competence acquisition component.

In order to achieve the aim set, the analysis relies on scientific literature, i.e., peer-reviewed scientific articles published in foreign and Lithuanian scientific journals. For appropriate selection of relevant scientific articles, we first focused on the key words to be used in the search in two languages: English and Lithuanian. For the search in Lithuanian sources, the following key words were used: *skaitmeninė kompetencija* (en. digital competencies), *skaitmeniniai įgūdžiai* (en. digital skills), *IKT* (en. ICT, an abbreviation for information and communication technologies), *mokytojas* (en. teacher), *pedagogas* (en. pedagogue), *pedagogikos programa* (en. pedagogical programme), *pedagogika* (en. pedagogy), *studentas* (en. student), *pedagogikos studentas* (en. pedagogy student). The key words were also searched for in their plural form. For the search in English sources, we used the same key words adding the following ones as well: future teacher, would-be teacher and Lithuania, Lithuanian. The compilation procedure of scientific sources was performed by two researchers separately. First, the search was performed in Google Scholar search engine resulting in an overview of more than a thousand of research articles. Then the articles were overviewed, and the names of researchers repeatedly authoring articles were searched in the SCOPUS database, which returned a bulk of scientific papers missed in the Google Scholar search. Besides, the same key words were used in the search of related scientific literature via the virtual library of Kaunas University of Technology, subscribing to such databases as EBSCO, Ebook Central (former Ebrary), Clarivate Analytics (Web of Science), Emerald, JSTOR, SAGE, Elsevier, Springer, Taylor and Francis, etc. The search in the Lithuanian language was also performed in the database Lituanistika, which provides bibliographic records, abstracts and full-text documents about the Lithuanian state, society, culture, nation and language and includes more than 85,000 bibliographic records and 52,000 full-text documents. The selection of the articles was conducted within the period since 2000 until present. However, in the final selection stages for the most relevant research articles, we mainly focused on the scientific literature of the past decade, because the search did not return too many relevant articles from the earlier period (i.e., 2000–2010).

The published research articles that we chose to include in our analysis had to meet the following inclusion criteria: research on future Lithuanian pedagogues; issues related to digital competence of pedagogues. Initially, we thought to exclude the research studies focusing on in-service teachers from our analysis; however, during the process of article selection, we decided that the research articles exclusively about would-be teachers might yield insufficient information. Therefore, in the perspective of teacher training, the selection of articles includes the digital competence of teachers developing their competencies throughout their careers as well as students in pedagogical programmes, and the digital competence development in high-school pupils.

In the analysis of all research articles that were finally selected, the focus was on the research methods, techniques, research tools, the sample size and the outcomes and implications of the study. Quantitative and qualitative research studies and those including the triangulation of research tools were included in the article selection criteria. Analysis of the research papers included checking the abstracts, the theoretical overview, description of methodology, results and conclusions of the research (see Table 16.1).

Limitations of the selection of articles for this literature review-based study are few. Dissertations and monographs were not included in the sample, and only research articles published in peer-reviewed scholarly journals were analysed. Conference proceedings were also disregarded in this analysis. Publications other than research articles might yield more information and results of overlooked research, especially in the topic as narrow as the state-of-the-art situation regarding the measurement of digital competence of future teachers (or teachers involved in the qualification raising and/or requalification programmes), however significant in the current state of transfer from traditional teaching towards technology-enhanced teaching integrating ICT tools on a regular basis. We believe that limiting the search and selection of the research articles to only two languages, i.e., English and Lithuanian, is not a considerable drawback as it is highly improbable that scholars, mainly Lithuanian, dealing with the topic would focus on publishing their research in other languages, e.g., Russian, German and French, and that the search for key words in the mentioned languages would yield a substantial number of research articles.

16.4 Results

Until 2011, research of ICT implementation in education in Lithuania was scarce. It was analysed by Dagienė and Mittermeir (2006), Dagienė and Kurilovas (2008), Pečiuliauskienė (2005), Pečiuliauskienė and Barkauskaitė (2006), Pečiuliauskienė and Dragūnienė (2008), Brazdeikis and Motuzas (2006) and some other researchers, but most of the studies are of a descriptive character and state the lack of experience, methodology and tools for implementation of ICT in education (Kalesnikienė, 2013). With time, the body of research started growing and currently the number of research papers dealing with implementation of ICT in education is growing. In this study, we rely on 28 articles in total, published both in Lithuanian and foreign research journals.

The search results demonstrate that articles published in Lithuanian journals prevail over those published in foreign journals, which might be considered an

Table 16.1 Summary of research articles included in the study sample (2007–2021)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Peciuliauskiene and Barkauskaite (2007)	Competence in applying ICT (competence in ICT), basic ICT competence, educational ICT competence	N = 900, bachelor students	A survey	Would-be teachers' competence development is a life-long process that needs to begin before the university studies
Kondratavičienė (2009)	Information technology, elementary education teacher, beginner, a computer programme	N = 37	Literature analysis, qualitative and quantitative data analysis	Teacher training needs to be provided more attention. The main problem is to understand what proper teacher training is
Dagienė (2011)	ICT competency for teachers, pre-service education programmes, self-evaluation of teachers' technological and pedagogical ICT competency, ICT literacy	2009	The data of the research study "Teachers' Training on ICT Application in Education" 2009	Content-based modules for teachers' ICT competence development are required
Gulbinas (2011)	Social pedagogical communication objects, information and communication technologies (ICT), activities and competencies of the social pedagogue		Document and scientific literature analysis	Basic computer literacy competence as well as general information culture of would-be social pedagogues and teachers need to be developed in order to enhance their lifelong learning capacities

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Kalesnikienė (2013)	Teacher's role, primary school teacher, information and communication technologies (ICT), primary school, Lithuania	N = 1400, primary school teachers N = 72, fourth grade pupils	A survey and qualitative (interpretative) research	Not all Lithuanian primary class teachers have the ICT competence needed in educational process. Pupils positively assess teachers who use ICT
Žygaitienė et al. (2013)	Professional teacher competencies, educational paradigm change	N = 21 teachers	Analysis of scientific literature and Lithuanian documents on education, interviewing	The ICT competence is becoming a key component of the learning environment, which enhances efficiency and attractiveness of the content. Systematic development of teachers' personal competencies is necessary
Numgaudienė and Žygaitienė (2014)	Content of the study programme, technology subject, technology pedagogics, home economics, teacher training		Analysis of scientific literature, European study programmes, legal acts and strategic education policy documents	Updating technology education curricula is an ongoing process

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Lukšėnienė et al. (2014)	Information technology (IT), information communication technology (ICT) application of skills, technology lesson	2011–2012, N = 603 managers of elementary school, technology teachers and 5–8 grades students	A survey	To develop pupils' ICT skills, more focus should be placed on ensuring internet connection, interactive teaching material, teaching content adaptation for work online
Petkus and Kurasova (2014)	Information technologies, teacher training			There is a decrease in the number of applicants to study and become IT teachers
Ignatova et al. (2015)	Personalisation affordance, ICT-based learning process, constructionist learning activities, evaluation framework	September 2011 to April 2014 N = 105 Lithuanian teachers	A multiple case study	Role change is a significant aspect in the development of ICT-based learning process for the personalisation affordance, increasing students' autonomy and leadership. Teachers are seen to be advisors, facilitators and friends
Indrašienė et al. (2015b)	Pedagogue, pedagogical studies, selecting profession, factors in selecting profession, motivation	March–April 2014 N = 117 students of social, special and career education programmes	Quantitative research and survey via questionnaire	Selection of pedagogical studies is determined by applicants' interests, predisposition, values and awareness of being useful for society

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Pečiuliauskienė and Dagys (2015)	Information abilities, metacognitive thinking, cognitive thinking	N = 380, school children (eighth-grade students)	Analysis of information literacy according to the theoretical SCONUL model, which encompasses seven literacy components (seven pillars)	The skills of information selection, processing, determining information strategies and search of information are weak
Žygaitienė and Sinkevičienė (2015)	Non-formal education of children, technological education, organisation	2011–2012, N = 526, teachers and children	Analysis of literature and documents, questionnaire	The most salient problems of non-formal education are inefficient financing, lack of properly equipped technology rooms, communication, high charges for interest groups, incompatibility of the time and activity of technological education
Andziulienė (2016)	Transformative education, integrated subject and foreign language teaching, teacher training, curriculum		Scientific literature and document analysis	The ICT competence encompasses the ability to use computers and apply them in teaching practices. Tools for self-reflection and synchronous and asynchronous collaboration are needed

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Bertašienė (2016)	Creativity, technology-based training, development of creativity, teacher training	N = 60, pedagogy students	Scientific literature analysis, document analysis, survey	Digital competence covers the basic skills of the search for information as well as skills of communication, collaboration, cooperation and independent deliver of the content by modern technologies
Jucevičienė (2017)	Teachers' European competencies, intercultural education; European literacy, European projects	2017, N = 87	A survey	Teachers develop their European competence by participating in projects on European issues and in various training seminars
Kubilinskienė et al. (2017)	Robotics, school education, application, systematic review, innovative tools, innovative approaches	2014	A systematic literature review	Robotics has become an aid allowing more intensive and flexible teaching
Kondratavičienė (2018)	Virtual learning environment, "EDUKA class", curriculum content, individualisation, differentiation,	2017, N = 109, primary school teachers	A survey	Virtual learning environments facilitate teacher's work as they enable differentiating content and monitoring students' progress by giving feedback to both students and their parents

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Kondratavičienė (2019)	Primary school students, values, ICT	N = 22, elementary school teachers	A qualitative content analysis method	Various smart technologies allow students to acquire knowledge and skills, as well as values of responsibility, honesty, sincerity, respect, tolerance, repentance, need for improvement, continuous learning and teamwork
Liubinienė and Kasperavičienė (2019)	Children, digital technologies, smart pedagogy, primary education, Lithuania	2017, N = 10, children aged from 7 to 10	Interviews	The contemporary context of smart pedagogy in Lithuania is insufficient in order to assure integration and access to smart educational environments. The national education programme needs to be updated
Juškevičienė (2020)	Computational thinking, CT abilities, class activities, physical devices, STEAM	2019, N = 13, teachers	A quantitative and qualitative case study	Computational thinking needs to be integrated into different subjects
Merfeldaitė et al. (2020)	Distance teaching and learning, organisation of education, general education school, COVID-19	2020, N = 22, deputy directors	A focus group	Distance teaching has dealt with various challenges, as the lack of IT solutions and readiness on the part teachers, parents, and heads of schools

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Taujanskienė et al. (2020)	Virtual learning environment, EDUKA class, primary education, mathematics, academic achievement	2018–2019, N = 100, first-graders,	A quasi-experiment	Virtual learning environments integrated into formal education affect significantly students' achievements
Volungevičienė et al. (2020)	Digital and network society (DNS), open online learning (OOL), higher education (HE) curriculum	13 interviews were conducted with experts working on a policy level in international associations, HE and private companies	Semi-structured interviews	Open online learning should prompt curriculum change in higher education in order to respond to digital and network society learning needs
Dagienė et al. (2021)	Informatics, informatics curriculum, informatics education, computing education, computer science, computational thinking, digital competencies	Experiments with thousands of students	A theory-based descriptive study	Constructionism and critical thinking-grounded approaches extend an informatics education curriculum. Students' cognitive progress enhances creativity and intellectual capacities

(continued)

Table 16.1 (continued)

Authors (year of publication)	Keywords	Year of study, sample size	Research tools	Outcomes and implications
Daukšienė et al. (2021)	Distance education, quality assurance, school activity areas, quality criteria groups, secondary school, COVID-19 pandemics	2020	Expert interviews and focus groups	In order to have a smooth transition to distance teaching and learning, the following areas are to be considered: strategy, management and administration; IT infrastructure; digital competence and professional development; assessment of studies in the digital environment; a support system for pupils and teachers; partnership, cooperation and networking; quality assurance
Sederevičiūtė-Pačiauskienė et al. (2021)	Technology-mediated learning, communion, supportive collaboration, teacher–student communication, pandemic	37 interviews from higher education teachers, university students, school teachers, and parents of minor school-aged children	Interviews	All members of the education process need to be prepared for successful teaching in the virtual space. Technical preparation is of high importance
Jevsikova et al. (2021)	Distance learning, online learning, distance learning technologies, technology acceptance, extended UTAUT model, pandemic, emergency	N = 550, in-service primary school teachers in Lithuania	Equation modelling technique with multi-group analysis was utilised to analyse the data	Distance learning technologies are significant for teachers' professional development. The findings will be applicable beyond the pandemic period

expected finding, especially because there is an open access scientific journal, published by Vytautas Magnus University in Kaunas (Lithuania) since 1962, which focuses on education issues. The selected sample of the research articles is mostly composed of the papers published in the past decade. The vast majority of the published research papers rely on quantitative (survey) and qualitative (focus groups, interviews) research methods as well as on the analysis of legal documents and scientific literature. Articles reporting results comparing the data of different countries are scarce. Table 16.1 presents a detailed summary of all included articles, indicating the year of the study, the number of respondents, the research tools and the main findings of the study.

16.5 Discussion

As the aim of our study is to accomplish the systematic literature analysis of the state-of-the-art situation of digital competence of both in-service and would-be teachers and secondary school students, the analysis of the results is centred around the following lines: the state-of-the-art situation of digital competence of high-school students; the state-of-the-art of digital competence of in-service teachers and development of digital competencies in young teacher training programmes as well as in-service teacher qualification programmes.

Our analysis has revealed that the state-of-the-art situation of digital competence of students in Lithuania is documented in the studies by Pečiuliauskienė and Dagys (2015), Kubilinskienė et al. (2017), Žygaitienė and Sinkevičienė (2015), Kondratavičienė (2018), Kliziene et al. (2021), Taujanskienė et al. (2020) and others. The study by Pečiuliauskienė and Dagys (2015) analyses information literacy of the basic school students (N = 380, eighth grade) according to the theoretical SCONUL model, which encompasses seven literacy components (seven pillars). The research results revealed that, in 2015, the information selection and processing abilities among the students were the weakest and the abilities of determining information strategies and search of information at that time were also weak. Another study accomplished by Kubilinskienė et al. (2017) draws our attention to application of innovative tools and innovative approaches in school education through robotics. The systematic literature review of 16 peer-reviewed articles in English, published in 2012–2013, accomplished by the Lithuanian researchers has shown that "robotics has been paving its way as a teaching aid in a more intensive and flexible manner" (Kubilinskienė et al., 2017). The study also stated the lack of research in the field and the need for further scientific research in this area in Lithuanian schools. The non-formal education of children in 2011–2012 was also insufficient due to inefficient financing of technology interest groups (high fees), lack of activity means, poor equipped technology rooms (Žygaitienė & Sinkevičienė, 2015).

Research of the state-of-the-art of digital competence of teachers seems to lack consistency (Indrašienė et al., 2015b; Jucevičienė, 2017; Juškevičienė, 2020; Kondratavičienė, 2018; Lukšėnienė et al., 2014; Žygaitienė et al., 2013). Indrašienė et al. (2015b) assume that pedagogues' opinion about the use of ICT during the learning process is mainly determined by their qualifications, work experience and ICT competence. Generally, it raises the issue that CT could be integrated into different subjects; however, sustained efforts are required for teacher training as well as analysis of how to encourage learners to apply CT skills into learning other disciplines (Juškevičienė, 2020). Based on the results of another study, Jucevičienė (2017) recommends that teachers may acquire and develop their competencies by participating in projects as well as in training workshops or seminars.

Teachers' digital competence should be supported by smart environments of the classrooms and the tools and/or study platforms that support smart education. The study accomplished by Lukšėnienė et al. (2014) points to the lack of well-equipped learning spaces, high-speed internet connection, modern interactive teaching materials, adaptation of educational content for work in cyberspace, etc. However, with time, the situation has been changing.

In Lithuania, virtual teaching/learning platforms (environments for mathematics, knowledge of nature, history, and language practice) in primary education became more widely used approximately 3 years ago after the implementation and application of the virtual teaching/learning platform EDUKA class (Kliziene et al., 2021). It was found that the virtual learning environment EDUKA class, intensively integrated into formal education and into mathematics, had a significant impact on students' achievement in mathematics (Taujanskienė et al., 2020). Moreover, according to Kondratavičienė (2018), virtual learning environment EDUKA class has facilitated teacher's work by differentiating learning content, monitoring student learning outcomes and progress by providing feedback to students and their parents. Kondratavičienė (2019) concludes that the use of interactive boards, computers, smartphones, educational programmes, games, digital content creation and sharing, robot programming and the use of smart technologies during the education process allow students not only to acquire knowledge and skills but also to develop the sense of responsibility, tolerance, need for improvement, continuous learning and teamwork.

The digital competence from the perspective of teacher training has been within the focus of research studies ground on both qualitative and quantitative research methods conducted by Peciuliauskiene and Barkauskaite (2007), Kondratavičienė (2009), Dagienė (2011), Gulbinas (2011), Andziulienė (2016), Bertašienė (2016), Numgaudienė and Žygaitienė (2014), etc. Scholars note the decreasing number of school graduates wishing to study and become IT teachers, and teachers overall, despite the governmental efforts and measures to promote the teacher's profession. The reasons indicated for low interest in the future teacher's career are mainly low salaries and difficult work with kids (Petkus & Kurasova, 2014). The expectations as to the competencies of the future teacher are very high from all stakeholders. Besides, the acquisition of competencies, especially the digital competence, leads to its constant improvement and continuous catching up with the technological development and pace on the part of the in-service teachers. Peciuliauskiene and Barkauskaite's (2007) large-scale survey findings suggest that the future teacher's competence is a life-long process and its acquisition should start as early as secondary school grades 11 and 12 through the subject of information technologies. Other researchers also draw attention to the issue of the necessity of permanent and regular improvement of the digital competence. The most recent studies emphasise the importance of continuous development, as the findings apply "beyond the pandemic isolation period" (Jevsikova et al., 2021).

However, among key aspects of proper teacher training, methods of using IT in the educational process (Kondratavičienė, 2009), necessity of content-based ICT training courses for would-be teachers and those in service (Dagienė, 2011), as well as other issues have been mentioned. Gulbinas (2011) notes that the standard for ICT competence development should be defined for social pedagogues and that the competence should also be focused around its acquisition and continuous development. Next to the basic computer literacy skills, the study and/or qualification development programmes should include development of general information culture for lifelong learning competence development and e-learning activities (Gulbinas, 2011). The digital competence development should go beyond the ability to use computers and apply them in teaching, requiring self-reflection and collaboration between peers and the teacher (Andziulienė, 2016). Collaboration and communication as part of the digital competence have been also highlighted in transforming teacher training, as technology should be employed to deliver, communicate and cooperate rather than to search for information only; on the other hand, skills of technology management, search for and selection of teaching materials are the basic digital competence components that a would-be teacher should be able to demonstrate with ease and confidence (Bertašienė, 2016).

For the many reasons stated, teacher training programmes must be transformed. Having analysed strategic documents and legal acts as well as pedagogical study programmes of a number of European universities, Numgaudienė and Žygaitienė (2014) stress the necessity of updating Lithuanian bachelor study programmes of technologies, induced by the changes in the general and technological competencies of technology teachers.

To sum up the current state-of-the-art situation of digital competence of both children and teachers in Lithuania, we may rely on the findings of the study accomplished by Liubinienė and Kasperavičienė (2019), who assume that the contemporary context of smart pedagogy in Lithuania seems to be insufficient to assure integration and access to smart educational environments for all children. For the effective knowledge gain through digital technologies, the needs to update the national education programme have been expressed in various research studies and reports. Moreover, the COVID-19 lockdown and the sudden shift to distance teaching and learning in the whole sector of education have revealed, as supported by the findings of Merfeldaitė et al. (2020), that in the organisation of distance teaching, general education schools faced the challenges related to the lack of IT solutions for distance teaching and learning. Further on, recommendations provided by Daukšienė et al. (2021) conclude that in order to have a smooth transition to distance teaching and learning, the following areas in school activities are to be considered: strategy, management and administration; IT infrastructure; digital learning content; DC and professional development; assessment of studies in the digital environment; systematic support for both pupils and teachers; partnership, cooperation and networking; and quality assurance.

16.6 Conclusion

The contemporary context of smart pedagogy in Lithuania (as we see from the systematic analysis of research papers from 2007 up to the first lockdown) seemed to be insufficient to assure integration and access to smart educational environments to all children. But the situation is currently changing to the best at a quick pace (due to COVID-19 lockdowns and the shift to online education from March 15, 2020, to present).

The stimulus for developing the digital competencies of teachers is the active participation in the international projects, which open up the possibilities for Lithuanian teachers to gain knowledge, improve and develop skills of digital competencies. Overall, the systematic literature analysis of the state-of-the-art of digital competence of both high-school pupils, would-be and in-service teachers in Lithuania shows that the successful process of digitalisation in education depends not only on the qualifications of teachers but also the involvement of students, parents as well as school administration and even stakeholders.

The COVID-19 pandemic-induced lockdowns have forced the schools to adopt virtual environments almost instantaneously. Some research studies conducted during the pandemic period have emphasised the technical preparation of schools over the academic preparation (Sederevičiūtė-Pačiauskienė et al., 2021). This may indicate that despite the research findings of the past decade that the digital competence of in-service and would-be teachers should be given more attention in different qualification and/or study programmes, it has been over the last years developing and improved by teachers to a degree where it might not be the primary concern anymore. Therefore, more research is needed to establish implications and guidelines for policymakers and pedagogical study programme implementers for the continuous development of teachers' digital competence.

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Chapter 17
Digital Competencies of Higher Education Institutions in Mexico: A Systematic Literature Review

Claudia Blanca González Calleros, Josefina Guerrero García, Yadira Navarro Rangel, Juan Manuel González Calleros, and Cesar Alberto Collazos Ordoñez

Abstract The objective of this publication is to identify the digital competencies that teachers in training have, within Higher Education Institutions in Mexico, through the analysis and systematization of previous research in 20 years from 2001 to date. For this purpose, a systematic review of the literature has been carried out through a systematic, explicit, and reproducible method. For this review, two filters were carried out: a practical criterion and a methodological quality criterion. As part of the first filter, five sources of information were used: EBSCO, Web of Science, Scopus, Google Scholar, and Redalyc. As a result, we found several articles with different approaches and research methodologies. It was found that teachers in higher education institutions have a medium–low mastery of digital competencies; the digital competencies with the highest mastery being those linked to the commitment and social responsibility of teachers in the use of Information and Communication Technology. Different institutions in Mexico have implemented different training programs in digital competencies for university teachers. As part of the training objectives of these projects, it is sought that teachers understand virtual environments, to make the change in their functions. It highlights the need for adequate training, not

C. B. González Calleros (✉) · Y. Navarro Rangel
Facultad de Ciencias de la Electrónica, Benemérita Universidad Autónoma de Puebla, Puebla, México
e-mail: claudia.gonzalezcalleros@viep.com.mx

Y. Navarro Rangel
e-mail: yadira.navarro@viep.com.mx

J. Guerrero García · J. M. González Calleros
Facultad de Ciencias de la Computación, Benemérita Universidad Autónoma de Puebla, Puebla, México
e-mail: josefina.guerrerogarcia@viep.com.mx

J. M. González Calleros
e-mail: jm.gonzalezcalleros@viep.com.mx

C. A. Collazos Ordoñez
Facultad de Ingeniería Electrónica y Telecomunicaciones, Departamento de Sistemas, Universidad del Cauca, Popayán, Colombia
e-mail: ccollazo@unicauca.edu.co

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only in technology but also in pedagogy and curriculum, adequate infrastructure, and changes in institutional policies.

Keywords Digital competence · ICT · Information and communication technology · Digital literacy · Teachers in training · Teacher training · Teacher training · University · Higher education · Mexico

17.1 Introduction

Society's need to maintain education despite contextual obstacles, maximizing the use of digital resources, offers an opportunity for universal access to higher education and, an opportunity to insert into a labor market based on digital competencies characterized, in some professions, by home office more frequently (Jimenez et al., 2017).

The use of Information and Communication Technology (ICT) in the classroom has become essential, because of the dizzying revolution in the development of the necessary skills for good academic and professional development, it is for them that institutions and education systems must adapt to provide students with the necessary skills. One of these competencies is undoubtedly the Digital Competencies (DC).

Ilomäki et al. (2011) define DC as a concept that describes technology-related skills. Over the last few years, several terms have been used to describe skills and competence in the use of digital technologies, such as ICT skills, technology skills, information technology skills, twenty-first-century skills, information literacy, digital literacy, and digital skills.

On the other hand, when DC is defined as teachers' professional development, the concept relates to the individual teacher's ability to apply ICT in learning activities to enhance students' knowledge development and understanding (Krumsvik, 2008; Spante et al., 2018).

Krumsvik (2008) elaborates and extends the definition of digital competence by introducing a holistic model that combines levels of analysis and prerequisites of individual competence. Thus, the broadening of the concept of digital competence refers to the inclusion of other areas and the development of the concept towards professional contexts.

Nowadays, communicative, ethical, or intellectual competencies, to mention just a few, are no longer sufficient to guarantee good teaching performance. In this sense, García Aretio (2014) points out that in the new educational environments, where knowledge has become the main source of wealth and digital technologies the most effective tools for its production and dissemination, teachers must be able to activate other types of resources that allow them to use technology effectively, especially in their teaching practice. DC, according to the Common European Framework, is also part of the competencies for lifelong learning (Herreros Martínez, 2014), which requires the safe and critical use of technologies for work, leisure, and communication.

According to the Common European Framework, there are five areas of digital competence, which include:

1. Information and information literacy
2. Communication and collaboration
3. Digital content creation
4. Security
5. Troubleshooting.

According to INFET (2017), the first three dimensions of digital competence are linear in terms of the development of their key competencies. However, the remaining dimensions (Safety and Problem solving) are more transversal. This means that, while areas 1–3 deal with competencies that can be restated in terms of specific activities and uses of the individual or group of individuals, areas 4 and 5 apply to any type of activity carried out through digital media and resources (Gómez Camarena et al., 2020).

Through DC, it is possible to develop other skills such as collective work, autonomous learning, creativity, innovation, intercultural dialogue, and problem-solving in learning. As a result, DC training is imperative at all educational levels (Rodríguez Pérez, 2007).

Consequently, the question arises whether Higher Education teachers possess the digital competencies necessary to adequately guide the teaching–learning process within ICT-mediated social environments (Jimenez et al., 2017).

This document is divided into six sections. The second section presents the theoretical framework focused on defining the DTC, as well as the use of technological resources by higher education teachers in Mexican institutions.

The third section focuses on a methodology that was used to conduct the systematic review of the literature. Section 17.4 describes the results of the systematic review, Sect. 17.5 discusses these results and finally, Sect. 17.6 provides a summary.

17.2 Theoretical Framework

To better understand the object of this work, the concepts related to digital competencies in teachers and their relationship with trainee teachers in higher education institutions in Mexico are defined. Different concepts and methodologies were reviewed to present the frame of reference that guides this systematic review and at the same time establish the meaning that the central terms of the review will have in the context of this document.

Today's knowledge society requires individuals capable of interpreting and processing phenomena and large amounts of information creatively and innovatively within changing environments. The availability of technological resources, within the infrastructure of institutions, are a milestone in the processes of innovation in the use of ICT by higher education teachers. These processes are multifaceted and involve different factors such as economy, politics, ideology, culture, and psychological aspects. This set of elements has an impact on different contexts, from the classroom to a set of universities (Vera Noriega et al., 2014).

One of the fundamental transformations in higher education is the result of the strong presence of ICT within institutions. However, the presence and use of ICT are not always accompanied by training plans; moreover, little importance is given to their design and implementation (Cabero-Almenara et al., 2020). Often the training of teachers, in digital competencies, is carried out from models that focus more on instrumental and technological aspects than on pedagogical and didactic aspects (Cabero-Almenara & Martínez-Gimeno, 2019; Cabero-Almenara et al., 2020; Fernández et al., 2017; Padilla-Hernández et al., 2020; Semerci & Aydin, 2018).

A deficient or non-existent training plan results, in many cases, in poor teacher training, which has nothing to do with interest in the use of ICT, but rather with lack of institutional support, lack of time, lack of resources, and a deficient or non-existent training plan (Cabero-Almenara et al., 2020).

Among the main factors that favor the digital training of teachers and their educational practice are teachers' availability for pedagogical innovation, their experience, the pedagogical methods that guide their educational practice, and the daily use of ICT (Arellano Vega & Andrade Cázares, 2020).

The use of ICT in Higher Education favors the innovative development of projects that facilitate attitudinal, cultural, thinking, teaching practices, and pedagogical models change; giving rise to new educational environments that directly affect teaching strategies, learning strategies, curriculum, and pedagogical models (Vera Noriega et al., 2014).

On the other hand, Digital Teaching Competence (DTC) has been defined by different authors and from different approaches. Nowadays, the DTC is a fundamental piece for the educational integration of ICT as part of the functions of teachers (Durán Cuartero et al., 2016a; Lázaro Cantabrana & Gisbert Cervera, 2015; Tejada Fernández & Pozos Pérez, 2018).

Durán Cuartero et al. (2016b) try to define the DTC making an extensive tour of the definitions made by authors such as: Ferrari (2013), Gutiérrez (2011); Gisbert & Esteve (2011), Gallardo-Echenique et al. (2015), among others. And it defines DTC as:

> … the set of values, beliefs, knowledge, skills, and attitudes in technological, informational, and communicative aspects that leads us to complex multiple literacies (Gutiérrez, 2011; Gisbert & Esteve, 2011; Larraz, 2013). Digital competence in teaching brings together all these aspects of digital competence, adding the pedagogical-didactic criterion for the effective integration of these elements in the teaching-learning process (Krumsvik, 2011) p. 3.

Zempoalteca et al. (2017), through a documentary review, point out that Mexican universities are part of the technological challenge of the knowledge society, however, the presence of ICT is superficial in university teaching, since as mentioned above, the pedagogical models that accompany their use are traditional and not very innovative. It has been observed that teachers use ICT to prepare classes, but not to work with students. This may be a consequence of deficient or scarce teacher training, focused only on the development of technical and not pedagogical aspects.

The training of teachers in digital skills is an important factor in promoting systemic change in teaching; lifelong learning is a commitment to the future of university institutions. Teachers with the highest technological training use ICT frequently, promote change and improve the technological skills of students (Pozuelo Echegaray, 2014). Digital competence goes beyond understanding the use of technology, it is necessary to understand its impact on the digital world and effectively encourage its integration (Prendes et al., 2018; Revelo et al., 2018).

17.3 Research Methodology

The objective of the present literature review is to identify, evaluate, and synthesize the existing body of complete and registered works produced regarding the level of digital competence of higher education teachers within public and private institutions in Mexico; the above through a systematic, explicit, and reproducible method proposed by Fink (2014).

This review is divided into seven tasks, which are set out below and are broken down in Fig. 17.1:

1. Selection of research questions.
2. Select bibliographic or article databases, websites, and other sources.
3. Choice of search terms.
4. Application of practical selection criteria.
5. Application of methodological selection criteria.
6. Performing the review.
7. Synthesize the results.

17.3.1 Selection of Research Questions

Aligned to the problem that gives rise to this systematic review of the literature, it was decided to study the digital competence of teachers in the training of higher levels in public and private institutions in Mexico, a second aspect is the use and appropriation of ICT of these teachers, finally, to know the level of digital competence of teachers and how this level is measured in Mexico. The research questions that guide this SLR are the following:

RQ1. How are university teachers in training trained to use ICT in Mexico?
RQ2. What are the digital competencies of teachers in training at the higher education level in Mexico?

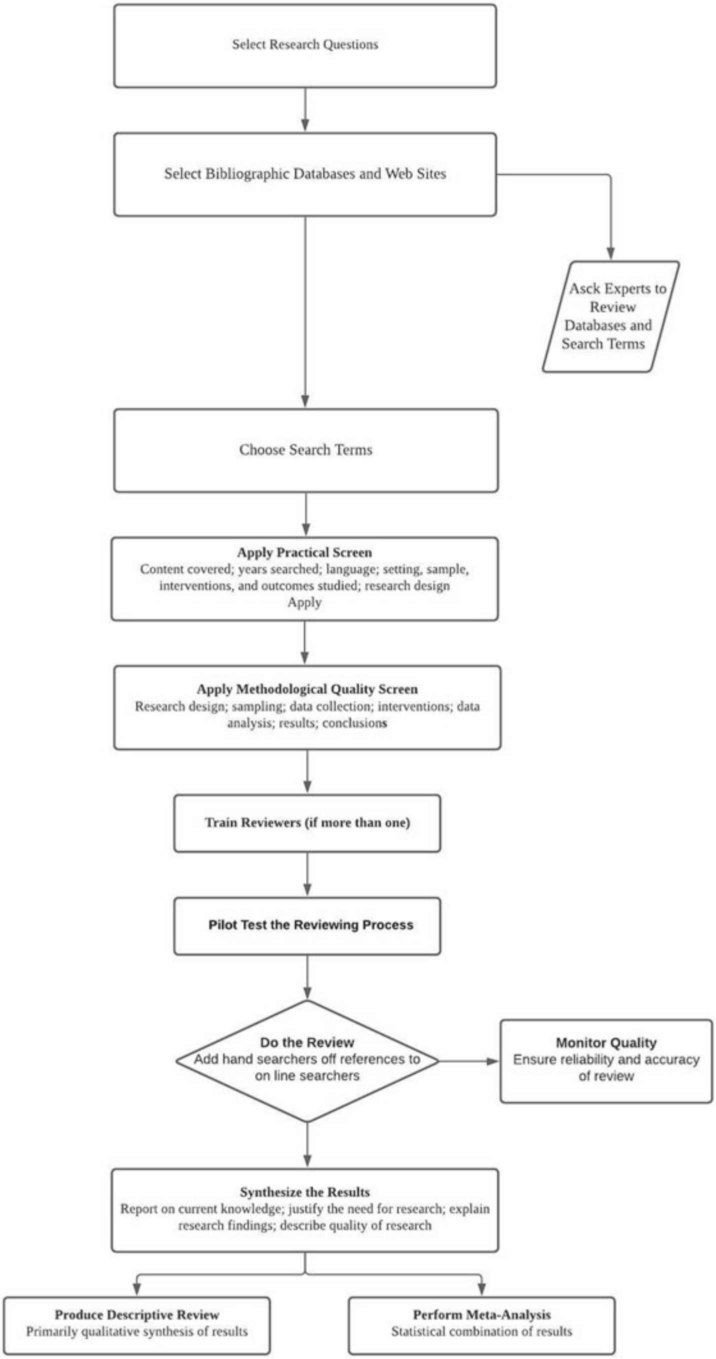

Fig. 17.1 Steps involved in conducting a research literature review. *Source* Fink, A. (2014). Conducting research literature reviews: From the internet to paper (University of California (ed.); Fourth, Vol. 2, p. 4). SAGE

RQ3. What is the level of digital competence of teachers in training at a higher level?

RQ4. How is the level of digital competence in Mexico measured?

17.3.2 Selection of Bibliographic Databases

The bibliographic databases of interest for this review were those that we considered containing full reports of original studies. Other sources of literature review included experts in the field of interest, the Web and the reference lists contained in the articles, the databases and review sources considered were EBSCO, Web of Science, Scopus, Google Scholar, and Redalyc.

17.3.3 Choice of Search Terms

The search terms used were words and phrases related to digital competencies, teacher trainees, higher education level, and institutions in Mexico. These terms were used to obtain appropriate articles, books, and reports. The words, phrases, and concepts that frame the research questions and use a particular grammar and logic to perform the search are presented in Table 17.1.

Search strings were also performed, using Boolean operators, according to the topics suggested within the inclusion criteria. The following is a description of how this process was carried out:

Academic Google Search. Mexico AND "digital competence" AND "teacher training" AND "higher education".

Table 17.1 Words, phrases, and concepts frame the research questions

Keyword/phrase	Homologous word/phrase
Digital competence	Digital competencies Digital skills Digital literacy
Information and communication technology	ICT
Teacher training	Teacher education Professional development In-service training Coaching
Higher education	University
Mexico	Mexico Mexico City

Search in Scopus and WEB OF SCIENCE. ("digital competence" OR "digital competencies" OR "digital skills" OR "digital literacy") AND ("teacher training" OR "teacher education" OR "professional development" OR "in-service training" OR "coaching") AND ("higher education" OR "university") AND (México OR MEXICAN OR MEXICANS).

Redalyc. "Digital competence" and "teachers in training" and "institutions of higher education" and Mexico.

It is worth mentioning that the search was conducted in English and Spanish to broaden the bibliographic selection since many Mexican researchers also publish in English. The research procedure presented in Fig. 17.1 was performed twice, both for Spanish and English.

17.3.4 Application of Practical Selection Criteria

Preliminary literature searches always yield many articles, but only a few are relevant. To arrive at relevant articles, we established inclusion and exclusion criteria for the review. As part of the practical selection criteria, we included factors such as the language in which the article is printed, the type of article (journal article, proceedings), the date of publication among others.

We limited the candidate articles to those that had the term digital competence or its equivalent in their titles for English and Spanish. From these articles, we selected only those that were published from 2001 to the present. Articles written in another language were excluded, as well as documents that speak of digital competencies or the equivalent of in-service teachers and documents developed at the elementary or high school level. Table 17.2 presents the inclusion and exclusion criteria considered within the practical criteria for this SLR.

17.3.5 Application of Methodological Selection Criteria

The second filter was methodological quality; this criterion focuses on the scientific nature of the research, i.e. how well a study has been designed and implemented to achieve its objectives; only methodologically sound studies produce accurate results (Fink, 2014). Because of the above, we focused our attention and review only on these studies to ensure the accuracy of the review. Standards were established, to identify high-quality studies, reviewing only those that met the selected standards. This had an impact in such a way that the search was narrowed considerably.

For the selection of high-quality studies, the following questions were answered (Fink, 2014):

- Is the study's research design internally and externally valid?
- Are the data sources used in the study reliable and valid?

Table 17.2 Practical selection criteria

Type	Inclusion criterion
Study content	• This includes studies that focus only on the digital competencies of trainee university teachers • Excludes all studies that address the digital competencies of in-service university teachers
Language of the publication	• Studies in English and Spanish are included • Studies in another language are excluded
Context	• Higher education studies are included. Country Mexico • Excludes all studies at the basic level, or higher secondary education
Research method	• Studies with qualitative strategies are included • Studies with qualitative strategies are included
Sampling	• Studies with university teachers are included • Excludes studies with elementary or high school teachers
Type of publication	• Indexed journals • Books • Book chapters • Proceedings • Excluding conference memoirs, journals that are not indexed
Date of publication	• Studies published between 2001 and 2021 are included

- Are the analytical methods appropriate given the characteristics and quality of the study data?
- Are the results mean in practical and statistical terms?

17.3.6 Data Analysis

This section is part of the necessary steps to carry out a bibliographic review of research. Once the search was carried out in the five databases and following the previously selected practical selection criteria and with the execution of the previously defined query, 638 publications were obtained distributed in the different databases as shown in Table 17.3. It is worth mentioning that in addition, a review of the bibliographic references contained in each of the selected documents was carried out, which allowed the search to be expanded and relevant articles to be identified for the present review.

As can be seen, the database with the highest number of publications retrieved was Scopus and the database with the lowest number of documents was Web of Science, however, the selection process and the quality criteria determined the selection of the publications to be considered in this Systematic Literature Review.

After applying the practical inclusion and exclusion criteria, the review was reduced to 68 documents. Subsequently, the methodological inclusion criteria were applied, guaranteeing the quality of the methodology, sample, and results. It is worth

Table 17.3 Documents retrieved

Database	Documents retrieved
Scopus	391
Web of science	12
Academic Google	53
Redalyc	160
EBSCO	22
Miscellaneous (references)	12
Total number of documents	650

mentioning that originally only documents with quantitative results were considered for inclusion, however after the first reading, it was detected that there were descriptive or documentary analysis documents that presented results on proposals from different universities for the training of teachers in digital competencies, therefore it was decided to include qualitative, quantitative, mixed, descriptive and documentary review studies, guaranteeing a better quality of the review. Once the process was completed, 22 documents were finally selected to form part of this SLR.

The analysis of documents was carried out by thematic area. This allowed us to broaden the scope of the research by the unit of analysis and provide new comprehensive data by thematic core. The four emerging themes emerged in response to the research questions and are set out below:

1. Training of university teachers in the use of ICT in higher education institutions in Mexico.
2. Digital competencies of teachers in training at the higher education level in Mexico.
3. Level of digital competence of trainee teachers at the higher education level.
4. The mechanism for measuring the digital competence of teachers in Mexico.

17.4 Results

A table was elaborated for the analysis of the works found, classifying them by thematic area, including among other characteristics: Reference, Publication year, Authors, Title, DOI, Link, Abstract, Author Keywords, Publisher, Language of Original Document, Document Type, Name of the journal, Open Access, Source, Methodology, Sample.

Although the review was carried out considering a period from 2001 to date, the results of this SLR show that, with the established search criteria, there is no evidence of scientific activity published in the selected databases before 2007.

In the documentary analysis, it was detected that the keywords, both in Spanish and English, most used by the different authors were higher education, ICT, university professor, teacher training, Competencias digitales, Digital competence, TIC, formación docente, actitudes, educación superior, Information and communication technologies, Digital alphabetization, Alfabetización digital, Tecnologías de la información y la comunicación. The above is evidence that the search carried outfits the parameters established by the different authors.

Concerning the predominant language in the articles considered in the SLR, 17 documents were found in Spanish and 5 articles in English. The largest number of documents is indexed in Redalyc, which is an indexing system that integrates journals of high scientific and editorial quality from Latin America and the Caribbean, Spain, and Portugal.

The analyzed documents are mostly articles and only two proceedings. As can be seen in Table 17.2, within the practical inclusion criteria, different types of documents were considered, however, the result of the search, under the parameters established by the authors only showed articles and proceedings, in the case of the latter, some were not considered in the analysis because despite being in the databases, access is restricted.

Similarly, the journals and proceedings where the documents were published were analyzed. These are indexed journals published by universities and research centers of national and international prestige, such as Universidad Autónoma de Barcelona, Universidad Peruana de Ciencia Aplicadas, Associação Ibérica de Sistemas e Tecnologias de Informacao, el Instituto Politécnico Nacional, Universidad de Granada, Universidad de Sevilla, Universidad Iberoamericana, Ciudad de México, Universidad de Guadalajara, among others. From this last university comes Apertura, a journal that uses Open Journal Systems 2.4.8.1, which is an open-access journal manager and software developed, financed, and distributed free of charge by the Public Knowledge project, is a scientific journal specialized in educational innovation in virtual environments, indexed in different databases. Special emphasis is placed on this journal as it is the source of the largest number of publications.

From the search results, it was observed that in the Mexican media, DC studies are mostly published in local journals, published in Spanish.

Within the methodology, we found articles with different approaches and research methodologies such as exploratory analysis of fundamentally quantitative character and descriptive and inferential scope based on the design and application of an ad hoc instrument; narrative biographical method, specifically life stories; mixed descriptive exploratory study of the transformational-concurrent type (QUA + QUAL); systematic literature reviews; quantitative-descriptive correlational research design, single and multiple case studies. It can be observed that most of the studies are descriptive or review studies. Some of the DC studies are accompanied by research on university teacher training, however, in many cases, these studies are merely descriptive, emphasizing the importance and necessity of teacher training in the use of ICTs, but lacking empirical analysis.

DC research is carried out in a few local research centers. Concerning the type of sampling used by the different authors, the non-probabilistic convenience sample, intentional sampling, documentary, and simple probabilistic sampling stand out, justifying in each case their choice.

17.4.1 Summary of Results

As a result of this systematic review of the literature, the analysis and theoretical construction are presented, providing a critical perspective of the selected papers by thematic area, answering the questions that guided this review. As part of this process, Table 17.4 presents a detailed summary of the 22 selected articles, including the thematic area, the authors of the study, the year of publication, the research method used, the type of sampling, and the results.

We can observe that the largest number of documents is found within the thematic area called "university teacher training", which refers to the training of university teachers in training in the use of ICT in Higher Education Institutions in Mexico.

17.5 Discussion

Different institutions in Mexico such as the Universidad Veracruzana, the Universidad Autónoma de México, the Universidad Iberoamericana México, and the Universidad Autónoma de Chiapas have implemented different training programs in digital competencies for university teachers, among which PROJECT H@BITAT PUMA, DEAMeT, The Classroom Project, International Certificate Programme in Digital Literacy stand out (Aguirre & Ruiz, 2012; Amaya et al., 2018; Berruecos Vila & Ochoa-Carrasco, 2019; Clemente, 2012; Farías et al., 2013; Kriscautzky Laxague & Martínez Sánchez, 2010; Lucero Bravo et al., 2018; Martínez-Falcón & Kriscautzky-Laxague, 2011; Miguel Román, 2020; Pacheco et al., 2018; Pérez García & Andrade Cázares, 2020; Zempoalteca Durán et al., 2017).

As part of the training objectives of these projects, it is sought that teachers understand virtual environments, make the change in their functions, have a new look on students, and offer them active ways of learning (Berruecos Vila & Ochoa-Carrasco, 2019).

Studies such as Amaya et al. (2018) show that after adequate training university teachers acquire or improve their level of digital competence. However, Kriscautzky Laxague and Martínez Sánchez (2010), Pacheco et al. (2018) highlight the need for adequate training, not only in technology but also in pedagogy and curriculum, adequate infrastructure, and changes in institutional policies.

Martínez (2015) makes a training proposal through a program that includes the role of the teacher and the incorporation of ICT in the classroom, didactic planning with ICT integration, the analysis of the Substitution Augmentation Modification Redefinition (SAMR) model, the analysis of the Technological Pedagogical Content Knowledge (TPACK) model, the digital competencies of the twenty-first-century teacher and technological trends, for a better teaching performance for the benefit of the teaching process. Learning.

Table 17.4 Summary of results of systematic literature analysis

Thematic	Author/year	Methodology	Sample	Results
Competence level/measuring mechanism	(Alvarez-Flores, 2021)	Quantitative nature and descriptive and inferential scope based on the design and application of an ad hoc instrument to address the diagnosis of the critical and safe use of the Internet	The study population consisted of university professors from Hispanic institutions	The results show that university institutions train professors on digital skills, but there is a lack of training on Internet security. There is a tendency for professors to have negative online experiences
Digital competencies of trainee teachers	(Padilla-Hernández et al., 2020)	Biographical method, specifically life stories	The sample of participants was formed intentionally based on the suggestions of teachers with experience in the participating educational institutions	Based on the findings, they propose a list of categories and indicators for understanding CDD as an evolution focused on teacher professional development and as a complementary perspective for teacher diagnosis and training projects
Competence level	(Pozos Peréz & Tejada Fernández, 2018)	A mixed descriptive exploratory and descriptive exploratory study of the transformational-concurrent type (QUA + QUAL) has been carried out	The population of the study refers to the teaching staff of Higher Education Institutions in the Metropolitan Area of the Valley of Mexico. A sample of 20 institutions (11 public, 9 private) participated, with 247 teachers involved	The results indicate a medium–low proficiency in the digital competencies that correspond to the teaching role (planning, developing, and conducting learning experiences and ICT-supported assessment)

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Martínez-Falcón & Kriscautzky-Laxague, 2011)	Descriptive	Documentary	PROJECT H@BITAT PUMA: Training teachers in the use of ICT in education experience at Universidad Nacional Autónonma de México
University teacher training	(Berruecos Vila & Ochoa-Carrasco, 2019)	Descriptive	Documentary	DEAMeT reflects the effort to train teachers in its pedagogical use; workshops and courses are designed to enable them to understand virtual environments, make the shift in their roles, take a new look at students and offer them active forms of learning
Competence level	(Saltos Rivas et al., 2019)	The research is framed within the methodological strategy of meta-analysis developed by various authors	Documentary	The results of the study show a low proportion (64%) in terms of the preparation of students and teachers concerning digital competencies, which is supported by the low heterogeneity present, reflecting the high weight of the difficulties that exist in the countries that make up the Latin American continent to invest these people with the necessary knowledge in this sector of knowledge

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Aguirre & Ruiz, 2012)	Descriptive analysis	Documentary	A learning experience is presented in the Aula Project of the Universidad Veracruzana, a model of management and mediation to transform educational practices, where the incorporation of technology of the information and communication (ICT) in the teaching–learning processes is processes educational environments that enrich the training of students and the knowledge they students' education and teachers' knowledge
University teacher training	(Zempoalteca Durán et al., 2017)	The research corresponds to a quantitative-descriptive correlational research design	5,775 students and 334 teachers from five public institutions of higher education in administrative sciences in the metropolitan area of Querétaro, Mexico	The Classroom Project is a way of transforming learning processes in which complex thinking, the development of competencies, research, and ICT are the pillars of redefining practices

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Pérez García & Andrade Cázares, 2020)	Mixed, as a third paradigm that allows techniques, methods, concepts or terminology to be combined in a single study. The relationship established was QUAN + QUAL, through the strategy of complementation to recover different images of the performance scenario	28 teachers; of these, 16 are women and 12 are men, 8 are hourly and 20 are full time	Although they report an average level of digital competence and high use of technological resources. These factors do not affect the development of strategic integration proposals. They express the incorporation of technology from the content-pedagogy-technology relationship. However, an imbalance is observed, the technological component is addressed with high priority, and deficiencies are identified in the pedagogical component

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Amaya et al., 2018)	Descriptive analysis	76 teachers, who have so far accredited the ICDL base certification	124 teachers from the different faculties in the International Certificate Programme in Digital Literacy (ICDL), of whom 76 have so far passed the ICDL basic certification related to basic computer literacy, basic knowledge of online applications, word processing, and spreadsheets. This work reports on their progress in acquiring digital competencies and compares the results they achieved at the beginning and end of the certification

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
Competence level/measuring mechanism	(Padilla Partida, 2018)	Quantitative, cross-sectional, and descriptive, as it seeks to specify the properties, characteristics, and profiles of people, groups, communities, processes the properties, characteristics, and profiles of people, groups, communities, processes, objects or any other phenomenon that is subjected to analysis	The participants in this study were the teachers of the Guadalajara Unit, a total of 59	The results reveal that the technological resources that have been mostly incorporated into the classroom are e-mail and PowerPoint, and those associated with Web 2.0, such as wikis, blogs, or the Moodle or Classroom platforms, are far behind. This research provides evidence on the uses of ICT in a teacher training school and offers an idea of the gap between what is recommended in the development of digital competencies and the reality in the classroom
University teacher training	(Pacheco et al., 2018)	Interpretive paradigm, is a multiple case study, with several cases at the same time to analyze and describe reality. The semi-structured interview was the method used to collect information	Three teachers from the UAEH Tlahuelilpan campus participated in this research	The results indicate the need for adequate training, not only technological but also pedagogical and curricular, adequate infrastructure, and changes in institutional policies, among others. This response to the theoretical models mentioned above. It is suggested that HEIs consider these results when implementing a Learning Management System to support the educational process

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Miguel Román, 2020)	The research design is mixed. This research will present an approach based on the discourse analysis of the categories that were identified in the systematization of the semi-structured questionnaires that were applied (qualitative approach)	Non-probabilistic convenience sample made up of 34 teachers, 76 students from different degree courses, three administrators	Despite what coordinators and students say, the teachers claim to have developed digital skills (53.13%), teaching strategies contextualized to the nature of virtual classes (18.75%), organizational skills (9.38%), socio-emotional skills (9.38%), and effective communication skills (9.38%)
University teacher training	(Farías et al., 2013)	The research is framed as a case study, it is a cross-sectional study since the data collection was carried out from February 1 to March 31, 2011. With a mixed approach, both quantitative and qualitative instruments were applied	In the diagnostic stage, 49 teachers participated by answering an online questionnaire, 6 of them responded to the qualitative interview instrument, and 12 teachers effectively completed the training program, the latter was considered for the application of the fine instrument	The results show the opportunities and difficulties encountered in the development of a teacher training program in this modality, as well as the characteristics of the profile of the teachers who took advantage of this experience

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Clemente, 2012)	Descriptive analysis	Documentary	The result was an initial proposal for the digital literacy of university teachers based on multidimensional research carried out at the Autonomous University of Chiapas, Mexico, with the presentation of the circumstances of some Mexican Higher Education Institutions that have conducted studies on the use and application of information and communication technologies by teachers

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
Competence level/measuring mechanism	(Rodríguez Armenta, 2007)	This study is based on a case study research methodology. The research has quantitative elements	For the research case, purposive sampling was selected	Within the results, it is mentioned that having the necessary equipment and infrastructure to enter fully into the use of ICT is not enough, since although 79.19% have Internet access, more than 80% of the teachers indicated their need for knowledge and skills in the use of software to support their teaching work. For this reason, the author suggests that it is urgent to include in the PICASA an axis that houses courses through which academic staff can have the necessary equipment and infrastructure to enter fully into use it

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
Competence level	(Rambay Tobar & De la Cruz Lozado, 2021)	Documentary research	Documentary	The author identifies that university teachers must develop seven digital competencies: (1) Planning and design of learning experiences in face-to-face and virtual environments; (2) Developing and conducting face-to-face and networked collaborative learning experiences; (3) Guidance, guidance, and evaluation of knowledge construction processes in face-to-face and virtual environments; (4) Knowledge management and professional development with ICT support; (5) Pedagogical research, development, and innovation with/for the use of ICT in education; (6) Diversity, ethics, and responsible use of ICT in the teaching profession; (7) Environment, health, and safety at work with the use of ICT

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
Competence level	(Vera Noriega et al., 2014)	Quantitative	A representative sample of 432 voluntary subjects from the different areas of knowledge of the UPM was formed, based on Sierra's formula (1998). This sample was designed with 95% reliability, 3% error, and $p = 0.5$ and $q = 0.5$	Amongst its outcomes, it highlights that the teachers master the ICT in a moderate to a moderately high manner. In addition, after ANOVA analysis and Student t-tests, it was found that factors such as E-mail, Internet, age, and adoption based on interests modify the level of mastery towards the Information and Communication Technology
University teacher training	(Garcia et al., 2014)	Descriptive analysis	Documentary	"Learning by doing" is the principle of the workshop described here as a success story, as it was found that the participating teacher, by using the tools as a normal user, becomes aware of the different problems or knowledge their students will have and what things they should pay more attention to; on the other hand, interacting directly with the tool and the language used in each of them is a motivating factor for the teachers who can now communicate with their students more directly and colloquially

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Martínez, 2015)	Descriptive analysis	The participating population consisted of 25 teachers from ENTS	The seminar took place over 6 months in mixed mode, with a 5-h face-to-face session each month, in which the following topics were presented: (1) The role of the teacher and the incorporation of ICT in the classroom. (2) Didactic planning with ICT integration. (3) Analysis of the Substitution Augmentation Modification Redefinition (SAMR) model. (4) Analysis of the Technological Pedagogical Content Knowledge (TPACK) model. (5) The digital competencies of the twenty-first-century teacher. (6) Technological trends

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
University teacher training	(Kriscautzky Laxague & Martínez Sánchez, 2010)	Descriptive analysis	Documentary	The learning perspective made it possible to understand the relationship between the teacher, the learner, the knowledge, and the teaching situation that enables its construction. Secondly, and closely related to the previous point, it was fundamental for the program to move from the teacher's work to the student's work with ICT. Thirdly, the vision of the educational use of ICT as tools that expand, enhance and complement classroom teaching was highlighted. Finally, based on the above premises, they make a didactic proposal that supports the academic training program with the use of ICT for university teachers

(continued)

Table 17.4 (continued)

Thematic	Author/year	Methodology	Sample	Results
Competence level	(Hugo et al., 2019)	The methodology used was mixed, with a descriptive approach	The population sample was determined by simple probability sampling, and consisted of 127 university professors, of both sexes, with different professional profiles and assigned with different contracting statuses in public higher education institutions in the North Coast area of the State of Jalisco	79% of the participants know the meaning of "Digital Competence" and 94% of the participants recognize the importance of this competence. In general, 26% of university teachers have a very high mastery, followed by 39% of teachers with a high mastery and the rest are at a moderate-low level on the use and mastery of digital competence. The four dimensions addressed in the instrument for identifying and assessing the digital competence of university teachers reflected areas of strength and limitations

Padilla-Hernández et al. (2019) identified some critical incidents that hinder the acquisition and development of Digital Competencies by university teachers in institutions in Mexico. The incidents were grouped into four groups: background in the use of information and communication technologies (ICT); selection and creation of subject content; exploration of digital resources for learning and teaching; and development of ICT projects and initiatives. Cross-cutting aspects of competence development were also recognized: teachers' reflections, the type of changes in the use of ICT, the support received, and the difficulties experienced. Based on the findings, it proposes a list of categories and indicators to understand teachers' digital competencies as an evolution focused on teachers' professional development and as a complementary perspective for diagnosis and teacher training projects.

Alvarez-Flores (2021), Hugo et al. (2019), Padilla Partida (2018), Pérez García and Andrade Cázares (2020), Pozos Pérez and Tejada Fernández (2018), Rodríguez Armenta (2007) show us through their studies the level of digital competence of teachers.

Pozos Pérez and Tejada Fernández (2018), Saltos Rivas et al. (2019), Pérez García & Andrade Cázares (2020) point out that teachers in higher education institutions have a medium–low mastery of digital competencies; the digital competencies with the highest mastery being those linked to the commitment and social responsibility of teachers in the use of ICT. However, the need for training is emphasized because of the low average level of mastery of the competencies verified, since an imbalance is observed between the technological component with high priority and deficiencies are identified in the pedagogical component.

Among the digital resources that have been incorporated into the classroom by teachers are email and PowerPoint, while Web 2.0, such as wikis, blogs, or Moodle or Classroom platforms, are far behind, showing a gap between what is recommended in the development of digital skills and the reality in the classroom (Padilla Partida, 2018).

For his part, Alvarez-Flores (2021) shows that university institutions in Mexico train teachers in digital skills, but lack training in Internet safety, showing negative experiences of online teachers.

17.6 Conclusions

For universities to meet the challenges of higher education in the twenty-first century, they must invest in the training of their faculty, who must have a specialized educational background, familiar with teaching methods, be content experts, and have digital skills. Certification recognized by international organizations guarantees the quality of their training. Based on the Systematic Literature Review, it is shown that teachers express the need for digital knowledge and skills to support their education. Therefore, it is necessary to include teacher training programs through which teachers can acquire the necessary equipment and infrastructure to fully participate in the use of ICT.

As future work, we will seek to maintain constant monitoring of all the work related to the development of digital competencies in higher education institutions in Mexico, to keep this review updated and allow decision-makers inside and outside the institutions to develop new research, including innovative proposals, as well as the implementation of platforms for monitoring and control as an alternative to this work.

The academic bodies sometimes publish works that do not have the scope of indexed journals; however, they are important research in the development, measurement, and implementation of digital competencies in teaching. Therefore, the aim is to create a synergy between these research bodies to publicize the work developed at the national level and scale it up to the regional level, thus strengthening the work and cooperation in Latin America.

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Chapter 18
From Tools to Complexity?—A Systematic Literature Analysis of Digital Competence Among Pre-service Teachers in Norway

Nils Christian Tveiterås and Siri Sollied Madsen

Abstract In the last decades, the field of education has rapidly developed along with the development of digital technology. The recent COVID-19 pandemic has affected this development, leading to an educational revolution that involves the extensive use of online learning. This change makes it crucial to understand how teachers' digital competence has developed along with this phenomenon, as well as how teacher students are being prepared to work as future teachers. This article presents a literature review regarding how the term 'digital competence' has been understood and operationalised in the context of Norwegian teacher education in the last two decades, as well as how pre-service teachers' digital competence has been measured when researched. In the earliest findings uncovered by the review, the research is tool oriented, while a greater awareness of the professional complexity of digital competence in education emerges from 2014 to 2017. From then on, a challenge arises regarding added complexity. A somewhat complex understanding of teachers' professional digital competence (PDC) makes measuring PDC a difficult task, and it is challenging to link theoretical foundations with conducted research on the subject. This article addresses these issues and contributes to the discussion regarding the term 'professional digital competence' and how it is understood in a Norwegian educational context.

Keywords Pre-service teachers · Student teacher · Digital literacy · Professional digital competence · Early childhood

N. C. Tveiterås (✉) · S. S. Madsen
Department of Education, UiT The Arctic University of Norway, Tromsø, Norway
e-mail: nils.c.tveiteras@uit.no

S. S. Madsen
e-mail: siri.s.madsen@uit.no

Ł. Tomczyk and L. Fedeli (eds.), *Digital Literacy for Teachers*, Lecture Notes in Educational Technology, https://doi.org/10.1007/978-981-19-1738-7_18

18.1 Introduction

The term 'digital competence' is a moving target that has evolved along with the ongoing development of digital technology, including the way in which this technology is integrated into and changes society. Technology affects every aspect of our everyday lives and has changed the way we learn, communicate, entertain ourselves, locate information, and acquire knowledge. In 2010, *The Norwegian Centre for ICT in Education* was established to ensure that information and communication technology (ICT) is used to improve the quality of education, learning outcomes, and learning strategies for young children, pupils, and students in higher education. In 2012, the Centre introduced the concept of 'professional digital competence', and in 2017, they published *Professional Digital Competence Framework for Teachers* (Kelentrić et al., 2017), a guidance document for policy developers, heads of department, teacher educators, teachers, and student teachers. The framework explains that these societal changes are and will continue to become increasingly apparent at every level of the Norwegian education system. This process creates new challenges for teachers' working methods in pedagogical, didactic, and administrative contexts.

In addition, the COVID-19 pandemic has affected the field of education tremendously and is referred to as part of an educational transformation. On 12th March 2020, the Norwegian government introduced the strongest and most intrusive measures ever taken during peacetime. Related to a lock-down of society, the measures included closing all kindergartens, schools, upper secondary schools, colleges, and universities. The pandemic has, for the last year and a half, helped to accelerate the use of online teaching, transforming education from physical traditional teaching to online education (Maity et al., 2021). Digital competence is understood as a moving target, but it may never have moved as fast as it has in the last year and a half.

Biesta (2016) writes that, in discussing digital technology and education, questions regarding the purpose of education, the content of education (curricula), and the form of education (pedagogy and didactics) are central. As Erstad et al. (2021) states, it is of fundamental importance to understand how the terms 'digital competence' and 'digital literacy' have become integrated elements in curricula, as well as how these terms relate to the changes seen in educational systems. This paper reviews how digital competence is understood and operationalised in educational policy and research in Norway, as well as how Norwegian pre-service teachers' digital competence has been measured. The review contains peer-reviewed research papers published between 2000 and 2021.

Regarding the content of education, various white papers and formal strategies have addressed digital technology in Norway since the 1990s (Hatlevik et al., 2013; NOU, 2014). Despite a series of previous strategies, the programme for digital competence 2004–2008 (Ministry of Education and Research, 2004) was the first strategy treating digital technology as an integrated element of education. This was further established through the educational reform *The Knowledge Promotion* (Ministry of Education and Research, 2006b), in which digital competence was defined as one of five basic skills implemented in all subjects for all grades in primary and secondary education. With this reform, Norway was among the first countries in the world in which digital competence was included as a core element of a national curriculum (Erstad et al., 2021). Since this reform, the understanding of the term 'digital competence' has developed, and it is, according to Erstad et al. (2021), of fundamental importance to understand how digital competence is defined as a component of education during the transition from the twentieth century to the twenty-first century. This article will begin by examining how digital technology and the term 'digital competence', as a central part of Norwegian curriculum, has developed since this term was introduced in the educational reform of 2006. This is followed by a systematic literature review presenting trends and development in research on digital competences among Norwegian pre-service teachers from 2000 to 2021.

18.1.1 Research Questions

- How is the term 'digital competence' understood and operationalised in educational policy and research in Norway?
- What mean trends regarding the development and measurement of pre-service teachers' digital competence are found through reviewing the research literature from 2000 to 2021?

18.2 The Position of Digital Competence in Norwegian Education

Teacher education in Norway contains different programmes aimed at different levels of the educational system, ranging from early childhood education for kindergarten teachers to various teacher programmes for primary and secondary education. The approach to digital competence and its position in curricula and educational policy differ between these programmes, but digital competence is highlighted as central and important across all programmes.

18.2.1 Formal Policy for Early Childhood Education

Digital competence was first mentioned in the framework plan for kindergartens in 1995 and introduced as part of the chapter 'Nature, environment, and technology' in 2006 (Ministry of Education and Research, 2006a). In white paper number 41 (2008–2009), *Quality in kindergartens*, it is claimed that early childhood education is increasing the focus on subjects relating to primary and secondary educations' notion of basic skills, with this including the ability to use digital tools (Ministry of

Education and Research, 2009). It is further stated that digital competence should be central to education at all levels and that children in early childhood education should come to view digital tools as a source of play, communication, and knowledge. In 2009, the Ministry defined the use of digital technology in early childhood education as a part of the quality- and innovation initiative in kindergartens (Ministry of Education and Research, 2009). The current framework plan for kindergartens (Ministry of Education and Research, 2017) has a stronger emphasis on digital technology and dedicates a section to digital practices under the heading 'work methods', which states the following:

> Digital practices in kindergarten shall encourage the children to play, be creative and learn. The use of digital tools must support the children's learning processes and help implement the principles of the Framework Plan on creating a rich and varied learning environment for all children. (Ministry of Education and Research, 2017, p. 44)

The framework plan also provides guidelines stating that staff should be actively involved with the children when using digital tools. Furthermore, the digital practice must involve digital judgement, and staff must support the children to develop an early ethical understanding of digital media. Four bullet points are listed as mandatory guidelines for digital practice in kindergarten (Ministry of Education and Research, 2017, p. 45). Staff in kindergartens shall:

- exercise sound digital judgement with regard to searching for information, be conscious of copyright issues, critically analyse sources, and safeguard the children's privacy.
- enable the children to explore, play, learn and create using digital forms of expression.
- evaluate relevance and suitability and participate in the children's media usage.
- explore the creative and inventive use of digital tools together with the children.

Early childhood education in Norway has seven learning areas intended to promote well-being, all-round development, and good health: (1) Communication, language, and text; (2) Body, movement, food, and health; (3) Art, culture, and creativity; (4) Nature, environment, and technology; (5) Quantities, space, and shapes; (6) Ethics, religion, and philosophy; and (7) Local community and society. All learning areas are substantially the same as the subjects children will subsequently encounter in primary education and are to be recurring themes in the kindergarten content. The framework plan states that a range of technologies and digital tools are to be used when working with the various learning areas. Specifically, for the learning area 'Nature, environment and technology', it is stated that staff should use digital tools to inspire the children's mathematical thinking (Ministry of Education and Research, 2017).

The preparation of pre-service teachers for early childhood education

The kindergarten teacher education programme (referred to internationally as the early childhood education programme) is regulated through national curriculum regulations for kindergarten teacher education (Ministry of Education and Research, 2016a). It is comprised of six mandatory areas of knowledge, as well as specialisation and a bachelor thesis. The six areas of knowledge are (1) Art, culture, and creativity; (2) Children's development, play, and learning; (3) Nature, health, and movement; (4) Language, text, and mathematics; (5) Society, religion, beliefs, and ethics; and (6) Leadership, co-operation, and development.

The education of teachers for kindergartens must be in accordance with *The Kindergarten Act* (Barnehageloven, 2005) and the regulations of a framework plan for the content and tasks of kindergartens (Forskrift om rammeplan for barnehagens innhold og oppgaver, 2017). As stated in the regulations of the framework for early childhood education studies (2012, Sect. 2), graduated students must have obtained a broad knowledge of children's beginning digital competencies. This means that digital competency is seen as an integrated part of all learning areas in kindergartens and, subsequently, all areas of kindergarten teacher education programmes.

Kindergarten practices

The national report on ICT in Education, *Monitor 2019*, concludes that staff in kindergartens appear to have a good digital practice. The report describes a balanced use of digital technology in pedagogical work. Most staff perceive digital technology as a support that brings possibilities to their pedagogical practices, and a majority use digital technology on either a daily or a weekly basis. The reasons for using digital technology are the possibilities it creates in pedagogical work, as well as the fact that the curriculum makes it mandatory. The report also claims that staff have potential for improvement regarding how they are facilitating children's exploration, play, and learning, as well as facilitating children's abilities to create and express themselves through digital technology (Fjørtoft et al., 2019).

18.2.2 Formal Policy for Primary and Secondary Education

Regarding primary and secondary education, the official Norwegian report *Students' learning in schools of the future* (NOU, 2014) explains how digital technology has been an area of focus since the mid-1990s, with various strategies and plans for infrastructure, teachers' competence, and the use of certain software programmes. As mentioned above, digital competence was formally introduced as a basic skill, one of five cross-curricular competencies listed in the educational reform in 2006. This makes digital competence part of all subjects at all levels of primary and secondary education in Norway (Ministry of Education and Research, 2006). In addition to formal curricula, the *Framework for teachers' professional digital competence* served as a guide for the teaching profession. This framework describes how important it is to highlight the significant role the teaching profession plays in the development of digitally competent students (Kelentrić et al., 2017).

In 2020, new curricula came into effect, representing a renewal of *the Knowledge Promotion*, which aims to give students more in-depth learning and better understanding of learning content. The renewal marked a shift towards more future-oriented perspectives, including twenty-first century skills, such as critical thinking, collaboration, communication and creativity (Keane et al., 2016). The amount of learning objectives is reduced to better facilitate in-depth learning. Three interdisciplinary themes are integrated in education to develop students' basic competence across subjects, and student participation is strengthened (Union of Education Norway, 2020). The three interdisciplinary topics are health and life skills, democracy and citizenship, and sustainable development. Digital skill, as a basic skill, is still to be incorporated into all subjects, but the subjects now have different roles and responsibilities in terms of the development of the five skills (Udir, 2021).

The preparation of pre-service teachers for primary and secondary education

The education of pre-service teachers for primary and secondary education is regulated through the *Framework plan for primary and lower secondary teacher education for years 1–7* (Ministry of Education and Research, 2016b) and the *Framework plan for primary and lower secondary teacher education for years 5–10* (Ministry of Education and Research, 2016c). Upon completing the primary and lower secondary teacher education programme, the requirements state that the graduates must be able to evaluate and use relevant teaching materials, digital tools, and resources in their teaching and to teach their pupils digital skills. The graduates must also be able to communicate on issues related to professional practice and possess digital skills appropriate to the profession (Ministry of Education and Research, 2016b, c).

School practices

Regarding the pedagogical use of digital technology in schools, *Monitor 2019* reports that students in primary education interact with one another through learning games and quizzes but individual work in digital devices is the most widespread practice (Fjørtoft et al., 2019). This was critiqued in 2013, when the Digit-committee concluded that the practice in schools resulted in students who are able to use digital tools, but mainly as consumers (NOU, 2013). Some claim that this challenge is not merely related to digital practices but that Norwegian education positions the students as passive receivers of knowledge. Jordet (2020) claims that Norwegian school is characterised by a tradition that gives little room for children's relational, meaning seeking, creative, explorative, and intentional nature. According to the objectives of education and training, students 'must have the opportunity to be creative, committed and inquisitive' (The Education Act, 1998, Sect. 1.1). Regarding the recent changes in Norwegian curricula, it is too soon to conclude how the renewal of *the Knowledge Promotion* will affect existing cultures in Norwegian education, but these changes are challenging the more traditional ways of teaching by highlighting the following:

> Creative abilities contribute to enriching society. Collaboration inspires innovation and entrepreneurship so that new ideas can be transformed into action. Pupils who learn about and through creative activities develop the ability to express themselves in different ways, and to solve problems and ask new questions. (The Directorate of Education, 2020, p. 7)

This concern is also addressed in *Professional Digital Competence Framework for Teachers*, which claims that 'it is more important than ever that children and young people are not merely passive consumers of products, services and information but also critical users and active producers of content themselves' (Kelentrić et al., 2017, p. 1).

18.2.3 From Tool-Oriented Skills to Cross-Curricular Competence

The report *Students learning in schools of the future* (NOU, 2014) states that, when digital competence was introduced as a basic skill along with *the Knowledge Promotion*, the original focus was students' ability to use digital tools. The following official report *The school of the future—renewal of subjects and competences* states that digital development leads to changes in content and methods for all subjects in school. Digital competence has subsequently also come to be seen as a cross-curricular competence (NOU, 2015).

Competence in using a diversity of tools and competence connected to safety and security are examples of digital competence without any immediate connection to any of today's school subjects. Tool competence refers to the practical use of universal digital units and systems. Examples are using a computer and established software for word and number processing, presentations, and images, while security refers to, e.g., learning how to protect one's own digitally stored information. As well as being a cross-curricular competence in itself, digital competence is also understood to be part of other cross-curricular competences, such as critical thinking, communication and collaborating. For example, today, critical thinking will generally be about assessing information, which is accessible digitally, and mastering digital tools and surroundings is an important part of communication and collaboration (NOU, 2015).

What began as a skill-oriented understanding in *the Knowledge Promotion* of 2006 has developed into a more complex concept of cross-curricula competencies. In the revised framework for basic skills from 2017, one finds a broader understanding of digital skills. In this framework, digital skills are defined as the ability to gather and assess information, be creative with digital resources, and digitally communicate and collaborate with others. This involves being able to use digital resources appropriately and in a safe matter to solve practical tasks, and digital skills include the development of digital judgment by obtaining knowledge about and good strategies for online activities (The Directorate of Education, 2017).

Throughout the educational system, from early childhood education to secondary education, digital competence is seen as central. This is reflected in the preparation of Norwegian pre-service teachers. However, digital development is changing the educational context at a rapid pace, as well as our understanding and definition of digital competence. In Norway, several researchers have studied what professional digital competence entails for teachers (Gudmundsdottir et al., 2020), and in the newer literature, the term builds on a complex understanding of several competence areas (Brevik et al., 2019; Hatlevik & Bjarnø, 2021; Singh & Engeness, 2021). This complex understanding seems to be part of a certain Nordic interpretation of the conceptualisation of digital competence (Godhe, 2019).

18.2.4 The Nordic Perspective

In a recent review of policy documents and relevant research in Norway, Finland, and Sweden, Erstad et al. (2021) conclude that digital competence has become a key area of importance in Norway. This conclusion is based on several national initiatives to promote digital competence in different educational settings. However, according to the authors, the field of research is still fragmented and varies in quality. Even though Norway is presented as one of the first countries to include digital competence as a core element in the national curriculum, there is, according to Erstad et al. (2021), a current lack of a national agenda for research on digital competence and no real research base to inform practitioners and the development of policy. In Godhes's (2019) analysis of Swedish, Danish, Finnish, and Norwegian curricula, she found a common emphasis on societal issues and critical approaches. Godhe (2019) describes this emphasis as an indication of a certain Nordic interpretation of how digital competence is conceptualised. From a Norwegian perspective, this emphasis is evident throughout the mentioned framework for teachers' professional digital competence, as well as curricula and frameworks for kindergarten and primary and secondary education. This notion coincides with Erstad et al. (2021) analysis, in which they describe digital competence as central to contemporary curriculum development. The term 'digital competence' has developed into a complex concept, and from this development follows uncertainty concerning conceptual clarity (Erstad et al., 2021). The following systematic review regarding digital competence in teacher education in Norway contributes to a clearer understanding of the concept of digital competence in the education of pre-service teachers.

18.3 Methodology

A systematic approach to a literature review should 'provide an accurate account of the process that was undertaken to identify evidence for the review' (Booth et al., 2012, p. 80). Hence, this section provides a detailed description of how we arrived at our conclusions. This includes the setting of the inclusion criteria, the carrying out of the literature search, the selection of the articles, and the analysis of these articles. An overview of the database searches, with the details, number of results, and number of included articles, can be found in Table 18.1.

Table 18.1 Database search overview

Database	Search details	Number of results	Number of included articles
ERIC	("digital competence" OR "digital literacy") AND (Norway OR Norwegian) AND teacher AND student https://eric.ed.gov/?q=%28%22digital+competence%22+OR+%22digital+literacy%22%29+AND+%28Norway+OR+Norwegian%29+AND+teacher+AND+student Search performed on August 12 2021	15	3
Web of science	(((ALL = (digital competence OR digital literacy)) AND ALL = (Norway OR norwegian))) AND ALL = (teacher student) https://www.webofscience.com/wos/woscc/summary/3306c8e8-f15e-47b4-9977-76c739fe2640-045adf43/relevance/1 Search performed on August 18 2021	90	12
Nordic journal of digital literacy	("digital competence" OR "digital literacy") AND (Norway OR Norwegian) AND teacher AND student https://www.idunn.no/sok#?q=(%22digital%20competence%22%20OR%20%22digital%20literacy%22)%20AND%20(Norway%20OR%20Norwegian)%20AND%20teacher%20AND%20student&j=dk&p=1 Search performed on August 19, 2021	92	3

(continued)

Table 18.1 (continued)

Database	Search details	Number of results	Number of included articles
Science direct	("digital competence" OR "digital literacy") AND (Norway OR Norwegian) AND teacher AND student https://www.sciencedirect.com/search?qs=%28%22digital%20competence%22%20OR%20%22digital%20literacy%22%29%20AND%20%28Norway%20OR%20Norwegian%29%20AND%20teacher%20AND%20student&date=2001-2021&show=100&lastSelectedFacet=articleTypes Search was also refined with filter for only Review articles and research articles Search performed on August 22, 2021	133	4
Total number of included articles			22

18.3.1 Inclusion Criteria

According to the research questions, the aim of this literature review was to examine the empirical scientific literature published between 2000 and 2021 about Norwegian pre-service teachers' digital competence and the ways in which this has been measured. The articles had to report on research within a Norwegian context and be peer-reviewed to be considered. To further direct the literature search, we set these additional criteria for selection:

1. Pre-service teachers (qualifying for pre-school, primary or secondary school, or post-graduate teaching certificates) must be participants in the presented study.
2. The presented study must be related to pre-service teachers' digital competence/professional digital competence.

18.3.2 Literature Search

Initial search

To obtain an overview of the field and identify suitable keywords, we performed an initial scoping search. The variety of terms characterising the field made the selection of the search terms difficult. Digital competence is also referred to as skills or literacy, and within the target population, there are students from various teacher programmes. Moreover, different terms are used for such students (e.g., pre-service teachers, student teachers, teacher students, and pedagogical students). This made the search process complex.

One way to avoid excluding any teacher education programmes was to solely search with words identifying digital competence and the location of Norway. We attempted this with various combinations in two databases, *ERIC* and *Web of Science* (see Table 18.2). One challenge was that the search either returned too few results or too much material outside of our scope. However, we found that in relevant articles the terms 'student teacher' and 'teacher student' seemed to be frequently used, and 'teacher' and 'student' were therefore chosen as search terms. We also decided to retain both 'competence' and 'literacy' because, though the first term is more

Table 18.2 Initial search overview

Database	Search phrase	Number of results
ERIC	Professional digital competence Norway	224
	Digital literacy + Norwegian	5
Web of science	Digital competence Norway	204
	Professional digital competence Norway	5

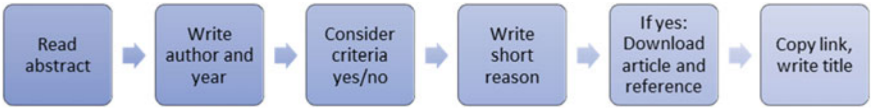

Fig. 18.1 Article selection procedure

common in Norway (Røkenes & Krumsvik, 2016, p. 2), they are both frequently used in the research literature. Hence, after this initial search stage, we considered the following list of search terms expedient to proceed with: 'digital competence', 'digital literacy', 'teacher', 'student', 'Norway', and 'Norwegian'.

Search of databases

Furthermore, the selected search terms were used in searching three different scientific databases (see Table 18.1). These were chosen because they index highly recognised journals in the field of education, in which most Norwegian studies of significance are likely to be published. In addition to the three international databases, we searched specifically within the *Nordic Journal of Digital Literacy*, which is a Norwegian scientific journal specialising in this field and therefore relevant. On *Web of Science*, we made use of the advanced search option to add and combine separate search criteria. A similar procedure was used for the other database searches by applying Boolean operators (see https://eric.ed.gov/?advanced and https://service.elsevier.com/app/answers/detail/a_id/25974/supporthub/sciencedirect/). The time frame (2001–2021) was also added or checked manually.

Article selection

The next stage of the process was selecting articles for the review by reading the abstract of each article and evaluating this according to the initial criteria. Each search and evaluation were documented according to the procedure shown in Fig. 18.1. During this search stage, 25 articles were included for further assessment. Later, through a more in-depth reading of the articles, three articles were reconsidered and found not to meet the criteria. Hence, the final number of included articles was reduced to 22.

18.3.3 Analysis

The next step was to assess each article more thoroughly according to the aims of the study. This was done by setting up a scheme as shown in Table 18.3 and performing a targeted reading of relevant sections in the articles. The main focus was to identify the results regarding Norwegian pre-service teachers and their digital competence, as well as what methods were used to measure this. Some of the articles also included other units of analysis in addition to student teachers (e.g., other nationalities, teacher educators, and institutions), and in such cases, these units were ignored. In the table,

Table 18.3 Literature analysis results overview

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
1	Video papers—an attempt to narrow the notorious gap between theory and practice in teacher education (Krumsvik & Smith, 2009)	Teacher students one-year post-graduate teaching certificate grade 8–3 (n = 6)	Qualitative Small (pilot) case study Structured interview	Lack of explicit DC definition Tool/skill-oriented focus pedagogical and didactical use of ICT	Video papers make required reading more enriching and less tiring VP speaks to the digitally literate generation of students and provides ‘hands-on’ experience with ICT and multimodality, which may increase digital competence	Tool use/digital practice

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
2	Educating Teachers for the New Millennium (Tømte, 2013) (Originally 2013, reprint in special issue 2015)	3 teacher education institutions, teacher students for grades 1–10 (n = 54) teacher educators (n = 27), programme managers (n = 23)	Qualitative Multiple case study Document analysis, interviews with management, teacher trainers, and student teachers	Refers to several generic DC definitions and concept development but does not explicitly approve of any digital competence is the set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socialising, consuming, and empowerment (Ferrari, 2012, p. 3). It corresponds to what has been the dominant understanding of digital competence in Norway, as communicated as early as 2005 by the National Network of ICT in education: 'Skills, knowledge, creativity and attitudes required to be able to use digital tools in learning and living in a knowledge society' (Erstad et al., 2005)	Identifies an increasing awareness of the use of ICT in education from 2009 to 2012 Teacher students are not sufficiently well prepared to use ICT for pedagogical purposes through their ITE	Equipment situation Mastery of software and ICT tools

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
3	Social Networking Sites in Education—Governmental Recommendations and Actual Use (Helleve et al., 2013)	Pre-service teachers in years 3 and 4, post-graduate certificate from 6 teacher education institutions, grades 11–13 (n = 474) (Study 1 of 2)	Quantitative Questionnaire	Digital competence mentioned as one of the five basic skills, but no explicit definition Digital media ethics (Ess, 2009)	Pre-service teachers report negative attitudes towards the use of Social Networking Sites for communication between teacher–pupil. They don't use SNS for pedagogical purposes	Responsible ICT use social networking sites/social media Digital media ethics
4	Development of Student Teachers' Digital Competence in Teacher Education—A Literature Review (Røkenes & Krumsvik, 2014)	Teacher students qualifying to teach in the secondary school level Grade 8–13	Qualitative Literature review Thematic analysis	Several DC definitions mentioned (e.g., Ferrari, 2012; Erstad et al., 2005) Krumsvik's definition of professional digital competence: 'the teacher's… proficiency in using ICT in a professional context with good pedagogic-didactic judgment and his or her awareness of its implications for learning strategies and the digital Bildung of pupils and students' (Krumsvik, 2011, pp. 44–45)	Identified 8 approaches used by teacher education programmes to develop DC in student teachers (collaboration, metacognition, blending, modelling, authentic learning, student-active learning, assessment, and bridging theory/practice gap) Only 2 studies from Norwegian context, of which 1 (Krumsvik & Smith, 2009) is already included in this review	Broad Pedagogical use of ICT

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
5	Appropriation of digital competence in Teacher Education (Instefjord, 2014) (Originally 2014, reprint in special issue 2015)	Pre-service teachers, 1st and 2nd year (n = 14) Grade 1–10	Qualitative Multiple case study (2 cases) Focus group interviews	Learning as situated process (Somekh, 2008) Mastery and appropriation (Wertsch, 1998) Mentions several broad definitions (Ferrari, 2012; Ng, 2012; Krumsvik, 2011) Focus in article on DC as a tool for teaching and learningara>	Students rate their own levels of digital competence as high, and acquired such before starting the programme. PDC training is detached from the remainder of subjects, identifying a need for more integration	Tool use for teaching and learning Digital practice Interactive whiteboards
6	Educating online student teachers to master professional digital competence: The TPACK-framework goes online (Tømte et al., 2015)	Online teacher students (n = 96) grade 1–7 and 5–10	Mixed methods Case study Survey of students Group interviews	Brief overview of international development of the concept, mentions Krumsvik's definition (see above) but leans mostly on the TPACK-framework (Koehler & Mishra, 2009) as an important avenue for understanding teachers' abilities to combine diverse fields of competence	Few results regarding students presented in the article Online learning provides opportunities for teacher educators to act as role models in integrating ICT	Online learning
7	Expressing Professional Identity through Blogging—A Case Study of Blogging in the Study of the Subject of Norwegian in Pre-School Teacher Education (Kvåle & Rambø, 2015)	Pre-school teacher students 3rd year (final semester) (n = 8) Grade pre-school	Qualitative Case study, text analysis	Theories of professional identity New media literacy theory Lacks explicit DC definition but highlights the need for research on the subject-specific use of ICT	Digital practices in teacher education must be connected to specific subjects and contextualised according to overall aims Comments on the few studies of ICT in Norwegian pre-school teacher Education	Tool use/digital practice Blogs

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
8	The use of flipped classrooms to stimulate students' participation in an academic course in Initial Teacher Education (Helgevold & Moen, 2015)	Teacher students, course in *Philosophy of science and research methods* (n = 81) Grade?	Mixed methods Semi-structured questionnaire (n = 81) Interviews (n = 5) Analysis of students' written texts (n = 107)	Student-centred learning Socio-cultural perspectives Digital competence mentioned as one of the basic skills, no explicit definition Pedagogical use of ICT	FC perceived good for Preparing (online lectures + writing) Stimulated involvement Variation in modalities Relevant to future teaching practices Varying how students perceived group work on campus	Tool use/digital practice Flipped classroom
9	Participant activity and facilitator strategies in an LMS-based discussion forum (Strømman, 2015)	Student teachers Grades 1–7	Qualitative Interpretative Analysis of written data from discussion forum Interviews	Research-based theory on discussions forum Lack of DC definition The word 'digital competence' is not used, but the practice investigated is described as practice and also related to the ways student teachers are expected to engage in collaborative activities and use digital strategies in their future work as teachers	Implications for increasing activity in online forums Students, though used to social networking sites, do not engage accordingly in LMS (learning management system-based discussions; it is considered a 'school genre'	Tool use/digital practice Online interaction

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
Break 1 (2014–2015): From a perspective concerning digital support for traditional pedagogy towards digital competence as a more complex concept challenging the premises of teaching						
10	Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education (Røkenes & Krumsvik, 2016)	Postgraduate student teachers (specialising in English as second language, ESL) Grades 8–13	Mixed methods Case study Local Participant observations (n = 18–20) Two surveys (n = 41, n = 112) Semi-structured interviews (n = 15)	Theoretical model of digital competence development (Krumsvik) Two axes: Self-awareness and practical proficiency Four core components: – Basic digital skills – Didactic ICT-competence – Learning strategies awareness – Digital Bildung	Showing practice examples from ITE, specifically at a micro-level	Broad PDC development factors (modelling, scaffolding learning experiences, linking theory and practice, reflection, access to resources and support, innovative assessment practices, and collaborative learning) Student teachers' self-perceived digital competence

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Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
11	Introducing Blended Learning MOOC – A Study of One bMOOC in Norwegian Teacher Education (Langseth & Haugsbakken, 2016)	Online teacher students n = 256 grade?	Mixed methods LMS data on user participation Qualitative interviews semi-structured	Connectivism DC (uses the term digital literacy) definition from Martin (2006): 'The awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesise digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process' The article focuses on tool use, developing DC through use, and trying new technology	Questions whether teacher students have enough digital competence to make use of online learning objects in formal learning (see p. 68) (Digital natives myth)	Online learning Online co-operation Connectivism MOOC

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Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
12	What's in a wiki? (Brox, 2017)	Student teachers, undergraduate 3rd year, subject Norwegian (n = 13) grade?	Qualitative Case involving the use of wikis Semi-structured interviews Analysis of logs from the project	New materialism Actor-network theory Lacks explicit DC definition but discusses other DC studies and criticises a tools-based understanding The article reports on a larger study, with a focus on how wikis could function as a tool for learning and enhance students' digital competence, but it adopts a more critical and wider perspective on technology than 'supporting and enhancing' learning Broader discussion of human-technology relations using theories that question a one-way understanding of agency, artefacts, and affordances, (e.g., technologies not neutral, inherent agency of software and algorithms)	Student teachers unable to connect experiences with the digital tool to concepts such as digital competence and learning outcomes Theoretical implications: questioning the tool metaphor in understanding human-technology relation	Tool use/digital practice Wikis Theoretical discussion about technology as something more than a tool

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Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
Break 2 (since 2017): Professional digital competence as a distinct concept is broadly applied						
13	Educating digitally competent teachers: a study of integration of professional digital competence in teacher education (Instefjord & Munthe, 2017)	Pre-service teachers, 4th year (final or first year of MA) Grades 1–10 (n = 654) (Student teachers only part of the study, which also included teacher educators (n = 387), mentor teachers (n = 288))	Quantitative National questionnaire Descriptive and explanatory analyses	DC definition: 'Being able to integrate and use technology for educational purposes involves having a set of generic skills suitable for all situations, both personal and professional, as well as specific teaching profession skills. This is what is referred to as professional digital competence for teachers' (article refers to Lund et al. (2014)) Mentions several theories of technology integration	Student teachers are critical of the ICT/DC component of education but have favourable opinions of their own competence	Tool use Technical, pedagogical, ethical

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Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
14	Newly qualified teachers' professional digital competence: implications for teacher education (Gudmundsdottir & Hatlevik, 2018)	Newly qualified (0–2 years) Grades 1–10 (n = 356) Questions about initial teacher education	Quantitative National survey Country case Self-reports	Theories about ICT self-beliefs; ICT self-efficacy, perceived usefulness of ICT, perceived PDC developed through ITE Professional Digital Competence three-pillar (dimensions) model, inspired by TPACK framework but including a specific profession-oriented aspect of PDC: 1. Generic digital competence, which cuts across disciplines and specifies general knowledge, skills, and attitudes that teachers, teacher educators, and student teachers require in order to teach and learn in digital environments 2. Subject/didactic digital competence, which captures what is specific to each subject when taught with and through ICT 3. Profession-oriented competence, which includes various aspects related to and supporting teaching in technology-rich environments. This pillar includes school-home communication, the psychosocial learning environment, classroom management and relational skills, and teachers' own research and continuous professional development in the field of ICT (Gudmundstdottir & Ottestad, 2016)	Perceived poor quality/contribution from ICT training during ITE 80% positive beliefs about ICT Negative beliefs about distractions from ICT	Self-efficacy Perceived usefulness of ICT

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
15	Transformative agency in teacher education: Fostering professional digital competence (Brevik et al., 2019)	Student teachers, 6th term of ME programme Online course (n = 139) Grade?	Mixed methods Digital traces in course (n = 139) Survey (n = 92) Focus group interviews (n = 12)	Uses the PDC three-pillar model (Gudmundsdottir & Hatlevik, 2018) and adds a fourth dimension, *Transformative digital agency* Transformative digital agency 'captures (student) teachers' competence in taking initiatives and transforming their practices by selecting and using relevant digital tools. It arises as a necessity when (student) teachers are placed in demanding situations involving challenges or a conflict of motives, thus creating a wish or need to break out of the current situation' (Brevik et al., 2019, p. 4) Article also refers to understanding of PDC derived from Lund et al. (2014)	Student teachers actively sought to resolve demanding situations by going beyond their current PDC through engaging in diverse forms of transformative agency (selecting and using relevant digital tools) SPOC was helpful in this matter	Digital agency (see p. 4) Digital practice: SPOC (small private online course thematically focused on PDC)

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Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
16	Becoming a professional digital competent teacher (Helleve et al., 2020)	Teacher students in last part of education and newly qualified teachers (n = 7) Grade?	Qualitative Comparative study Case study Semi-structured interviews (n = 7) (Participants recruited from earlier in the study: Paper-based questionnaire (n = 475) and Web-based questionnaire (n = 35)) National	Lacks explicit DC definition but refers to an understanding of PDC from Lund et al. (2014): 'Comprising a deep understanding of technology, knowledge of students' learning processes, and an understanding of the specific disciplinary practices and features characterising individual school subjects' Also includes some aspects of the *Professional Digital Competence Framework for Teachers* (Kelentrić et al., 2017): 'the ability to design learning processes through learning objectives, to choose the means and types of evaluation, and to select the appropriate technology to support this relationship'	SNS used mainly for social reasons Awareness of challenges Negative to use for pedagogical purposes because of privacy issues Need for reflections and awareness in ITE	Social networking sites Digital media ethics

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
17	An analytical unit of transformative agency: Dynamics and dialectics (Lund & Vestøl, 2020)	Student teachers in a five-year master's programme (n = 195) Grade?	Mixed methods Report from an intervention to foster PDC Survey Assignments Group interviews (article reports mostly from these)	Cultural-historical activity theory PDC involves linking digitalization to epistemology, pedagogy, subject didactics, and professional endeavours, such as class management and connecting academic and experience-based knowledge (Lund et al., 2014) Links to (Brevik et al., 2019) and the adding of a fourth dimension to the three-pillar PDC model	64% reported the intervention developed their PDC (the article is more theoretical/methodical, with empirical examples)	Transformative agency Navigating online information, finding relevant research
18	Student teachers' responsible use of ICT: Examining two samples in Spain and Norway (Gudmundsdottir et al., 2020)	First-year student teachers Grades 1–10 and 8–13) (n = 563) (The study also included students in Spain (n = 681))	Quantitative Survey Scales for perceived competence in privacy issues and handling cyberbullying adapted from 2013 International Computer and Information Literacy Study (ICILS) questionnaire Scale for ability to evaluate digital content adapted from Norwegian Monitor Study 2011 Self-reporting	Refers to several studies and highlights the aspects of DC regarding digital judgement, risk evaluation, understanding the role of digitalisation in a democracy, evaluation of digital content, and being a responsible citizen These are also aspects of PDC The study draws on two PDC models – the three-pillar model (+ 4th pillar, digital agency) – the PEAT model for PDC developed by the DICTE-project (Dicte, 2019) (4 dimensions: pedagogical, ethical, attitudinal, technical) Emphasises the attitudes and ethics dimensions	Norwegian teacher students perceive themselves as competent in the three areas (privacy issues [PI], cyberbullying [CB], and the ability to evaluate digital content [EDC]) Relationships between the three concepts evaluated Strong relationship: PI–CB Moderate relationship: PI–EDC Weak relationship: EDC–CB	Responsible use of ICT, three concepts: Privacy issues Cyberbullying Ability to evaluate digital content

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
19	Perspectives on the tensions in teaching with technology in Norwegian teacher education analysed using Argyris and Schön's *theory of action* (Thorvaldsen & Madsen, 2020)	Fourth-year master's students in teacher education Grades 1–7 and 5–10 (n = 48) (study also included teaching staff, n = 64)	Quantitative Local survey University case Questionnaire (digital, Questback) Students' self-reports Statistical analysis (n = 112, including staff)	Theory of action, Argyris and Schön (1978) PDC with three aspects: pedagogic and didactic understanding subject-specific understanding technological understanding (Operationalisation of Tømte & Olsen, 2013;Lund et al. 2014). Also corresponding with TPACK's three components; content, pedagogy and technology	Staff have better PDC than students, but students have a more positive attitude Leads to differences in what impacts the use of digital tools	Professional attitudes Application of tools

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
20	Students' perceptions and use of a new digital tool in teacher education (Bader et al., 2021)	Student teachers specialising in English as a foreign language Grades 5–10 (n = 40)	Qualitative Intervention study Students' responses/attitudes towards and use of the tool 128 reflection notes by 40 student teachers Focus group interview, 3 students	Cultural-historical theory Formative assessment PDC definition: Students' attitudes to and actual use of digital technology are seen as contributing to a more nuanced understanding of students' digital competence, as well as their actual use. The authors build on Lund et al. (2014) and state that professional digital competence involves teachers not only appropriating technologies but also making their learners appropriate them and put them to productive use Includes newer development of PDC understanding involving digital agency and 'PDC as an agentive, quality and context sensitive as well as transformative capacity' (Aagaard & Lund, 2020)	Students' attitudes and use are related to perceived ease of use, not the learning-related potential of digital technology	Tool use/digital practice: *OneNote Class Notebook* Attitudes Use

(continued)

Table 18.3 (continued)

	Title, authors, year	Target teaching level (pre-school, primary, secondary)	Methods, type of study	Theoretical framework/digital competence (DC) definition or model	Results, implications	Digital competence area/emphasis
21	Student teacher podcasting: Agency and change (Carson et al., 2021)	Student teachers (n = 2) (60 podcast episodes created by the two, with guests, among them 52 other students) Grade?	Qualitative Interaction analysis – Observation – Analysis of content and dialogues	Socio-cultural approach Agency Dialogic spaces Lacks explicit PDC definition but mentions Koehler and Mishra (2009) and Lund et al., (2014) Connects the study to recent theoretical development linking PDC to digital agency/agentic learning (see other studies in this review)	Working with/producing podcasts can provide opportunities for agentic learning	Agency Digital practice – podcasting
22	Examining the relationship between resilience to digital distractions, ICT, motivation, approaches to studying, and time spent on individual studies (Hatlevik & Bjarnø, 2021)	Student teachers, year 1 Grades 1–7 and 5–10 (n = 219)	Q uantitative Questionnaire (study evaluation with added extra questions)	Lacks explicit PDC definition but addresses factors such as classroom management and coping with the challenges imposed by digitalisation Resilience Self-regulation Self-efficacy (could be understood as aspects of a broad DC/PDC understanding/definition)	Motivation, resilience to digital distractions, and gender positively correlated with approach to studying Students report high self-confidence in the use of digital tools	Resilience to digital distractions ICT self-efficacy Classroom management

we also included columns for the target teaching level (i.e., which education level the pre-service teachers will qualify to teach after graduation) and what theoretical framework or model was applied. Lastly, a column with short descriptions of the digital competence areas included in or the emphasis of each study was added. Investigating what the research focused on, there were not very apparent categories. However, some loose thematic categories were applied.

Some of the information in the table was also counted and checked more thoroughly in a spreadsheet (e.g., the number of articles with certain methods, theoretical frameworks, and school level), which is accounted for in Sect. 18.4, Results and discussion. A first impression from this phase indicated the sequential emerging of a broader and more complex concept, as well as that both theory and definitions had matured during the period we are examining. However, this situation had to be investigated in more detail, and through the next stages, we sorted the articles chronologically, searched for definitions, and added these definitions to the column 'Theoretical framework/digital competence definition or model'.

To further ensure the validity of the findings, a more thorough reading of each article was performed. This led to some corrections and updates to the findings table, as well as a clearer view of the anticipated concept development.

18.3.4 Reflections and Limitations

To ensure transparency, the following section will provide an account of the challenges faced, changes that had to be made once the project was underway, as well as the general limitations of the study.

In the literature search, we originally stipulated that articles must provide information regarding methods for measuring digital competence. Due to the range of methodological approaches in the literature, we decided it would be better to evaluate this after the selection of the articles. Furthermore, the chosen search terms originally included 'pre-service teacher' and 'pedagogy', but it soon became clear that these did not provide additional relevant results and would be redundant.

The choice of databases to search may have excluded some contributions. Firstly, searching three international databases with English search terms entails the exclusion of articles written in Norwegian. Likewise, by limiting the search to online journals, literature published in books would fall outside of the scope. Nonetheless, publishing internationally is common in the Norwegian research community, and it is reasonable to assume that important research contributions would be found in these channels. The book *Digital læring i skole og lærerutdanning (Digital learning in school and teacher education)* (Krumsvik, 2016) is comprised of contributions from several of the authors represented in this review, presenting the same or closely related content in Norwegian, an indication that the selected literature is representative.

During the analysis of the material, steps were taken to avoid a thematic bias towards schoolteachers and verify the finding that there are few articles on preschool teacher education. Two control searches were performed within each database, with the search terms ‘Early childhood education’ and ‘Pre-school teacher student’ replacing student teacher. The search did not return more relevant results, except for one article. This was first added because of its relevant topic but later excluded due to the empirical criterion. There is, however, also a chance that more research in this specific field is prone to being published in Norwegian.

A complete categorisation according to school level was difficult to obtain. Firstly, some articles did not explicitly state their target teaching level. Furthermore, both historically and organisationally, there are differences between teacher education programmes, especially regarding the intersection between upper and lower secondary school. However, one indicator of level is that master’s programmes are aimed at primary and secondary school, while pre-school teacher is a 3-year bachelor’s education.

Two of the articles that were originally included with publishing year 2015 were ultimately revealed to be reprints (Instefjord, 2014; Tømte, 2013). This caused some difficulties regarding the question of how to interpret the chronological development of concept understanding, but the larger trends discussed seem to remain the same.

When we turned our attention towards concept development, the choice to focus strictly on empirical research created some challenges. Among the references listed in the selected articles, we discovered some purely theoretical articles that were important for understanding this development and decided to read and comment on some of these as part of the discussion. This investigation could even have been elucidated by studies of in-service teachers or the compulsory school level. We chose, however, to keep the discussion limited to the realm of teacher education.

18.4 Results and Discussion

The present literature is, on many levels, a varied selection of articles regarding methods, thematic emphases, theoretical underpinnings, and which teacher programmes the studies report on. Although the topic of digital competence and student teachers has guided the selection process, the research questions differ extensively within the selection of articles, and the link to the term ‘digital competence’ is not always explicit or clear. Hence, in some cases, it is not the main findings in the studies that are the most interesting for this review but, rather, the ‘side-findings’.

In the following, selected findings will be elaborated and discussed. For a more detailed account of each article, see Table 18.3. We begin by presenting the different target teaching levels, and here, a significant imbalance in the literature must be commented on. Following this, a review of the methods provides an account of some attempts to measure digital competence, as well as showing the variety of such approaches. An introductory discussion of language and metaphors is also included. Next follows a short account of theoretical foundations, which provides fundamental information with which to understand the last and most extensive section, that presenting and discussing the concept development.

18.4.1 *Target Teaching Levels*

All the articles report on studies in which student teachers play a part, though they are not always the main focus. Concerning which grade the students are qualified to teach, ten studies address programmes qualifying to teach at the compulsory school level. Only five of the studies address teacher education programmes aimed at teaching grades 8–13, which corresponds with the lack of studies addressing such grades mentioned by Røkenes and Krumsvik (2014). Seven articles that do not explicitly state which levels they report on make these conclusions less certain.

However, what stands out as most striking is the low number of studies regarding pre-school teacher education, that is, only one of the selected articles. There are no indications in the articles not specifying school level that they report on this field either. This is also confirmed by the authors of that one article when they write that 'there are still few studies on the uses of ICT in Norwegian *pre-school teacher education*' (Kvåle & Rambø, 2015, p. 8).

Thus, digital competence in early childhood teacher education appears to have been less in focus, at least in the English peer-reviewed literature. Kvåle and Rambø (2015), reporting on the use of blogging in a course in Norwegian, do not define PDC but connect with the field through mentioning the 'growing research interest in the uses of ICT in Norwegian teacher education' and referring to other relevant articles. There is also a link to the PDC models presented in other articles, stressing the importance of relating ICT use to specific subjects.

Bølgan (2012), the additional result of the above-mentioned control searches, does not report empirical studies on student teachers but still provides important information about the development in the field of ICT in kindergartens and related education programmes in Norway. In an extensive review of history and policy documents, Bølgan paints a picture of a field in progress. However, there are indications that ICT in early childhood education and early childhood teacher education has lagged behind other parts of the education system. The author calls for a greater inclusion of early childhood education in national ICT strategies (Bølgan, 2012, p. 164). The article also presents a view of digital literacy as more than ICT skills and is thus in line with much of the other literature presented in this review. Considering the time that has passed since it was written as well as the development in policy described in the first part of this article, the lack of research articles in this area is striking. This lack may be due to it being a young research field or lacking a tradition of international publication. Nonetheless, the need for more development and research in the field of ICT and early childhood teacher education pointed out by Bølgan (2012) is still evident and also corresponds with recent investigations in the field (see Fjørtoft et al., 2019).

18.4.2 Methods Used in Selected Articles

Concerning methodology, there was a majority of purely qualitative studies (10), and slightly fewer relied solely on quantitative methods (6). However, the number of studies applying various sorts of mixed methods (6) makes this difference less distinct. It may be more correct to say that the articles show a great deal of variety in their methodological approaches. In the quantitative approaches, the measurement seems to rely mostly on the self-reporting of perceived competence or attitudes.

Among the quantitative studies, including those with mixed methods, only a few attempt to specifically measure digital competence as an overall concept. The studies that have most explicitly developed items for measuring teacher students' overall professional digital competence are Røkenes and Krumsvik (2016), Instefjord and Munthe (2017), Gudmundsdottir and Hatlevik (2018), and Thorvaldsen and Madsen (2020). In reading the descriptions of the methods and questionnaires used, two observations stand out. Firstly, measurement is mostly performed through the self-reporting of elements such as skills, usage, and attitudes. Secondly, wordings such as 'use of digital tools' and 'use of ICT' are repeatedly used, though in combination with words and phrases such as 'pedagogical', 'didactical', 'for learning', and 'for teaching'. How this relates to a broad or narrow understanding of digital competence will be discussed below. Tømte et al. (2015) include two items concerning students' digital literacy and students' social lives on the Internet but do not document which questions these consist of. Other quantitative studies have measured more specific areas within professional digital competence. Helleve et al. (2013) report from a study on social networking sites (SNS) and focus on the ethical aspect of digital competence. To measure these aspects of digital competence, the survey asks questions about the SNSs applied, the frequency of use, the motivation for use, as well as prospective actions after being qualified as teachers. Another study that delves into the ethical component of digital competence is Gudmundsdottir et al. (2020) article on student teachers' responsible use of ICT. The items investigated are 'perceived competence in privacy issues', 'perceived competence in handling of cyberbullying' and 'ability to evaluate digital content' (Gudmundsdottir et al., 2020, p. 8). Hatlevik and Bjarnø (2021) do not describe their research as being about digital competence, but it still includes two items that describe relevant aspects of such. These are 'resilience to digital distractions' and 'ICT self-efficacy'. Other authors use the quantitative approach to measure other aspects relevant to the study, e.g., the evaluation of courses or work form (Helgevold & Moen, 2015; Langseth & Haugsbakken, 2016; Lund & Vestøl, 2020), and the quantitative sections of these studies are thus less relevant to this discussion.

The qualitative studies do not measure student teachers' digital competence. Rather, they illuminate and discuss the concept from different angles, as well as showing how teacher education may contribute to the development of such competence. Three of these articles more clearly seek to develop the concept and they apply methods such as document analysis, interviews, and literature reviews (Instefjord, 2014; Røkenes & Krumsvik, 2014; Tømte, 2013). However, the majority (7) of the purely qualitative studies report on specific digital practices or the applications of digital tools, e.g., video papers (Krumsvik & Smith, 2009), blogging (Kvåle & Rambø, 2015), online discussion forums (Strømman, 2015), or podcasting (Carson et al., 2021). Røkenes and Krumsvik (2014) pointed out that previous reviews and studies had lacked in the area of 'micro- or interactional levels focusing on show-casing daily teaching practices and activities with ICT' (p. 251). The many examples of such approaches in this review indicate that the research community in Norway has responded to this situation. The methods used vary, but they are mainly traditional qualitative approaches, such as interviews (individual and focus group), observations, as well as the analysis of written data.

The tool metaphor used in the quantitative and mixed methods studies described above also frequently appears in the qualitative studies. Firstly, this is visible in the fact that some sort of digital tool and its use in an educational setting is the topic or object of interest in most studies. Furthermore, when considering language and formulations, both in the discussions of findings and the questions asked in interviews or surveys, a focus on the use of digital tools prevails to a large degree. This is also the case for studies applying mixed methods, as shown above.

Some studies are also exploring the possibilities in digital technologies for generating data (e.g., online written material such as wikis or discussion forums and video and sound recording). This is relevant to the topic of digital competence and may represent an underutilised resource that might shed light on findings from self-reported data in quantitative surveys or interviews, either confirming or correcting them. The reflections of Brox (2017, p. 139) on the discrepancy between data derived from digital practice and data derived from interviews may serve as an example of this.

18.4.3 Theoretical Foundations

In addition to articles using different versions of the term 'digital competence' as their main theoretical framework, many different theoretical perspectives are used in the literature. This seems to be related to the different research focuses. Some articles apply theory concerning the specific theme or object of the study (e.g., self-efficacy and digital media ethics), while others apply theories to understand the implementation of ICT or digital competence (e.g., mastery and appropriation, TPACK espoused/in use, theory of action).

However, one theoretical tradition that stands out as remarkably more frequent than any other is socio-cultural theory. Some articles state this quite explicitly (e.g., Brevik et al., 2019; Helgevold & Moen, 2015), and the influence of various members of this theoretical family has served as the foundation for the most commonly used models and definitions of PDC developed in Norway (Krumsvik, 2011; Lund et al., 2014). The same is the case with the earlier development of digital competence in compulsory school (Erstad et al., 2005), which has influenced more recent work regarding teacher education.

18.4.4 Digital Competence Concept Development

A great deal of work in this field seems to be more focused on conceptualising and developing a definition of digital competence than on measuring it. Introductions, theory sections, and discussions contain many references to others work, as well as the authors' own attempts. Some explicitly write themselves into the ongoing development of PDC, while others may be understood as such due to the closely related theme or research object.

Several definitions and models are thoroughly presented in the articles covered by the review. However, theoretical and conceptual discussions and development apparently do not always appear in reports on empirical work. Hence, some important foundational articles have been excluded. To complement the discussion, we will comment on some of these, as well as providing some contextual information, in the following presentation.

ICT and technology tools, 2001–2009

In approaching the articles chronologically, the first finding is the nearly 'non-finding' of articles from the first half of the time span. The earliest published article included in the review is from 2009, and it is not until 2013 that regular publications on the topic appear. This lack of earlier articles is probably due to the way in which we narrowed down the literature search and chosen search terms. Searching for ICT or technology in teacher education may have returned more results. Nonetheless, regarding the focus on concept development, it is perhaps an even more relevant finding that, at an early stage, the term is hardly used at all. There are also indications of this in the literature, both through the references and in repeated descriptions of a field focused on technology and ICT in itself, as opposed to progress towards viewing it in relation to pedagogical or didactical objectives.

ICT as tool for teaching and learning, 2009–2015

In articles from this period, different international definitions and frameworks are frequently referred to, particularly Ferrari (2012), with a more general definition, and Koehler and Mishra (2009), with their teaching-oriented TPACK-framework. Another common point of departure is to connect this research area in teacher education to the introduction of digital skills into the Norwegian curriculum for compulsory school. In addition to international studies, the work of the Norwegian scholar Rune J. Krumsvik begins to gain some attention.

Explicit definitions of digital competence are either lacking (Helgevold & Moen, 2015; Helleve et al., 2013; Krumsvik & Smith, 2009; Kvåle & Rambø, 2015) or become unclear in the presentation of multiple perspectives (Instefjord, 2014; Røkenes & Krumsvik, 2014; Tømte, 2013). Still, the studies from this period reveal that the understanding of digital competence in the field is in a process of maturing, from one with a limited focus on learning to use digital tools into a more pedagogical orientation stressing that digital tools should support teaching and learning.

Towards a broader concept understanding, 2014–2017

There is no clear cut in this case, but during 2014 and 2015, a break in how the terms are used and applied seems to appear, moving towards a more complex and broader concept. The scholarly debate on concept development gains momentum, and a lot of work is done in a relatively short time span, visible in an increasing number of relevant findings in the literature search. There is a clearer awareness of the need to specify and define digital competence when studying it, as shown most clearly in Røkenes and Krumsvik (2016) application of one theoretical model of digital competence as an analytical lens in their study.

Krumsvik has published extensively in the field of digital competence, and was early in proposing how to define the concept, both in a general educational setting and in relation to teacher education (Krumsvik, 2008). The model was further developed in several articles (Krumsvik, 2008, 2011, 2014). In addition to elaboration in his own work, the model and concept definition also inform and inspire other studies. Though frequently cited (six times in this review), this definition seems not to have had the same practical impact as others. The model has several theoretical foundations, among them the TPACK framework and socio-cultural learning theory, especially situated learning, and describes four components of digital competence: *basic digital skills*, *didactic ICT-competence*, *learning strategies*, and *digital Bildung* (Røkenes & Krumsvik, 2016, p. 3). In earlier works (Krumsvik, 2008, 2011), the different terms at use in the field have been discussed. While skills, literacy, and competence are common in the international literature, the introduction of Bildung (Norwegian: dannelse) is a more distinct Norwegian or Nordic approach. The term has been important in Norwegian education and pedagogy generally, as well as being more specifically related to digital competence. Facing recent policy developments indicating a reduced emphasis, Krumsvik (2011, p. 49) argues for a continued and renewed central position for the concept. Digital Bildung includes aspects such as ethics, technology's effects on humans, and a general awareness of the various dilemmas and challenges in a digitised society. Hence, the model not only encompasses basic digital skills and important factors related to the educational setting but is also, through the Bildung term, attempting to capture a much broader perspective.

Other articles from the period are not as explicit in defining and applying PDC theoretically, but nevertheless raise discussions considering the even broader understandings of technology and education that are vital to the conceptualisation of digital competence (see Brox, 2017; Langseth & Haugsbakken, 2016).

The conceptual article *What Does Professional Digital Competence Mean in Teacher Education?* (Lund et al., 2014) was also published during these years but was not included in this review due to the empirical criterion. Nonetheless, it appears to be a milestone in the concept development and is frequently mentioned, used, and elaborated on in articles in the present review. It is referred to in as many as twelve out of twenty-two reviewed articles, and since 2017, this reference appears in all but one of the reviewed articles. However, this alone says nothing about how and the extent to which its content and thoughts on the subject are applied. In the article, the authors argue for a broader concept of PDC and a deeper understanding of digitalisation's implications for education. They touch on both societal and epistemic consequences and discuss how teachers and teacher education should respond to these issues. Theoretically, like Krumsvik, their approach draws on socio-cultural perspectives. A central point seems to be concretising the overall digital competence into a subject-specific understanding, i.e., identifying what challenges and possibilities new technologies bring into each school subject. Hence, they leave room for a specific and concrete exemplification of what this may look like in three subjects. The article's contribution is thus both in painting a broad picture and showing what this means in practice. In the conclusion of the article, the authors refute the notion that their intention has been to suggest a definition (Lund et al., 2014, p. 295). It is perhaps then not so surprising that the articles drawing most clearly on this article's 'definition' of PDC provide quite different citations or recapitulations (see Helleve et al., 2020, p. 327; Instefjord & Munthe, 2017, p. 37; Lund & Vestøl, 2020, p. 5; Thorvaldsen & Madsen, 2020, p. 5285).

Professional Digital Competence for Teachers, 2017–2021

The articles published since 2017 display a greater awareness of the broader questions at hand. Writers seem more likely to apply clear definitions, and there is a more mature understanding of the concept. Discussions of how teachers should deal with ICT, technology, and digitalisation seem to have led to a consensus around and an increased use of the term *professional digital competence* (PDC) as a distinct concept. While international frameworks continue to be mentioned, there is a growing impact on the part of work originating in a Norwegian context. This may be an indication that the conceptual discussions and work in the field in the preceding years have had effect.

However, the work continues, though more gradually, and the articles reflect several scholars' different attempts to define or refine existing definitions of the concept of professional digital competence for teachers. Gudmundsdottir and Hatlevik (2018, p. 217) present and use a three-pillar model of PDC that is inspired by the TPACK model (Koehler & Mishra, 2009) and accredited to Gudmundsdottir and Ottestad (2016). The three dimensions the model is made up of are *generic digital competence*, *subject/didactic digital competence*, and *profession-oriented competence* (for details, see Table 18.3). The authors state that the latter is what distinguishes the model from TPACK. Interestingly, the three-pillar model actually appears earlier, in the article *Professional Digital Competence in Teacher Education* (Ottestad et al., 2014). The article was not included in this review, due to its scientific status and lack of empirical material. The authors describe how it was *The Norwegian Centre for ICT in Education* that proposed the model and invited to scholarly debate and academic exploration (pp. 248–249). Hence, the model seems to originate from a joint effort initiated by the ICT-centre to develop and adapt the concept of digital competence to the teacher profession and teacher education. This illustrates how such concept development often is a result of the interplay between policymakers and scholars.

The three dimensions, though not equal, seem to correspond, to a large degree, with the first three components of Krumsvik's model. However, as compared to the way in which the Bildung dimension that overarches Krumsvik's model broadens the perspective, these three dimensions appear to be narrower. An attempt to broaden the concept is made by Brevik et al., (2019, p. 4), who build on the three-pillar model mentioned above by adding a fourth dimension named *Transformative digital agency*. This extended version of the model is found in three additional articles. In Gudmundsdottir et al. (2020) the model is combined with one other model to investigate various aspects of the responsible use of ICT, Lund and Vestøl (2020) narrow down to the fourth dimension in a more theoretical investigation of its analytical usefulness, while Carson et al. (2021) apply the fourth dimension in analysing a specific digital practice.

Some years later, the ICT-centre is once again contributing in this area through publishing a framework for teachers' professional digital competence in which the intention with the concept is said to 'indicate the complexity and breadth of knowledge, skills, and competencies in teachers' professional practice that are associated with understanding the opportunities and challenges in today's digital society' (Kelentrić et al., 2017, p. 2). Dividing PDC into seven competence areas, each with its own description and list of bullet points on knowledge, skills, and competence, certainly paints a broad picture of the concept. However, with no clear definition of PDC provided, the question remains whether this broad perspective simultaneously renders the concept unmanageable to apply in teaching practice or research. It is especially the framework's use of the term Bildung that corresponds with a wider perspective on PDC. This term has played a role in school policy in Norway, both historically and in the current curriculum and, as mentioned above, it is also part of Krumsvik's model. The concept has been the subject of scholarly debate, as has its application to the digital arena. Some find it useful in limited areas, e.g., in relation to ethical issues or critical thinking, but it could also be argued that this concept is well suited to comprehend the broader dimensions of digital competence. At least this seems to be what Krumsvik is attempting by making this term the overarching dimension of his model. Kelentrić et al. (2017) use the term both in general terms and in connection to the specific dimensions of 'School in Society' and 'Ethics'. In the glossary attached to the framework, they provide a definition for digital Bildung that implies a very broad function similar to that of Krumsvik:

> Digital bildung is a term closely related to the German notion of Bildung and tradition of self -cultivation, and as such is often used as an English translation for the Nordic concept of digital dannelse. Digital bildung refers to the integrated development of the individual as a whole person, maturing in a digital culture. It therefore entails actively developing a person's social, cultural, and practical competence in interaction with the digital environment, and being able to link their own digital experiences to the world around them. It also entails a personal maturity, that enables each individual to act in line with social expectations and ethical norms in a digital culture, as well as to reflect critically, and make well-considered and independent decisions. (The Norwegian Centre for ICT in Education cited in Kelentrić et al., 2017)

Surprisingly, to judge by the low numbers of citations in this selection of articles, the framework does not seem to have had much impact in the research field of teacher education. It is only cited in two of the articles. Brevik et al. (2019) mention the framework as an example of the fact that '… PDC is now a well-known concept in Norway' (p. 2). However, as shown above, other definitions and frameworks are actually used in the article. The framework is also brought in by Helleve et al. (2020). They interestingly state that it does *not* define the concept (p. 327) and still later refer to a definition comprised of the design of learning processes, evaluation, and technology selection (p. 333). Though seemingly contradictory, the authors have chosen to focus on some of the many bullet points. Due to the comprehensiveness of the framework, such a selective approach may be the most fruitful way to put it to use and, hence, an understandable solution.

Another suggested model for PDC, the PEAT model, is presented briefly in Gudmundsdottir et al. (2020, p. 3). The model is developed within a European project (Dicte, 2019) to which Norwegian scholars contributed. Similar to the three (four) pillar model, this model is also comprised of four dimensions, though these are different: *pedagogical*, *ethical*, *attitudinal*, and *technical*. The most striking difference is the emphasis on ethics and attitudes, and these are also the dimensions the study focuses on. In the article, the authors argue for a view that the issues of responsible use are transversal skills across all dimensions of the three (four) pillar model. However, this appears as attempting to 'save' the model, which actually seems to lack some dimensions that both the PEAT model and the Krumsvik model have.

Thorvaldsen and Madsen (2020) do not propose some definition or model but, rather, refer to the definitions of Tømte and Olsen (2013) and Lund et al. (2014), and from these, they derive 'three defined aspects of PDC: pedagogic and didactic understanding, subject-specific understanding, and technological understanding' (p. 5285).

A concept outgrowing the field?

The various definitions, frameworks, and models presented in the articles have many similarities. They all stress the importance of exceeding a narrow understanding of digital competence as generic or basic skills. There also seems to be agreement on the fact that the move from isolated skills in using digital tools towards an emphasis on the pedagogical use of ICT for teaching and learning was an important development. However, this is where differing views become more visible. Where some scholars seem to see this as enough, others argue that this is also too narrow a view. Hence, there is variety in the arguments regarding and descriptions of what should constitute such a broader understanding. As shown above, the term Bildung is one approach that both Krumsvik and *The Norwegian Centre for ICT in Education* have proposed. The term entails aspects of ethics, attitudes, communication, creation, and production and is rooted in a larger perspective on students becoming part of a digital culture (Kelentrić et al., 2017).

Another argument for the broader perspective is found in the need for a deep technological understanding. This is foundational in the work of Lund et al. (2014) but also an important part of several discussions in other articles (e.g., Brevik et al., 2019; Brox, 2017; Langseth & Haugsbakken, 2016). Despite not always containing an explicit link to common notions of digital competence, these articles still bring up important discussions about the implications of digitalisation for education and the challenges the field faces when attempting to relate to constantly evolving technologies. The limitations to this deeper understanding caused by the commonly used tool metaphor have been pointed out by several authors. 'Technologies that do not act according to plan, provide resistance or fail to deliver improved learning outcomes will be dismissed in favour of well-trodden paths and reproduction of existing practices' (Brox, 2017, p. 139). The work on digital agency by several scholars (see Brevik et al., 2019; Carson et al., 2021) is also aware of such challenges. Lund and Vestøl (2020, p. 1) write that 'Digitalization does not merely result in powerful tools at our service but materialises in objects with intentions that interfere with and even override human decisions'.

The speed of technological development is also obviously an important part of the challenge of defining digital competence. What seemed, at the moment, to be an important tool or practice may not be shortly thereafter. The need to develop a concept that emphasises more general dimensions, without becoming entirely theoretical, is therefore evident. One article put it as this in a concluding remark:

> By the time they enter the classroom as teachers, tools may already be outdated. Focus should therefore be directed away from mastery of tools themselves and towards appropriation of a digital competence that embraces awareness of how technology can be used critically and reflectively in the process of building new knowledge. (Instefjord, 2014, p. 328)

This speed may also lead to a problematisation of the ideal of research-based and theory-informed teaching practices, as Langseth and Haugsbakken (2016, p. 62) write that 'research says much about what has promoted formal learning, less about what promotes learning in today's and tomorrow's technology informed educational cultures'.

Following the chronological development outlined above, one can see that broader perspectives are becoming more common in the field, both in explicit concept development and through discussions. Despite this, the tool metaphor persists in terms of both language and research focus. This is evident in both quantitative (questions asked) and qualitative studies (descriptions, case selection). One example of this apparent discrepancy appears when Røkenes and Krumsvik (2014) both communicate a broad understanding of digital competence and related concepts and, simultaneously, leave it unclear whether PDC is understood as equal to ICT for learning. Phrases such as the 'use of ICT' and the 'use of technology in teaching' appear frequently in the review. This may be due to the historical nature of a literature review, and the fact that much of the reviewed research has been inclined towards such an understanding. However, we see the same tendency in other, newer studies as well. Instefjord (2014) maintains a broad understanding of digital competence in the introduction but chooses to focus on 'the development of digital competence as a tool for teaching and learning' (p. 315), and even recent studies employ similar 'tool-language' (e.g., Bader et al., 2021; Thorvaldsen & Madsen, 2020).

One possible explanation for this discrepancy can be found in the impact of socio-cultural perspectives, in which the use of tools or artefacts has been essential in understanding learning (Helgevold & Moen, 2015, p. 40). As shown above, this theoretical tradition has informed and influenced the field of digital competence in the Norwegian setting. Another explanation could be that the theoretical concept development precedes the empirical research. If so, what we observe is a field still in the process of adapting both teaching and research practices to the broader concept understanding. A different approach, however, could be to question the problematisation of the narrowness of tool language. Perhaps broader perspectives, in more general terms, serve best as underlying and legitimising the use of ICT in schools, while the most useful focus in school practice and school development is focusing on questions regarding how to use ICT, as a tool, in good pedagogical and didactical ways. Nonetheless, the words and metaphors we use are important; hence, one should be aware of the risks discussed here.

18.5 Conclusion

The extent to which the studies define the term 'digital competence' varies, but some trends regarding how the term has developed over the years are evident. This development tends towards more concise definitions of digital competence and a more solid theoretical foundation. The earliest articles in the selection mention digital competence, with few if any references to theoretical frameworks, while more recent studies draw upon extensive concept development, both international and, increasingly, national. Based on the earliest findings in the review search, the 2009–2015 period, the research is, to a great degree, tool oriented. The focus is on testing and researching different applied tools and discussing didactics related to the experience gained through this.

From 2014 to 2017, a greater awareness of the professional complexity of digital competence in education emerges. The discussions, to a greater degree, concern the transformation of education due to digital technology, not how digital technology can supplement, improve, and enhance traditional teaching. In 2017, the term 'digital competence' is explicitly context-defined for teachers, as professional digital competence is introduced through the *Professional Digital Competence Framework for Teachers*. This framework defined an extensive and complex understanding of teachers' professional digital competence. The TPACK-framework (Koehler & Mishra, 2009) appears to represent a recurrent framework when Norwegian researchers are conceptualising and defining digital technology, even though theory development by Norwegian researchers seems to increasingly take the place for this and other international frameworks. In different ways, they aim for concepts and definitions that are broad and include the multitude of challenges and possibilities created by digital technology development.

However, there are several dilemmas arising from this. One is that the broad understanding of PDC makes measurement a difficult task, which is shown in the review of methods. There also seems to be a challenge in establishing a coherence between theoretical foundations and actual research. Claiming that digital competence is more than tool use but then going ahead and investigating exactly this is clearly incoherent. Hence, finding ways to both develop and, if possible, measure aspects of PDC that reflect broader perspectives is required. Regarding measuring of digital competence, this review also points out the frequent use of self-reporting. Further research may benefit from combining this with other approaches that measure and test actual practices or skills.

While digital competence, as an important aspect of teachers' professional competence, has gained attention in both empirical research and conceptual development, this review reveals that an important subgroup, pre-school teacher students, seems to be less prioritised. Further research should investigate PDC in this area in terms of policy, practice, and concept development. Research concerning some more recent developments in technology and education was surprisingly absent in the articles. The establishing of Future Classroom Labs in several Norwegian teacher education institutions would have been a relevant research area regarding teachers' PDC. Computer gaming and VR (virtual reality), two technologies gaining increased attention in schools, are not mentioned either. These are all areas that further research concerning pre-service teachers' digital competence should investigate.

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Chapter 19
Understanding Digital Literacy, Digital Competence, and Pedagogical Digital Competence: Implementing Online Teaching for Filipino Tertiary Educators During COVID-19

Vivencio O. Ballano, Nicolas T. Mallari, and Raul Roland R. Sebastian

Abstract This chapter aims to trace and clarify the meaning of digital literacy (DL), digital competence (DC), and pedagogical digital competence (PDC) in the global literature, as well as their relevance to the Filipino tertiary education teachers' PDC during the current COVID-19 pandemic that suspended face-to-face classes in favor of flexible, blended, and online teaching as mandated by the Philippines' Commission on Higher Education (CHED). It also examines the major obstacles that hinder the development of the Filipino teachers' PDC to be able to implement the CHED's long-distance learning requirement as part of its recommended flexible learning to minimize COVID-19 infection. Using a systematic literature review as the primary method and peer-reviewed journal articles, reports, and books as sources of textual data, it argues that responding adequately to the CHED's teaching mandate during the pandemic requires addressing the problems of lack of logistical support for teachers and students, such as weak and unstable Internet connection and lack of access to digital devices and educational technologies. It also needs to strengthen institutional support for information communication technology (ICT) infrastructure in colleges and universities and teachers' ICT training to enhance their PDC and attitude toward online and long-distance learning. This chapter recommends that the Philippine government through the CHED must encourage more studies to understand fully the implementation barriers to improve the Filipino tertiary educators' PDC during the current COVID-19.

Keywords Digital literacy · Digital competence · Pedagogical digital competence · Digital technology · Online learning · Flexible learning · Philippines

V. O. Ballano (✉) · N. T. Mallari · R. R. R. Sebastian
Polytechnic University of the Philippines (PUP), Manila, Philippines
e-mail: voballano@pup.edu.ph

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19.1 Introduction

The Novel Corona Virus disease (COVID-19), which originated from Wuhan, China, and became a global public health emergency on January 30, 2020, has caused unprecedented deaths and distress to everybody across the world (Klapproth et al., 2020; Singhal, 2020). Undoubtedly, aside from deaths and disruption of the economy, the COVID-19 pandemic has created the greatest disturbance of education in human history. To control the spread of the disease, governments around the world implemented lockdowns, temporarily closed schools, and implemented social distancing that affected greatly the daily routines and activities of students (Lee, 2020).

Because of its highly contagious nature, governments around the world suspended classes in the early part of 2020, resulting in the displacement of 98.6% of students around the world or 1.725 billion students from pre-school to tertiary education in 200 countries (United Nations, 2020). The mode of instruction largely shifted abruptly from face-to-face to online classes that heavily utilize digital technology. Indeed, the global pandemic has prompted schools to change their teaching strategies and adopt remote teaching that attempts to provide students with quality like physical teaching (Vaataja & Ruokamo, 2021). Thus, tertiary education institutions started to apply emergency education through different online platforms, which are unfamiliar to many teachers. Many schools, colleges, and universities have discontinued face-to-face instruction and were compelled to create and introduce alternative teaching strategies (Pokhrel & Chhetri, 2021).

This led to the adoption of a teaching orientation that mostly depend on digital technologies "to design learning environments that supported pedagogical practices involving students' collaboration, problem-solving, and knowledge-construction" (Butler et al., 2017, p. 236). Thus, the online and blended learning and teaching methods that largely depend on digital platforms such as Microsoft Teams, Google Classroom, Canvas, and Blackboard were used by tertiary educators for their courses, training, and skill development (Petrie, 2020). Pokhrel and Chhetri (2021, p. 135) also claimed "workplace chat, video meeting and file storage that keep classes organized and easy to work, as well as sharing of a variety of content like Word, PDF, Excel file, audio, or videos and many more, were also used by educators… to track student learning and assessment by using quizzes and the rubric-based assessment of submitted assignments."

The Philippines as one of the most hit countries by the COVID-19 pandemic is not exempted from this disruption in the school calendar and shift in pedagogical orientation. The country's educational system was in turmoil when President Rodrigo Duterte suspended physical classes in the remaining days of the school year 2019–2020 to prevent the increase of COVID-19 cases in the country (Al-Lily et al., 2020). Thus, more than 28 million learners in various academic levels were required to remain in their homes and follow the Philippine government's quarantine policies (UNESCO, 2020). And around 3.5 million students who were enrolled in around 2,400 higher education institutions (HEIs) were compelled to follow the government's new directives on long-distance and online learning methods (Joaquin et al., 2020). These can include some adapted forms of online learning such as "synchronous, real-time lectures and time-based outcomes assessments, or asynchronous, delayed-time activities, like pre-recorded video lectures and time-independent assessments" (Oztok 2013).

To provide a uniform learning method to colleges and universities in the country during the pandemic, the Commission on Higher Education (CHED), the Philippines' regulating body for tertiary education, released the Memorandum Order No. 4, series of 2020, to encourage all higher education institutions (HEIs) of the country to implement the flexible learning (FL) method in holding classes during the pandemic to minimize the risk of infection (CHED, 2020). Although the CHED's FL allows the use of modules and other non-online teaching methods, any HEIs adopt the "delivery methods of long-distance learning and facilities of educational technology, availability of devices, internet connectivity, level of digital literacy, and approaches" (CHED 2021, III. Definition). Thus, it requires the application of a student-centered approach, relying on digital technology and higher digital literacy (DL) for teachers who are expected to deal with young students in HEIs who are considered digital natives of the latest technology (Prensky, 2001).

As the world shifts to long-distance and online learning using digital technology when the COVID-19 pandemic struck in early 2020, the digital literacy (DL) of teachers became crucial for higher education to prevent the spread of the Coronavirus. Digital technology has become a pedagogical tool for many Filipino teachers with the growing digitalization of higher education in the Philippines. In the current technological age, "colleges and universities are now populated with students who have never experienced a moment of their existence without the presence of digital technology in most, if not all, aspects of their lives" (Medrick et al., 2016, p. 327). As Vaataja and Ruokamo (2021, p. 1) argue, "The current generation of youth is being educated in a world filled with digital technologies that shape everyday life." Thus, the CHED's FL method encourages HEI educators to continuously rethink their pedagogical practices (Sailin & Mahmor, 2018) and to apply digital technologies in instruction to enhance student responsibility, cooperation, and activity in learning (Butler et al., 2017). The adoption and utilization of digital educational technologies require teachers to acquire a higher level of digital literacy (DL), digital competence (DC), and pedagogical teaching competence (PDC) to be able to teach in long-distance and online platforms. But what precisely is the meaning of these terms for Filipino college teachers who are still struggling to cope with the emergency of shifting their teaching method from face-to-face teaching to long-distance or online teaching?

As a developing country, the Philippines' online education that requires digital skills for tertiary education teachers is still in progress. Clarifying DL, DC, and PDC in relation to digital teaching in tertiary education has not been well explored in the current educational research in the country. Describing and understanding the Filipino teachers' understanding of DL, DC, and PDC and their capability to implement the long-distance component of CHED's FL method during the current COVID-19 pandemic has not been explored in the literature. There is also a paucity of information on how online courses are assessed by faculty members (Moralista &

Oducado, 2020). Thus, using a systematic analysis of some relevant global literature on the DL, DC, and PDC, this book chapter aims to provide an overview of the meaning of these concepts in relation to online learning and to explore how these concepts resonate with the Filipino tertiary education teachers' experience, the major obstacles in enhancing them, and how they affect their ability to implement the CHED's mandate on online teaching and learning as part of the FL method.

This chapter consists of two major sections aside from the introduction and methodology. The first section provides an overview and clarifies the meaning of using the global literature. The second section is concentrated on how these basic concepts can be measured and applied to the Philippine educational environment and Filipino teachers' experience vis-à-vis the CHED's mandate to adopt long-distance learning during the current COVID-19 pandemic. It also examines the major obstacles in enhancing teachers' digital pedagogical competency that hinder them to respond to the requirements of online learning during the pandemic. It argues that despite the growing improvement of the PDC of Filipino tertiary teachers and their willingness to adapt to the online and long-distance learning system despite logistical and institutional obstacles, the state of digital education in the Philippines still lags behind in enhancing tertiary education with the necessary PDC and proper attitude to respond adequately to the challenges of the COVID-19 pandemic.

19.2 Method

This study applies the systematic literature review method. In its initial literature search, the authors searched for existing reviews, familiarized themselves with the research field, identified relevant databases and search terms, and formulated a search strategy to find the relevant online materials for the study (Booth 2016). The strategy and search terms were generated from the aims and questions. Peer-reviewed journals that deal on digital literacy and competence, pedagogical digital competence, online learning, and the Philippine government's program for flexible learning for higher education teachers from 2015 to 2021, with a special focus on literature that deals with online learning during the COVID-19 pandemic, were scrutinized and analyzed to achieve the chapter's objectives.

19.3 Understanding Digital Literacy, Competence, and Pedagogical Digital Competence

19.3.1 Defining DL and DC

The term DL started in the United States (US) with the publication of the book *Digital Literacy* by Paul Gilster in 1997. This book first defined the skills necessary to critically deal with information in an increasingly digital world (Pangrazio, Godhe, & Ledesma 2020). DL has been defined in various ways, but it is usually "associated with the identification and treatment of information, the creation of content, communication, and the safe use of digital tools" (Esteve-Mon et al., 2016, p. 818). It is related to the "use of information, content creation, communication, and safety in digital tool use" (Esteve-Mon et al., 2016, p. 818). To Gilster, DL is "the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers" and, particularly, through the medium of the Internet (Gilster in Pool, 1997, p. 6). To Pangrazio et al. (2020, pp. 453–54), DL "refers not only to the skills and capacities required to use digital texts, but also a disposition toward the digital that is both critical and creative." It includes the identification and treatment of information, the creation of content, communication, and the safe use of digital tools (Covello, 2010; Gilster, 1997).

Conversely, the word "literacy" in DL primarily refers to the ability to read but with the growing digitalization of society, its meaning has been expanded to refer to DL and DC (Buckingham, 2006). Although it is not directly synonymous to literacy, "the notion of competence is often used in a similar way as literacy" (Johanessen, Øgrim, & Giaever 2014, 301). Thus, Hatlevik and Christophersen (2013) aptly observed that DL and DC are often used interchangeably by scholars since their meanings overlap to some degree. Albeit with distinctions, education scholars tend to use DL as related to the concept of DC (Tyner, 1998). Both terms are used as in education literature as broader terms that incorporate skills, understandings, and critical reflections (Erstad, 2010). The European Digital Competence Framework (DigComp), which was published in 2013 and revised in 2016 and 2017, describes the DC of citizens as the application of digital technology in professional life (Ferrari, 2013; Carretero et al., 2017), while the European Framework for the Digital Competence of Educators (DigCompEdu), which was published in 2017, describes the DC as specifically related to the teaching profession (Redecker, 2017). With the growing digitalization of society, teachers are expected to possess a certain degree of competence in using digital technology for student learning.

DL is often used synonymously with the term DC, which is widely used internationally, especially in European contexts (Ferrari, 2012). DC is also interpreted as "acquiring the skill, ability, and knowledge to use computers and their applications, as well as software in teaching" (Medrick et al., 2016). The positive attitudes of teachers toward their competence in using computers will affect how they deliver knowledge to the students (Huang & Liaw, 2011). One study by Gasaymeh (2009) that explored the relationship between the faculty members' attitudes toward Internet-based distance education and their perceptions of their level of computer and Internet skills, and perceived value in online education indicated that faculty members tended to have moderately favorable attitudes toward Internet-based distance education. Thus, acquiring computer and Internet skills is crucial for teachers' DC to achieve satisfactory online teaching.

19.3.2 Teachers' DC and PDC

The DC for teachers is different from non-teaching professionals. A digitally competent teacher is one "who possesses the abilities, attitudes, and knowledge that are needed to engender true learning in a context that is enhanced by technology" (Hall et al., 2014). DC is a term that has evolved over the last few decades, though it has always been associated with the various literacies of the new media (Lankshear & Knobel, 2008). Existing literature reveals that DC for teachers is a relative term with respect to time and context. Education researchers define it in various ways (Krumsvik, 2009). Thus, there is no uniform view on what constitutes DC among education researchers who specialize in teachers' competence in the use of digital technologies for student learning (Johannesen et al., 2014), although the national curriculum can play a crucial role in defining the school's method in using digital tools and teachers' DC for learning (Johannesen et al., 2014).

A teacher's DC can consist of "a set of skills, abilities, and attitudes that the teacher must develop to incorporate digital technologies into their practice and professional development" (Lázaro-Cantabrana et al., 2019, p. 1). To Medrick et al., (2016, p. 327), DC can also refer to the teacher's adequate practical knowledge of digital skills as well as theoretical applications for integrating educational technology in the classroom. Teacher's DC involves "more than just the ability to use software or operate digital devices and involves a large variety of complex skills – cognitive, motoric, sociological, and emotional – users need to have in order to use digital environments effectively" (Eshet-Alkali & Amichai-Hamburger, 2004, p. 421). It is "not only having certain abilities, knowledge, and attitudes but also the capacity to put these in action and mobilize them in a certain educational context" (Esteve-Mon et al., 2016, p. 818).

In relation to the use of information communication technologies (ICSTs), the teacher's DC is not only learning the basic skills, tools, and expertise in digital technology but also knowing learning strategies in an educational setting (Johanessen et al., 2014). Thus, the concept of pedagogical digital competence (PDC) was conceived to refer to the teacher's knowledge, skills, and attitudes, as well as technology, learning theory, subject, context and learning, and the relationship between them in education (From, 2017). It implies a higher level of DC that affects the attitude, knowledge, and educational use of ICT for teaching and online learning (From, 2017). Thus, it is related to both technological knowledge and its didactic use (Rivera-Laylle et al., 2017). In today's technological age, it is expected that teachers should acquire adequate PDC skills to be able to use ICT for online teaching. They are expected to possess some basic digital and pedagogical skills to deal with certain situations in the learning and teaching profession (Lund et al., 2014). Thus, educators are expected to enhance their PDC and that of their students (Insteford & Munthe, 2017). However, despite the popularity of digital devices and educational tools, educational institutions and teachers are still struggling on how to "integrate technologies into the curriculum and prepare students for their (digital) futures" (Pangrazio et al., 2020, p. 443). Thus, university faculty must update their PDC and must be adept with the new methodologies in their academic specialization. It is "incumbent on the educational professionals to preserve, improve and update their level of digital competence, and so improve learning and teaching" (Mirete et al., 2020, p. 1). The faculty is expected to acquire the attitude, knowledge, and educational use of Information Communication Technology (ICT) for teaching and online learning (From, 2017).

19.3.3 Measuring DC and PDC

Measuring Teachers' PDC has no universal and uniform criteria and instruments in the global literature. In recent years, instruments or models have been developed to measure the level of technological competence and PDC of teachers. Martínez and Vidal (2015), for instance, created a self-perception instrument for teachers called INCOTIC which mediates the use of ICT: "INCOTIC-Grado aims to improve these processes by implementing the fundamental initial action of getting university students to diagnose their own digital competence. This initial step, which must be carried out before the teaching is planned, will enable [teachers] to determine what knowledge students consider they have already acquired at the beginning of their university degree" (Martinez & Vidal, 2015, p. 35). This INCOTIC tool can guide educators in planning their ICT-mediated instruction (Martinez & Vidal, 2015).

Another instrument, which is called the TPACK model (Technological Pedagogical and Content Knowledge), was created by Koehler and Mishra (2009) to describe the complex skills that teachers need to integrate digital tools for learning. This instrument is only one of the many methods used by scholars to describe digital skills teachers ought to possess to integrate DL into the learning processes. Its primary focus is for teachers to learn technological knowledge, as well as comprehension of content and pedagogy. In short, the TPACK model traces the educators' use of integrated technology to know other subject areas (Johanssen et al., 2014). To Cox and Graham (2009), the TPACK model is essential for educators to enhance their digital knowledge in a setting that maximizes their digital skills (Guillén-Gámez et al., 2021).

Aside from education scholars proposing instruments and models to measure teachers' PDC, state educational authorities also formulated frameworks to understand and measure DC in education. The European Framework for the Digital Competence of Educators (DigCompEdu), for example, details 22 educator-specific digital competencies organized in six areas to measure PDC. Its core is represented by areas 2–5, in which technologies are integrated into teaching in a pedagogically meaningful way (Redecker, 2017). Area 6 (Facilitating Learners' Digital Competence) is said to complete this framework "by highlighting that a digitally competent teacher should be able to promote information and media literacy and integrate specific activities to enable digital problem solving, digital content creation and digital technology use for communication and cooperation" (Ghomi & Redecker, 2019, p. 542).

Lastly, most of the research on teachers' PDC in the scientific-educational literature focuses on discovering the educational use of ICT for faculty (Ahmed et al., 2016; Amhag et al., 2019). Mercader and Sallan (2017), for example, have analyzed how teachers used ICT in instruction. Using a sample of 527 professors, they discovered that the tools that most teachers use are virtual presentations (97%) and LMS, such as Moodle or the Virtual Campus of universities (89.2%). Less than 40% of the teachers indicated that they use blogs, wikis, or social networks in their classes. In the same context, Barak (2017) used a sample of 52 science teachers and concluded that almost 40% of them used asynchronous online forums, with other less popular applications in the cloud, such as wikis, blogs, and social networks (45–25%) (Guillén-Gámez et al., 2021). In sum, to track down the teachers' PDC is indeed difficult with the diversity of teaching strategies teachers used in their digital teaching.

19.4 Filipino Tertiary Educators' PDC and Online Learning

The Philippines as a developing country has not escaped the growing digitalization of education in contemporary society. The rising Internet usage in the country rose from 9% in 1998 to 35% in 2014 (Labucay, 2014). Toward the end of the decade, with a population of about 106 million Filipinos in 2018, the Internet utilization of the population further increased to 62–63% or about 67 million Filipinos are considered Internet users (Estella & Löffelholz, 2019). In the field of education, this rising use of the Internet in the country also serves as a milestone that opens wide range of teaching and learning opportunities for the faculty and students (Lorenzo, 2016). Some studies suggested that the use of digital technology in teaching and online learning have slowly advanced in the field of education (Ma'arop & Embi, 2016; Matheos & Cleveland-Innes, 2018; Olelewe & Agomuo, 2016). Specifically, online instruction and learning are increasing among teachers in higher education (Forbes, 2016; Porter et al., 2014; Minty-Walker et al., 2017). Although there is an intensive study on online learning in tertiary education, it remains unclear, however, how educators engage themselves in the sudden shift to online or remote learning during the COVID-19 pandemic. In the Philippines, studies measuring the DL and DC of teachers in tertiary education in response to the COVID-19 pandemic are limited (Tarrayo et al., 2021).

The use of online learning in the Philippines is still new to many tertiary educators in the Philippines who are still socialized in conventional teaching and learning environment (De la Pena-Bandalaria, 2007), although Ocak (2011) is optimistic that transforming teachers' PDC and attitude toward online teaching and learning can still be enhanced. Thus, some education researchers agree that exploring the faculty's teaching and learning satisfaction toward online teaching should be explored (Martins & Nunes, 2016; Previtali & Scarozza, 2019; Selim, 2007) as most of the teachers' concerns on how to utilize online and blended learning methods were not sufficiently documented (Stacey & Gerbic, 2008). In the Philippines, there is a variety of approaches and frameworks in measuring teachers' PDC in tertiary learning approaches. While studies on online learning have been extensive, it remains unclear, however, how educators engage themselves in the sudden shift to online learning and long-distance education using digital technology to address the educational challenges brought about by the COVID-19 pandemic (Tarrayo et al., 2021).

Despite the general lack of research and documentation on the Filipino teachers' PDC and application of digital teaching in HEIs in the Philippines during the pandemic, some studies have indicated that some top private colleges and universities were able to integrate ICT and PDC in their response to COVID-19. One of the top Catholic universities in the Philippines, De La Salle University (DLSU), for instance, has resorted to blended and remote online learning during the pandemic, which combines both synchronous and asynchronous activities with some flexible options for students such as modules to complete their course requirements throughout the school year (De La Salle University, 2020). Another Catholic university Ateneo de Manila University also engages its faculty in online learning and provides some options to their students besides online classes to learn offline at their own pace (Villarin, 2020). Although these universities did not completely resort to online teaching and learning to address the pandemic, it did indicate that their teachers' PDC was heavily utilized in their online teaching system. Thus, the concept of blended learning, not wholly remote teaching, has been utilized by these HEIs during COVID-19, allowing other options for students who cannot cope with online learning. This is also true to other private colleges and universities in the country such as St. Scholastica College, University of Santo Thomas (UST), STI College, Adamson University, Far Eastern University (FEU), University of the East (UE), Ateneo de Davao University, and University of San Carlos (USC) (Joaquin et al., 2020, pp. 1–2).

The use of online and long-distance learning that requires a higher level of DC and PDC is not well utilized in public and state HEIs compared to top private institutions in the Philippines. State universities and colleges (SUCs) in the Philippines which offer free tuition fees and are generally located in the provinces, catering to students who are mostly come from lower classes, do not engage much in online teaching that requires a higher level of teachers' PDC. Although many faculty members in SUCs expressed a strong willingness to engage in online classes, limitations in Internet connectivity and access to digital devices have become common problems that hinder a higher engagement in online teaching and learning as encouraged by the CHED. A study by Callo and Yazon (2020), for instance, in Laguna State Polytechnic University

(LSPU) using quantitative research indicated that faculty and students are prepared for online teaching in case the pandemic continues, but they recommended that the institution should provide a series of training for teachers as a capacity building to enhance their PDC, especially equipping them with knowledge and competencies on the use of digital technology in teaching and learning.

19.5 Obstacles in Enhancing Filipino Teachers' PDC and Implementing Online Learning

In recent years, online learning has experienced significant development due to its flexibility in delivering instruction. The rapid adoption of information and communication technologies (ICTs) is an indication that new forms or approaches of teaching and learning are possible (Jeffrey et al., 2014). HEIs are now envisioning the role of ICTs in the teaching and learning environment. At the university level, Kuo et al. (2014), for instance, argued that blended learning that uses online teaching is now becoming one of the most popular teaching methods for teachers in HEIs. Thus, Filipino tertiary education teachers are expected to have a higher level of PDC to be digitally competent in their online classes than their students during the COVID-19 pandemic to assure quality education. As already mentioned, there are no uniform and universal methods of measuring teachers' PDC. Existing research and literature have revealed that Filipino teachers in HEIs have weak PDC which can also greatly affect the quality of their online teaching to their students. Digital pedagogical competencies are usually the skills teachers need to integrate digital technologies successfully into their teaching.

19.5.1 Logistical Problems

One primary obstacle to developing the Filipino teachers' PDC has something to do with logistical problems that are related to access to digital technology and devices and Internet connection. An ideal online learning under the flexible and online learning requires that both the teachers and students have adequate digital tools and devices, DC, as well as strong and steady Internet connectivity. In the Philippines, ownership of digital devices, poor digital infrastructure, and weak and expensive Internet connections for poorer teachers and students are common logistical problems that greatly impede the implementation of the CHED's long-distance learning. It is widely acknowledged that digital technology should have a significant presence in higher education to enhance teachers' PDC (Selwyn, 2016). "Technology provides structural measures through learning management systems as well as online platforms in order to increase collaboration and communication between students as well as between students and faculty" (Gudmundsdottir & Vasbø, 2017, pp. 1–2).

Although the world has witnessed an exponential growth in the use of digital technology in tertiary education, developing countries such as the Philippines are still lagging in this aspect. Computer and Internet access, as well as the use of digital technology in education, remain perennial issues in the country: serious logistical problems, inadequate financial assistance, structural capability, human resources, management support, as well as behavioral factors are perennial problems in online learning are fundamental challenges to tertiary education (Dotong et al., 2016). Internet connection in the country is both an issue and challenge not only for the students but also for teachers and the institution (Asio et al., 2021). In fact, there are still areas in the Philippines, particularly in rural areas, where a reliable supply of electricity and Internet is miles away to achieve.

Thus, access and connectivity issue in the use of digital technology greatly "inhibits and affects the capability of teachers to become skillful on the use of ICT in blending with teaching and learning" (Alvarez, 2020, p. 116). As Tanucan et al., (2021) argue, implementing long-distance learning during the pandemic can be hampered by the perennial problems of weak Internet connection and poor digital infrastructure and technologies in the country. Indeed, these logistical problems can obstruct the enhancement of teachers' PDC and the full implementation of the CHED's online learning in the Philippines especially during the COVID-19 pandemic, resulting in weak or modest readiness of schools to implement various modalities of remote education (e.g., Alea et al., 2020; Mallillin et al., 2020).

But implementing online learning that integrates digital technology in teaching can still be feasible for Filipinos as they are among the top users of the Internet and social media in the world (Baclig, 2020). Faculty members in HEIs have shown moderate readiness to engage in online learning with their students (Mallillin et al., 2020). This can be enhanced, however, if teachers are given adequate and appropriate training in digital technologies (Koehler et al., 2013). A study done by Alea et al. (2020) during the initial stage of the pandemic in the Philippines, for instance, revealed that Filipino teachers and students expressed their "readiness to switch to distance learning education; however, they felt hampered due to lack of facilities, equipment, and capacity building to distance learning education" (p. 141).

19.5.2 Preference for Face-To-Face Teaching

Another primary obstacle is the preference of tertiary educators for face-to-face teaching despite the shift to online education because of the pandemic. Apelgren and Olsson (2010, pp. 30–31) argued that PDC has six aspects that are crucial for online teaching, namely, attitude, knowledge, ability to adapt to the situation, perseverance, and continuous development (Vaataja & Ruokamo, 2021, pp. 2–3). "PDC is connected to teachers' knowledge, skills, and attitudes in relation to digital technology, learning theory, and context" (From, 2017, p. 47). Several studies have shown that many Filipino teachers still prefer physical classes to online classrooms, indicating their lack of preparation and the necessary PDC skills for online teaching.

The change from face-to-face pedagogy to online learning has challenged instructors' and students' ability to adapt to the new digital technologies (Mok et al., 2021, p. 4). In the Philippines, the ability of tertiary education to enhance the students' online learning is dependent on teachers' PDC in handling digital educational technologies during the pandemic. Thus, in one study by Cabauatan et al. (2021) among 236 faculty members in a comprehensive university in the Philippines, for instance, revealed that although most of them owned a computer with a high 96.61 Internet access, they still lacked confidence in handling online classes and preferred the traditional approach of face-to-face classes, thus showing a low attitude toward online teaching that is demanded by the CHED to respond to the pandemic.

This is also illustrated in another study by Moralista and Ocudado (2020, p. 4736) which showed that teachers have low attitudes toward online teaching and still expressed a preference for physical classes despite having an intermediate computer competency. To them, online education is prone to academic dishonesty, lacking in personal touch compared to face-to-face classes, and difficult to handle in terms of technology. Also, they felt a feeling of "unnaturalness" in online learning as revealed in some studies (e.g., Larreamendy-Joerns & Leinhardt, 2006; Aldan & Anwar, 2020). Other studies also revealed the faculty's skepticism and confusion concerning online education that can hinder blended learning developments (Jobst, 2016; Ooms et al., 2008; Wingo et al., 2017).

This negative view concerning online education and preference for face-to-face classes is related to their lack of knowledge and training on ICT integration and poor digital infrastructure in many schools (Aldosemani et al., 2018; Benson et al., 2011; Tshabalala et al., 2014). The pandemic has really caught many Filipino teachers and students in higher education unprepared in online learning. "The sudden transfer of conventional face-to-face classes to online learning regardless of instructors and students' readiness, [has] resulted in the new phenomenon called "emergency online learning," which has created many confusions to instructors, students, and higher education administrators" (Mok et al., 2021, p. 2). Pokhrel and Chhetri (2021, p. 135) contend, "The use of suitable and relevant pedagogy for online education may depend on the expertise and exposure to information and communications technology (ICT) for both educators and the learners." The emergency of the COVID-19 pandemic has prematurely exposed Filipino tertiary educators to the realities of online teaching that requires a higher level of PDC.

19.5.3 Lack of Institutional Investment and Faculty Training for PDC

Another major obstacle in enhancing the teachers' PDC for higher education faculty is the lack of institutional investment of HEIs to provide advanced e-learning technologies and regular training and seminars to enhance the faculty's PDC and poor research. In the Philippines, HEIs that invested much in acquiring e-learning technology and improving faculty PDC before COVID-19 are more likely to be prepared for online learning compared to those which have just started in response to the pandemic (Cabauatan et al., 2021). DC varies between people and is related to aspects such as a person's interests, belief in their own ability, actual ability, and access to social support or other resources when needed (Larsson-Lund, 2018, p. 733). Different organizations and institutions have identified different indicators or standards that describe teachers' PDC (Muñoz-Repiso et al., 2020). In the Philippines, many HEIs are still behind in ICT pedagogical training for their faculty. As Dotong et al. (2016) explain, limitations such as shortage of ICT facilities, poor maintenance of available or existing ICT resources, and lack of ICT budget have seriously affected teachers' PDC to engage in online teaching (e.g., Lorenzo, 2016; Tomaro, 2018; Vergel de Dios, 2016).

Lastly, the weak PDC of Filipino tertiary educators can be linked to the poor research productivity of many HEIs in the Philippines. As Yazon et al. (2019) argue, the increase in understanding, finding, using, and creating information using digital technologies is positively related to faculty members' ability to conduct, complete, present, and publish a research article. This is a problem in many colleges and universities in the country whose focus is on teaching rather than research. Thus, most tertiary education teachers are less exposed to digital technology and online sources in scientific research and publication which can greatly enhance their PDC. "Faculty member's digital competence is strong and significantly correlated to their research productivity, which clearly indicates that as their knowledge, skills, and attitudes for working, living and learning in the knowledge society increases, there is also a significant increase in their ability to produce publishable research outputs" (Callo & Yazon, 2020, p. 3511). Finally, Mena, Singh and Clarke (2018, p. 588) also stated that digital competencies include the contents, skills, knowledge, and attitudes that connect technical expertise with pedagogical purposes to enhance students' learning. Thus, the success of online education as demanded by the CHED to address the COVID-19 largely depends on the expertise and exposure of the faculty to ICT, scientific research, (Pokhrel & Chhetri, 2021) and access to digital devices, educational tools, Internet connection, institutional support, and training.

19.6 Conclusion

This chapter has provided an overview and clarification on the meaning of DL, DC, and PDC in online and long-distance learning using the global literature review. DL and DC for teachers, which are usually understood as synonymous by education scholars, are different from those of other professions. Although there is no uniform definition and standard in understanding and measuring these digital skills as applied to education in the global literature, the ability to use and apply digital tools and pedagogies effectively to pursue online or long-distance teaching and learning are the common features in understanding teachers' DL, DC, and PDC. Measuring these skills were also varied depending on the objectives of the study, from the use of INCOTIC, TPACK, DigiCOM, and other instruments. Although the Philippine tertiary education has a growing access to digital technology and is generally open to new ICT digital educational tools to implement online teaching and learning in response to the CHED's flexible learning and long-distance learning mandate, most of the HEIs and their faculty are still caught unprepared and still adjusting to the sudden shift from face-to-face to online classes in response to the COVID-19 pandemic. The major obstacle in enhancing the Filipino tertiary education teachers' PDC include weak Internet connection, lack of access to digital devices and educational technologies, lack of institutional support for ICT infrastructure, and regular teachers' ICT training to enhance their PDC and attitude toward online teaching.

To make them responsive to the CHED's mandate on flexible and online learning during the current COVID-19 pandemic, this study recommends that these major obstacles must be addressed by the Philippine government through the CHED. The weak PDC and negative attitude of many Filipino tertiary teachers toward online teaching and learning is systemic in nature. Thus, more studies should be commissioned by the CHED to understand fully the problem and encourage education to recommend ways to the Philippine government on how to solve them.

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Chapter 20
Digital Literacy Among Students of Pedagogical Faculties in Poland—A Systematic Literature Analysis

Łukasz Tomczyk

Abstract The aim of this article is to explore the level of digital literacy (DL) among students of the pedagogical faculties in Poland based on previous research. DL is one of the key competences of future teaching staff. The discussion on DL and how it is measured is part of the reflection on the shape of the future school and educational programmes at universities of pedagogy. Understanding the state of preparation of new pedagogical cohorts in the intensively developing information society requires the organization of those conclusions reached so far by the relevant research. For this purpose, a systematic analysis of the literature (peer-reviewed articles) indexed in repositories and scientific databases such as Google Scholar, EBSCO, Scopus and Web of Science was used. Based on data from 2001 to 2021 on Polish students, these being future educators, it was noted that: (1) Measurement of DL is rare, with preference given to theoretical analyses; (2) The research is dominated by quantitative techniques and tools mostly deprived of theoretical framework and psychometric properties based on a number of inconsistent indicators; (3) Occasionally DigCompEdu, TPACK, Eurostat typologies are used for measurement; (4) DL measurement is mostly based on students' self-declarations; (5) Studies are conducted in different centres without representative samples, and the samples used are usually small; (6) The level of DL is most often described as average or good; (7) Students of pedagogical faculties prefer to rely on common software and services of the information society; (8) Attitude towards new media in education is diversified within this group; and (9) There is a need to develop new, standardized research tools measuring DL, which might nullify the Dunning–Kruger effect.

Keywords Digital literacy · Digital competencies · ICT · New media · School · Students · Pre-service teachers · Poland · Higher education

Ł. Tomczyk (✉)
Jagiellonian University, Stefana Batorego 12, 30-322 Kraków, Poland
e-mail: tomczyk_lukasz@prokonto.pl

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20.1 Introduction

Digital competence is considered a basic skill in many occupational groups. Information and Communication Technology (ICT) proficiency, knowledge and attitudes have become as natural as, for example, the ability to communicate in one's native language, or the possession of mathematical skills. Therefore, it is not without reason that digital competence (also referred to as digital or media literacy) is seen worldwide as a key skill that determines the quality of professional and private life (Knobel & Lankshear, 2006; Tomczyk et al., 2017). ICT literacy, understanding the functioning of new media and the mechanisms of their impact on the psychosocial functioning of individuals and groups creates new spaces of social functioning as well as novel research areas (Tomczyk, 2020).

The changes that have taken place in recent years have forced a transformation in thinking about the possibilities of using ICT. New media are omnipresent in human life. It is now inconceivable not to use ICT to satisfy private needs or to fulfil professional duties. Recent months have significantly confirmed the importance of ICT in fulfilling obligations and leisure activities, or in meeting communication and educational needs (Pyżalski, 2020). The COVID pandemic has become a kind of testing ground for the unprecedented use of ICTs on a large scale and with very high frequency.

Changes related to the intensive development of the information society can be seen in many sectors of economic life (Ziemba, 2019). However, due to the scale of the changes taking place in 2020 and 2021, it seems particularly justified to undertake a more in-depth reflection on the directions of the digitization of education both in Poland and worldwide (Ptaszek et al., 2020). ICT has been enriching the palette of teaching forms, methods and means for more than two decades (Huk, 2011; Frania, 2014; Fedeli, 2013; Herout, 2016, 2017). Many of the solutions that are based on web applications (e.g. quizzes, file repositories, LMS, sites supporting interaction between learners) are now used just as readily as traditional, analogue teaching means. The postulates of media pedagogy visible in the literature in recent years related to the use of ICT in education (Morbitzer, 2007; Plebańska, 2011; Potyrała, 2017; Walter, 2012) have now become a fait accompli in selected scopes. Nevertheless, the high saturation of learning and teaching processes with ICT tools does not exempt us from raising questions related to the quality of this process. The large number of e-solutions used in didactics does not automatically increase the quality of learning and teaching. This, in turn, prompts another question about the level of digital competence in pedagogical contexts among current and future pedagogical staff.

Due to the intense changes, as well as due to the pandemic events of recent months (Potyrała et al., 2021; Tomczyk and Walker, 2021), a number of new research fields are emerging. In scientific studies (Ernst-Milerska, 2020; Jaskulska & Jankowiak, 2020; Kochan, 2020), the authors not only refer primarily to the conditions of crisis e-learning during the pandemic (Tomczyk, 2021) but also pose new questions related to the future of school, based on previous experiences and the preparation of teachers to use ICT in the teaching and educational process. The elementary research areas of media pedagogy are now more clearly recognized and appreciated in the praxeological dimension. Therefore, taking into account the fact that digital competence issues are more and more often the basis for many didactic and educational activities, it seems important to find out what the level and skills of using ICT are not only among current teachers but also teachers of the future. However, all of this requires the implementation of a systematic stocktaking of one of the key competences.

20.2 Theoretical Framework of Digital Competence

The notion of digital competence provides a starting point for understanding how current and future teachers use new media. In this study, the term digital competence will be equated with digital literacy. Both terms mean the same thing and are considered a key competence (Ogonowska, 2016).

In the Polish literature, many definitional approaches to digital competence can be found. According to Agnieszka Ogonowska, digital competence is "a set of skills, knowledge and attitudes that are required for the active use of digital technologies, and the free and critical use of information and communication technologies in work, leisure, education and communication" (Ogonowska, 2015, pp. 100–101). Digital competence is one of the technical skills related to new media—devices, applications and websites. This technical dimension overlaps with the individual aspect, which relates to attitudes towards new media and an awareness of how such developments affect individuals and groups. Digital competence is a hybrid of technical, ICT, legal, ethical and social skills (Tomczyk, 2019).

The notion of digital competence is also sometimes identified with the terms media competence, information competence, media literacy and information literacy. The multiplicity of definitions is due to the adoption of different perspectives in defining the same process, which is the human functioning in an information society (Matusiak, 2020). The terminology of digital competence is related to the fundamental aspects of this construct, that is, information, media, ICT proficiency. However, within the definition of digital competence, more and more attention is paid to those dimensions related to the quality of life, digital security and digital exclusion, all of which take digital competence beyond the simple recognition of this key competence as an activity narrowed down to the use of IT devices, software and web resources.

The multidimensionality of the notion of digital competences (often referred to as media competences) has been highlighted by experts from an opinion-leading Polish NGO, Fundacja Nowoczesna Polska (The Modern Poland Foundation), who emphasize that these skills consist of the effective analysis and use of information, building relationships in the digital environment, using appropriate language in the media environment, the creative use of new media, respect for other people, understanding intellectual value and respect for the law, maintaining safety and taking into account the economic aspects of the media space. The members of the aforementioned think-tank point out that digital competence (computer literacy, digital thinking) and mobile security are components of media competence, and are therefore a subordinate (or intersecting) concept to the term digital competence (FNP, 2014). The cited definition of media competence goes beyond the classical definitional approaches of digital competence, showing the multiplicity of processes and conditions related to the use of new media.

In turn, specialists from the Digital Centre point out that digital competence should not be considered in isolation from the activities undertaken in everyday life. Digital literacy should be connected directly to the activities that allow an individual to function in different areas, as well as taking into account their occupation or age. Digital competence is more related to opportunities, needs and key areas of human life than to a set of rigid skills focused solely on the use of new media. In this view, digital competence has in itself a variety of components: digital (the 'hard' skills of handling hardware and software), and information (including the skills of searching, archiving and saving information), and a key element of the functional dimension of the skills possessed in the areas of work and personal development, leisure, relationships with loved ones, everyday matters, health, civic engagement, finance and religion (Jasiewicz et al., 2015). The conceptual approach proposed by the representatives of the Digital Centre goes significantly beyond the typical perception of digital competences as skills that are created in interaction with new media and are designed for new media. This definition emphasizes that digital competences are part of the key competences and thus are applied in different aspects of life. This approach is particularly useful for the analysis of the digital competence of future and present teachers, who use their knowledge and skills about new media in teaching and learning contexts.

The Italian researchers who performed a systematic analysis of 13 popular definition models of digital competences from 2004 to 2014 identified several essential components for the concepts of digital skills and competences. Among the defining elements of this concept in opinion pieces by information society scholars, they identified, among other aspects, the following dimensions: (a) operational, technical and formal, (b) informational and cognitive, (c) communicative, (d) related to creation and (e) strategic (Iordache et al., 2017). Each category is characterized by clearly defined indicators that translate into a specific set of knowledge, skills and attitudes related to the use of new media in different contexts. Based on a brief review of the literature, it can be seen that the framing of the concept is characterized by a wide variation at the levels of the definition, the operationalization of indicators and measurement.

In the Polish literature, we can find digital competences divided into a sub-group of general competences, i.e. basic skills that every ICT user should have. Additionally, these competences are differentiated by occupation or needs and interests (Piecuch, 2012). This general division will guide the present analysis, where the group of students of pedagogical faculties is a specific collective that is prepared for a profession of strategic importance for the functioning of society. There are many typologies in the literature referring to the use of ICT in education, including:

- UNESCO—ICT Competency Standards for Teachers;
- European Commission—The Digital Competence Framework DigComp 2.1;
- International Society for Technology in Education—The ISTE Standards for Educators;
- Technological Pedagogical Content Knowledge—TPACK.

In the typologies mentioned above, the definitions of digital competence have been transposed to the teaching and learning activities undertaken in educational institutions. These typologies may provide a clear theoretical framework for the development of curricula that focus on the effective use of ICT in education. Nevertheless, due to the lack of a homogeneous definition of digital competence and the diverse conditions related to the implementation of ICT in formal education and higher education worldwide (Tomczyk & Sunday Oyelere, 2019), there is a need to undertake more detailed local analyses. When analysing digital competences, first attempts to structure the measurement of digital competences in relation to skill levels have also emerged in recent years. It seems reasonable to cite at this point the Digital Skills Indicator where assumptions can be found dividing skills into low, basic and secondary (Tarkowski et al., 2018), and the European Computer Skills Certificate ECDL (Henseruk, 2019; Glaza & Wędrowska, 2008). Attempts to create a unified framework defining the level of digital competence, as well as to prepare a single universal definition, have so far proven to be completely unsuccessful. However, the concepts referred to could be very useful for the creation of new diagnostic tools, and that usefulness could extend as far as the training of future pedagogical staff.

In this paper, digital competence will be understood as a hybrid of skills and knowledge related to the use of hardware and software in private and professional (educational) life. Digital competence in this text will also be seen in terms of attitudes towards new technologies, and the ability to assess (or reflect on) how ICTs change the lives of individuals as well as whole social groups. Thus, digital competence will go beyond the consideration of digital competence only as those skills that are technical and narrowed down to the efficient retrieval, processing and storage of information of various types. Digital competence in the text will be praxeological in nature. A diagram of digital competence is presented in Fig. 20.1.

The definition of digital competence applied here broadens the field of research. Each component is crucial for intentional functioning in interaction with new media and other users. The issue of reflection becomes an important component for increasing digital resilience to the negative impact of digital media, i.e. increasing digital safety (Tomczyk & Potyrała, 2019). Nevertheless, it should be clearly emphasized that the lack of fulfilment of any of the elements of the definition of digital competence will not exclude any studies from a systematic analysis of digital competence among pedagogical students. This is due to the fact that the concept analysed has greatly evolved in the last two decades—from a term that was linked only to the technical operation of IT equipment to a more complex concept, standing in relation to activities and processes occurring in society.

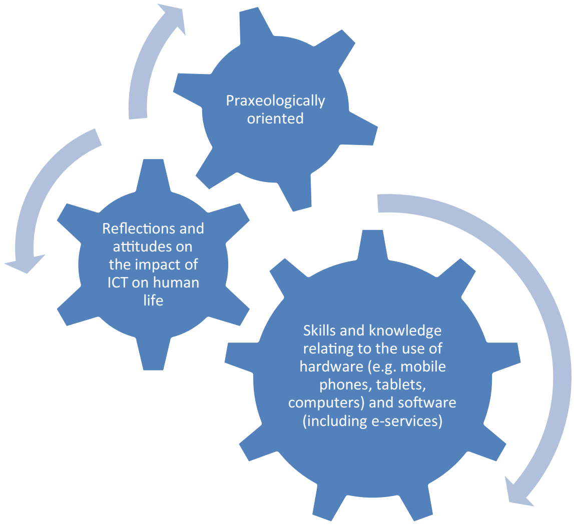

Fig. 20.1 Definition of digital competence

20.3 Research Methodology

20.3.1 Objective and Subject Matter

The aim of the research is to explore the level of digital competence (DL) in Poland among students of pedagogical faculties. An indirect aim of the research is also to present the ways (methods, techniques and tools) in which digital competence in Poland is measured. The aim of the research was narrowed down to students of pedagogical faculties due to the specific conditions required in the teaching profession, where DL is combined with skills and knowledge of pedagogical sciences (with a particular emphasis on didactics and educational aspects).

The subject of the analysis are documents, or more specifically, scientific articles, which went through the review process and were published in Polish and foreign scientific journals. The object of research has been selected by assigning key words and the date of publication of the document. The subject of the research focused only on the students of pedagogical faculties, those who are described as the teachers of the future.

20.3.2 Research Procedure

The subject matter of the research was selected by using the following keywords: *digital competence (and the following synonyms—digital skills, media competence), students, pedagogy, pre-service teachers, Poland or Polish.* The keywords in Polish were translated into English in order to broaden the literature selection due to the fact that Polish researchers also publish their texts in congress languages (with a special focus on English). The term pre-service teachers was also added to the key words in English, which is very often used in the foreign literature as a term clearly indicating a group of students of pedagogical faculties. The research procedure presented in Fig. 20.2 was performed twice, once for each of the two language variants, Polish and English.

The selection of the object of research, i.e. scientific articles, was carried out using search engines of scientific texts, viz Google Scholar, as well as the EBSCO database. This is due to the fact that both databases index the largest number of online journals. Moreover, in the selection of the subject matter of the study, the two largest databases of scientific articles that form the basis for the list of ranked journals of the Polish Ministry of Education and Science were also used, namely, Scopus and Web of Science. The selection of the research subject was narrowed down to the period 2001–2021 due to the technological changes that have influenced the development of digital competences in that time (e.g. the development of broadband Internet in Poland, and the intensive incorporation of new media in school and academic didactics in pedagogical faculties). A diagram of the research procedure is presented in Fig. 20.2.

Based on the procedure of text selection within the systematic discourse analysis, a total of several thousand scientific articles containing the indicated key words were analysed. The specific number of texts covered by the analyses, i.e. that met the criteria presented in diagram number 2 for both Polish- and English-language papers, is difficult to state unambiguously, because some articles are simultaneously indexed in many databases and repositories.

The articles analysed were characterized by clear inclusion criteria within the research procedure. These were attributes such as the research group or sample had to be related to students of pedagogical faculties in Poland, the measurement needed to include issues of digital competence and the research needed to have a description of results. Failure to meet these requirements resulted in the rejection of the text from the systematic literature analysis procedure. Research on active teachers (not students) was an exclusion factor from the analyses.

20.3.3 Research Technique

The research employed a systematic literature analysis (SLA), which involves the preparation of a model that enables the precise establishment of parameters for the selection of texts, and the accompanying analysis and synthesis of available research findings around a specific research question. The SLA has been documented in detail and the procedure can be replicated with ease. The SLA allows the reliability of the research results to be assessed. Each article that met the search criteria was analysed in terms of the selection of methods, techniques and research tools for the research variables. The SLA did not consider the selection of texts in terms of

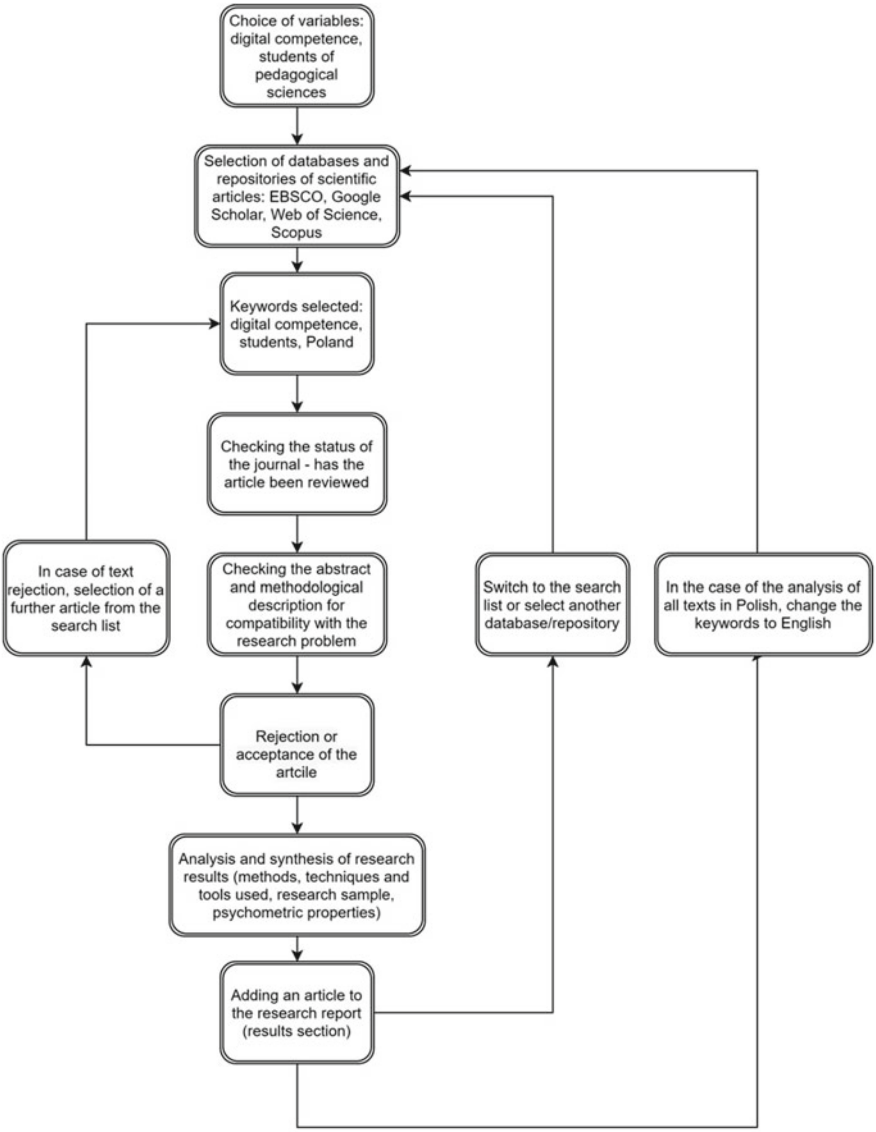

Fig. 20.2 Scheme of the test procedure

preferred research methodology. Both quantitative and qualitative strategies as well as the triangulation of research tools were included in the text selection criteria. Text selection was performed by checking (a) the abstracts and (b) the description of the research methodology. The description of each classified text included information about the research findings in the form of their synthetic representation (the level and type of digital competence) (see Orłowska et al., 2017).

20.3.4 Research Limitations

The research limitations that are present in the study are primarily related to the inclusion of only those articles that have been indexed through the indicated repositories and databases of scientific content. Print-only scientific journals and monographs were not included in the selection of texts, with only studies in digital versions being analysed. This is a significant limitation, which resulted from the place where the research was conducted, i.e. a foreign scientific centre (University of Macerata, Italy). Moreover, the subject of the study was limited to two languages: English and Polish. This is a barrier leading to the potential reduction in the number of scientific papers analysed, as relevant texts may have been published in other congress languages (e.g. German, French, Spanish, Russian, Italian). Despite the fact that the selected scientific databases and content repositories contain many articles, there is a risk that there is content in the Polish literature on the subject that has not been indexed properly (including keywords), which may have contributed to a decrease in the number of articles subject to analysis. Additionally, it should be noted that not all articles have properly constructed abstracts and appropriately designated keywords (including the terms: key competences, digital skills, media literacy), which may have contributed to the exclusion of valuable studies from the SLA.

20.4 Results

The SLA involved the analysis of 31 studies that sought to demonstrate digital competence among future teaching staff. The search for information about research conducted in the last two decades was conducted using a multi-source analysis of materials in digital form due to the scattering of available articles. On the basis of the search results, it was noticed that in Polish media pedagogy studies devoted to DL it is the local journals, published in Polish, which dominate. Research on DL is more intensive in the last decade than, for example, two decades back or earlier. Studies related to DL are very often combined with other texts on teacher preparation for the profession; however, these are usually theoretical studies with an overview of definitional positions, emphasizing the importance of ICT use in education.

Usually, in empirical texts, the theoretical framework is a non-systematic review of Polish, and less often foreign studies on the topic. Empirical texts measuring DL are rare. Within the SLA framework, one can find many scientific articles of a general nature, showing different theoretical assumptions and detailing the need for educating future pedagogical staff in the use of ICT. Empirical reports are in a distinct minority compared to review texts.

Research on DL is carried out in various research centres. There is no leading institution in this field, one which specializes in scientific analyses related to the preparation of future teachers to use ICT. The research is usually conducted on small, non-representative research samples, so most of the results do not allow generalization, and thus the real picture of DL among future teaching staff often remains opaque. In analysing the literature, it was noticed that the measurement tools applied are characterized by great diversity. In Polish media pedagogy, there is a very small percentage of studies based on common theoretical frameworks (e.g. international typologies). The authors prefer to create their own diagnostic tools, not necessarily rooted in the available theoretical frameworks or standards related to the formation of DL.

The vast majority of research is conducted using self-declaration and quantitative techniques (diagnostic survey). Self-assessment is the dominant way to measure practical skills, ICT knowledge or attitudes. Tests measuring real ICT skills are rare. Most researchers do not present the weaknesses of measurement by self-declaration in their studies, treating this way of showing DL as not needing correction due to its inherent subjectivity. Also, the research results very rarely include a determination of the level of DL, resulting at least from the theoretical framework, or from self-reported assumptions. There are only a few research results that group future educators according to their level of proficiency in using ICT.

It is also interesting to note that there are studies that are conducted using a single tool among Poland's neighbouring countries simultaneously in the Czech Republic, Slovakia, Ukraine and also distant Croatia. Comparative research is a relatively new trend that can be observed in media pedagogy. It is common for analyses of this type to be a derivative of the implementation of projects financed from external sources or to stem from the long-term cooperation of researchers from Polish scientific centres with representatives of foreign universities.

A detailed summary of the SLA including the study authors, the year of the study, the number of respondents, a description of the research tool used along with the psychometric characteristics, the theoretical framework and the results of the study is presented in Table 20.1.

20.5 Discussion

The research conducted so far on the measurement of DL is characterized by a predominance of theoretical considerations with a particular emphasis on reproducing definitions and reviews of foreign typologies of DL. The Polish literature on the measurement of DL is marked by a high degree of discretion in measuring this key competence. Most of the tools used do not have a clear theoretical framework (apart from those based on the popular DigCompEdu typologies, Eurostat longitudinal studies or TPACK). This may be due to the fact that DL is defined in a variety of ways by different authors (Dobson & Willinsky, 2009) and there is no single, unquestionable definition that limits the indicators to be measured. Alternatively, this state of affairs may also be due to the high creativity of Polish authors in developing their own tools, which are not compatible with the existing framework defining DL (Iordache et al., 2017). The theoretical basis is the weakest point in

Table 20.1 Summary of results of systematic literature analysis

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Aksman (2012)	Frycz Modrzewski Academy (N = 130), 2009	Survey questionnaire, self-evaluation, no psychometric properties 10 DL dimensions	Definitions of Polish media educators	Recognizing the complexity of the concept of DL, linking DL to activities beyond maintenance
Winiarczyk and Warzocha (2020)	Jan Kochanowski University (155), University of Rzeszów (73), 2018/2019	Online diagnostic survey, self-evaluation, no psychometric properties 10 main indicators grouped in terms of situations of hypothetical application of DL in education and self-assessment of DL, as well as pathways related to the acquisition and improvement of DL	Various government documents, no leading definition	The majority of students rate their DL at an intermediate level. Almost half declare that they have acquired sufficient ICT skills during their studies. Most often students want to use multimedia projectors and interactive whiteboards
Długosz and Foryś (2020)	Pedagogical University, 2020 (N = 1927)	CAWI web survey distributed by internal mail, no psychometric properties Attitude towards new media	General assumptions about e-learning in a pandemic crisis	Pedagogical students prefer receiving condensed knowledge. Little scope for students to be independent in their learning processes using a variety of digital sources and forms

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Warzocha (2017)	University of Rzeszów (N = 25 women)	No information, no psychometric properties 8 questions on how to obtain, process, store information, communicate or share files. A 5-grade Likert scale was used	Lack of a clear theoretical framework	The vast majority of students rate their information processing skills very highly
Michnik et al. (2014)	Purposive sampling (N = 90), 2013	Portal mojaankieta.pl and printed versions of the questionnaire. Lack of information about the respondent selection key and information on psychometric properties of the tool Several vaguely specified research items defining the style of using new media, and in the teaching and learning dimensions as well	Definitions Nosal, Strykowski. The division into digital immigrants and autochthons M. Prensky	Students mostly use word processing applications and create multimedia presentations
Badora (2020)	Catholic University of Lublin (N = 42)	Analysis of free statements, No information on the key of selection of respondents One open question	Literature review on creativity and cyberspace	Recognizing the potential of cyberspace for the creative application of ICT among future educators

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Majewska (2020)	Students of pedagogical faculties in the period 2015–2019, Nicolaus Copernicus University in Toruń (N = 88)	Triangulation of research methods: ability to design prevention materials using ICT, knowledge test, interview, questionnaire A task to be carried out using ICT	General overview of Polish and foreign studies	13% of students have negative attitudes towards ICT. Almost one in three has a sufficient level of independence in working with software. Almost one in five students has no problems in learning how to use new software
Kiedrowicz (2018)	University of Technology and Humanities in Radom (N = 100), 2016	Diagnostic survey, no details on methodology Questions about the style of use of new media. Seven main indicators related to: time of use of new media, method of accessing the Internet, characteristics of the Internet, purpose of Internet use, assessment of the reliability of information, negative effects of using mobile devices	General overview of Polish research on media pedagogy	Education students mostly use their smartphone to get online. The internet is used to connect with the world, access information and is a source of entertainment

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Czerski (2021)	Marie Curie-Skłodowska University, (N = 226)	Diagnostic survey, triangulation of research methods using, among others, the Facebook Intensity Questionnaire Style of using the social networking site Facebook	Health behaviour and Facebook use	Students characterized by high levels of problematic Facebook use are a small collective
Wobalis (2016)	Adam Mickiewicz University in Poznań (N = 677), longitudinal study 2010–2016	Triangulation of research techniques: (a) interactive test of theoretical ICT knowledge; (b) survey, (c) text editing practical activities; (d) speech analysis related to e-risks 30 questions about the equipment they own, how they use technology, forms of Internet activity, subjective assessment of their IT skills in word processing, use of office applications and Internet tools The knowledge test consisted of 60 questions on how ICT works	General overview of Polish research on media pedagogy	Students have deficiencies in DL resulting from the quality of educational activities in previous educational stages. Students from recent years are characterized by a lower level of DL than earlier years, which may be a signal of a reduction in the quality of ICT education over the years in secondary schools Students overestimate self-assessment in word processing. They make elementary mistakes in practical exercises

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Jedryczkowski (2019)	University of Zielona Góra (2016), N = 118	Big data analysis, online test for audio-visual material Level of sustained attention to online content, knowledge test, time spent reading online material, percentage distribution of online activity on the e-learning platform	A review of definitions and research on cognitive processes in learning and teaching with digital teaching videos	Materials in the form of videos (tutorials) prepared by lecturers were not a significant source of professional preparation for pedagogical students. Quick browsing of content in e-learning courses leads to errors in understanding academic courses
Smyrnova-Trybulska and Wilmann-Bałdys (2009)	University of Silesia, Cieszyn Branch 2005–2006 (N = 18)	DL self-evaluation. A digital survey hosted on the Moodle platform 4 questions based on self-declarations and 30 questions related to e-learning	General information about e-learning and IT education	Students of Information Technology specialization evaluate their own ICT and e-learning skills higher than students of other specializations
Strykowski and Strykowska-Nowakowska (2018)	Adam Mickiewicz University, no data on year of study (N = 60)	Diagnostic survey, self-evaluation The 5 main media competences, with 38 indicators. Answers on a 5-degree Likert scale	Overview of concepts from general definitions through the term competence to key competences. A detailed discussion of the term media competence	Difficulties in understanding the concept of competences. Students do best when receiving media messages, and also perceive the need to update their own competences

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Kandzia (2018)	Cardinal Stefan Wyszyński University ($N = 15$, two groups)	Project method, pre-test and post-test consisting of 10 questions	No	Most students start using the e-learning platform with poor knowledge of how it works. Complex workshops make it possible to significantly improve the knowledge of this e-learning. Strengthening DL in e-learning requires both the student's own work and the support of the course leader

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Bielinis et al. (2018)	University of Warmia and Mazury in Olsztyn, 2016 and 2018 surveys (N = 203)	Triangulation of research techniques: mind maps, reflective essay, survey research No description of the quantitative tool	M. Prensky—digital native and digital indigenous and a general review of the literature	Over the years, a decrease in the frequency of use of services connected with access to pirated content and online downloading has been observed. At the same time, there is an increase in the frequency of use of information services, repositories of multimedia files such as YouTube. Students are sceptical about complete digitization, but they appreciate the combination of teaching solutions from the online and offline worlds

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Pulak and Staniek (2017)	Ignatianum University of Kraków, 2016 (N = 144)	Diagnostic survey, self-evaluation 5 main areas, no detailed description of the selection of indicators	General overview of media pedagogy	Students rate poorly their own skills related to creating websites, creating and editing multimedia materials, and compiling numerical data. They rate highly the skills related to searching for content on the Internet, using SNS, and creating multimedia presentations. The respondents consider the following as the most important in the teaching profession: searching and printing text, using WWW resources and creating multimedia presentations
Wieczorek-Tomaszewska (2014)	Pedagogical University, AGH University of Science and Technology, University of Silesia, Warsaw University of Technology, University of Gdansk	Focus sessions in different academic centres, as well as self-declarations Visual Literacy Standards No A—no detailed information about the tool	Background information on the visual literacy competency standards for higher education	Students declare that they can select graphics for specific purposes, and can search for graphics effectively. Issues concerning ethics, use of images, legal and social aspects are less understood in this group

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Frania (2016)	University of Silesia in Katowice, 2015 (N = 286)	Diagnostic survey, questionnaire among Polish and Croatian students 4 questions using the Likert scale, a self-administered tool	General introduction using the literature on media pedagogy	Students use smartphones most often for teaching and learning purposes, and audiobooks least often
Romaniuk and Łukasiewicz-Wieleba (2020)	Academy of Special Education, 2020 (N = 515)	Online survey, recruitment of study participants by email Questions related to e-learning as well as to crisis e-learning and the assessment of own “IT” competences on a 5-point Likert scale	General information about crisis e-learning, remote education	The vast majority of people rate their own DL as good
Kiedrowicz (2015)	University of Technology and Humanities in Radom, 2015 (N = 74)	Surveys—no details available New media usage style, smartphone use, assessing the reliability of information	Some background information on the information society	The time spent using a smartphone is increasing

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Borawska-Kalbarczyk (2013)	University of Białystok, N = 226	Surveys—no details available Some general questions related to information processes in the online and offline sphere	Psychosocial functioning of generation C in the information society—background information	A few years back, students preferred printed materials to ready-made studies obtained from the Internet as learning sources. Every tenth respondent emphasized that new media made learning difficult for them. Almost half of the respondents had no problems with multithreaded processing of digital information (multitasking)
Frania (2017a)	University of Silesia in Katowice, 2015 (N = 286)	Diagnostic survey, questionnaire among Polish and Croatian students Identify the usefulness of ICT in pedagogical work	General introduction using the literature on media pedagogy	Of most use for education are computers with internet, smartphones and tablets

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Tomczyk et al. (2021) Oyelere and Tomczyk (2020)	Pedagogical University of Cracow, 2019	Online diagnostic survey, triangulation of 4 research tools. Psychometric properties were determined—factor analysis and internal consistency 25 indicators: attitude towards new media, style of using new media, experience with e-learning, DL self-evaluation of using popular software	The TPACK concept	Students use e-services very extensively. Students rate their own DL highly in terms of word processing, searching for information and creating presentations. They rate their own DLs slightly lower in terms of handling spreadsheets. Students have mixed feelings about the impact of ICT on the learning and teaching process
Frania (2017b)	University of Silesia in Katowice, 2015 (N = 286)	Knowledge test among Polish and Croatian students 20 questions and 5 levels of digital security knowledge from very high to very low	General introduction using the literature on media pedagogy	Around 70% scored high and very high on the digital security knowledge test
Tomczyk et al. (2017)	Pedagogical University of Cracow, State Higher Vocational School in Oświęcim, Janusz Korczak Pedagogical University, 2014–2015 (N = 466)	Quantitative research, diagnostic survey, self-declarations 13 indicators related to the use of ICT in education	Overview of definitions related to DL	Identification of 4 groups of pedagogical students: techno-optimists, techno-pessimists, techno-realists, techno-ignorant

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Morze et al. (2019)	University of Silesia (N = 63)	Quantitative research, diagnostic survey, self-declarations. Comparison of declarations of Polish and Ukrainian students Question on the use of media in education—24 ICT-based solutions. 10-grade scale	Eramsus + project objectives	Polish students perceive less need for ICT-based solutions in education than their Ukrainian peers. The greatest interest is in collaborative learning using ICT, the least in storytelling
Kędzierska and Mróz(2017)	Pedagogical University of Cracow, 2017 (N = 136)	Online questionnaire, self-declarations 8 questions	Social contexts of information growth on the Internet—general assumptions	There is a need to strengthen competences related to the evaluation of information on the Internet
Eger et al. (2018, 2020)	Pedagogical University of Cracow 2017–2018 (N = 341)	Online questionnaire, self-declarations, comparative study in Poland, the Czech Republic and Slovakia. A factor analysis was conducted 37 indicators grouped for 6 variables	An overview of European studies measuring DL. Indicators from Eurostat and the ICT Literacy Panel were used	Four levels of proficiency in ICT use were identified, from basic to expert. Polish students of pedagogical faculties declare that they have more advanced DL than their peers from other countries. Students use ICT mainly for entertainment purposes, less frequently use e-government or e-learning platforms (pre-pandemic research)

(continued)

Table 20.1 (continued)

Authors (year of publication)	Survey area (number of respondents), survey year	Research tools used, psychometric properties, areas of measurement, number of research items	Theoretical framework	Results—applications
Ogrodzka-Mazur and Szafrańska-Gajdzica (2016)	University of Silesia in Katowice, 2014–2015 (N = 112)	No details of the research tool, self-evaluation 1 question related to general self-evaluation of own DL. In addition, 12 areas of ICT use	Overview of definitions related to future competences and digital competence	Students rate their own DL higher than technological ones
Chmura et al. (2019)	No information available	Self-declarations, diagnostic survey 37 items, 4-grade scale for 5 areas	DigCompEdu	Pedagogical students have a much more positive attitude towards the use of ICT in teaching than academic teachers
Demeshkant (2020)	Wroclaw University of Environmental and Life Sciences, 2017–2020 (N = 120)	Self-declarations 6 areas, 6 levels from A1 to C2	European competency framework for the digital competence of educators	PhD students are characterized by the following DL by level: A2 (44%), B1 (31%), B2 (35%). The highest level of DL was not achieved

the texts analysed. Usually, the tools are created based on very general assumptions from media pedagogy, and these do not include all research indicators. Therefore, the adoption of international typologies or the development of our own comprehensive standards combining knowledge, attitudes, new media literacy and teacher preparation is postulated in further research.

Different ways of measuring DL do not serve comparative research. Currently, it is difficult to unequivocally state what the level is of DL among future teaching staff in Poland. This is due to the inherent weakness of DL measurement based on self-declaration, as well as the selection of different measurement indicators in studies conducted in different Polish academic centres that educate future teaching staff. The unification of indicators will also allow the measurement of teachers' preparation for the teaching profession, which is increasingly associated with the effective and methodical use of ICT (Tomczyk et al., 2019b). Also, the issue of the unification of indicators provides an opportunity to avoid measuring DL as if "by the way" of studying other related issues, such as the use of social networks, or changes in the information society. The diversity of the ideas of Polish researchers related to the measurement of DL on the one hand leads to a broadening of the conceptual field of DL, while on the other hand, it does not serve adequate measurement.

An equally important issue arising from self-declaration is data distortion. This is because there are groups of ICT users who overestimate, underestimate or fail to assess their own DL. This is a phenomenon known in the literature and referred to as the Dunning–Kruger effect (Dunning, 2011; Potyrała & Tomczyk, 2021). The remedy for such a deficiency is to eliminate self-declarations or to include knowledge and skills tests covering different levels of ICT proficiency in the self-assessment.

Another aspect that makes it difficult to know the level of DL among prospective teachers is sample selection. Much current research is conducted without the use of random sampling. The selection of respondents is usually purposeful or random (though not achieved through random sampling). There is currently no research in the Polish literature devoted to DL among students of pedagogical faculties that allows for generalization. The student body is, for researchers, one of the most easily accessible research groups, so it is puzzling that so far the research has not been carried out on samples allowing the avoidance of random selection of samples and allowing the level to be shown of DL among young students of pedagogical sciences while preserving the appropriate level of confidence, as well as minimizing the maximum error.

The notion of DL has been expanding its domain in recent years, and covers an increasing number of areas within the information society. With the development of e-services, DL indicators are changing. For example, crisis e-learning has forced reflection on the preparation of current and future generations of teachers (Potyrała et al., 2021). This proves the point raised by researchers over a decade ago (Smyrnova-Trybulska & Willmann-Bałdys, 2009) that there was a need to include skills related to the use of e-learning platforms as components of the definition of DL among future teachers.

In addition, it should be noted that each teaching specialization is characterized both by the need for universal ICT-related skills and a specific canon of directed skills.

Teachers of different specialties use different types of software and devices in their work with students. Therefore, in creating a definition of DL for future generations of teachers, there is a need to design a universal variable with variable indicators for a variety of teacher specialties. For this purpose, the current typologies of DL need to be slightly modified.

The analysis shows that students of pedagogical faculties are very keen to use the software they use most often, i.e. word processors, programmes for creating multimedia presentations, Internet resources. It is these kinds of skills that form the basis of their digital competence. Going beyond previous habits and including the aspect of lifelong learning in the concept of DL will enable the preparation of pedagogical staff that will be able to find their place in the rapidly changing information society (Ala-Mutka et al., 2008).

The use of ICT by students of pedagogical faculties is linked to their preparation at earlier stages of formal education. Therefore, the formation of DL in the university mode within the subjects' information technology, media in education and other related academic courses requires reference to the quality of education prior to higher education. The creation of theoretical and methodological frameworks improving DL among pedagogical students should take into account the issue of the lack of homogeneity in the level of this key skill.

In analysing the Polish literature on the subject, one can get the impression that DL incorporates everything that is related in any way to the handling of new media. The diversity of theoretical frameworks or their absence, the random selection of indicators, and the focus on measurement depending on the authors' own experience of the articles, are all factors that make it difficult to unify the term DL. Referring to the SLA results, it is also possible to see a number of different ways of framing the term itself as digital literacy, digital competence or media competence. For many authors, these terms are synonymous, leading to an increased possibility of terminological confusion.

20.6 Conclusions

Considering the data collected, it is important to emphasize that there are many research results that are shortcuts. Each way of measuring DL targets different areas of ICT-related activity. Some studies emphasize attitudes, others on operating typical programmes, or on using ICT in education. It is rare for studies to find a common denominator in the form of a set of identical diagnostic indicators. Therefore, it is crucial to develop a coherent, up-to-date and professionally relevant theoretical framework as the basis for a universal research tool.

Media pedagogy is an intensively developing sub-discipline of the sciences of education and upbringing. Therefore, it is considered legitimate to organize the terminology of issues pertaining to DL. A transparent and conceptually sharp theoretical framework will allow entry into a new level of DL research, which in turn will contribute to the improvement of the effective use of ICT in education and will also remove the information confusion present in the research results to date (Tomczyk et al., 2019a).

Current pedagogical students are a generation that has grown up in a world dominated by digital media (Pyżalski et al., 2019). A new generation with seemingly high ICT proficiency may contribute to changing the ways in which ICT is used in education due to the peculiarities of their own generation. The lack of a skilful diagnosis of the DL status of this socially important group may prove to be a factor blocking the modernization and development of education in this era of progressive and irreversible digitization.

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Chapter 21
Understanding the Implications of Digital Competence for the Education Process in Romania. A Literature Review

Gabriela Neagu

Abstract This chapter aims to investigate the role that information and communication technologies (ICT) must play in the educational system from Romania, focusing in particular on the next generations of specialists in the context of the "digital revolution". A review study was set up to present a complete and recent overview of empirical studies published in the last 20 years. To search for relevant studies, a comprehensive search will be performed using "ANELIS PLUS", between 2000 and 2021. This browser includes many databases such as ERIC, SAGE, SCIENCE DIRECT, SCOPUS, EBSCO, etc. To search for potential references, the term "ICT" will be combined with the following terms: "Romania", "digital skills", "digital competencies", "digital divide", "education system", "teachers", and "compétences numériques", "les enseignants", or "la Roumanie", to also have access to the French language databases Persee and Cairn. Also, to complete the list of studies, we use and search engines Google Scholar and ReseacheGate. Through this analysis, we will obtain a detailed picture of the relationship between ICT and the education system from Romania proving the issues of accessible ICT, the expected level of digital competencies of future specialists.

Keywords ITC · Digital competencies · Education system · Romania

21.1 Introduction

The educational system is the best framework for the transmission and formation of digital competence among the population: it has a trained staff, it has the capacity of developing educational programs adequate to every level of individual psycho-intellectual development, it has the authority of issuing documents (diplomas/certificates) which guarantee the level of digital competence of the graduates, etc. The role of the educational system in the formation and development of digital competence is acknowledged by the international institutions (CE, for

G. Neagu (✉)
Research Institute for Quality of Life, Romanian Academy, Bucharest, Romania
e-mail: gabi.neagu@iccv.ro

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example) and supported by the development of systems of indicators that measure the level of digital competence specific to education (DigCompEdu, for example).

In Romania, the digitization of the educational system is in its early stages; the first debate on this issue took place in the early 2000 years, aiming to meet several objectives such as ICT equipment for the teaching institutions, ICT classes in the curriculum, training of the teaching staff for the assimilation and transmission of ICT knowledge and competence to their students, etc.

These objectives have also been included in the official documents focusing on the digitization of education: Strategy for Digitizing Education in Romania, 2021–2027 and National Strategy for the Digital Agenda in Romania in 2015 (updated in 2020). The documents of educational policy are not only adequate to the national objectives but also aim to align the training of the educational staff and the students to the current and prospective requirements in Europe and to include elements stipulated by the European documents—EU directives on the key components for education and lifelong ICT learning (The Digital Competence Framework for Citizens (DigCompEdu), which was created by the European Commission). The five areas that cover digital competence—information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving—are also covered at the national level. The Digitalization Strategy in Romania, 2021–2027, describes the formation profile of the graduates of pre-university education (ISCED 0–4): basic level (ISCED 2), functional level (ISCED 2–3), and advanced level (ISCED 4). (Digitalization Strategy in Romania, 2020). Regarding the higher education level (ISCED 5–8), the document stipulates higher levels of digital competence which involve not just the communication abilities but also the creation of digital content and interactive content, acquisition of techniques that allow online environment integration in education, development of the digital didactic competencies that are relevant for the teaching and learning process, etc. (Strategy for Education Digitization in Romania 2021–2027, 2020:16–17). The Strategy for Education Digitization in Romania 2021–2027 includes at least two extremely ambitious objectives: the digital literacy of 90% of the Romanian population and the endowment with infrastructure and technological resources adapted for all educational institutions in Romania (Strategy for Education Digitization in Romania 2021–2027, 2020:13). Assessing the situation at the level of the national education system in terms of ICT is an important step in understanding the implications of ICT in education and the basis for achieving the objectives set out in the strategy documents.

Based on a review of the scientific literature of the past two decades, the aim of this chapter is to explore the level of digital competence of students from Romania. Two secondary objectives are also proposed in this chapter: the presentation of how digital competencies are measured in the Romanian education system and what are the factors that can influence the level of digital competencies of students.

21.2 Theoretical and Methodological Framework

21.2.1 Digital Competence

The concept of digital competence, although rather new, covers a large array of meanings: from the capacity of using a device (computer, phone), to a lifestyle and manner specific to contemporary society. There is a large diversity, not just conceptually but also in terms and defining the concept of digital competence. One of the most frequently used definitions belongs to the European Commission: "the confident, critical and responsible use of digital technologies, as well as their use for learning, the workplace and participation in society. "Literature often quotes the definition proposed by Ferarri (2012): 'the set of knowledge, skills, attitudes, abilities, strategies, and awareness that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning and socializing. (Ferrari, 2012:30). We also encounter this conceptual diversity in Romanian literature. Tudor (2016) used the concept of digital skills with the meaning of "using computers for obtaining, copying, evaluating, storing, presenting and transmission of information; to participate and communicate within working teams via the Internet or other available technologies" (Tudor, 2016:32). Other Romanian authors use the digital competencies concept and they understood it as the ability to use ICT (Tufă, 2010; Guran, 2003) in a responsible manner (Ceobanu et al. 2020).

Whatever the option of the specialists in terms of definitions, they reflect the holistic nature of the issue: the extent of ICT ("learning, the workplace and participation in society"), the multidimensionality of the digital competence ("the confident, critical and responsible use of digital technologies"), as well as its typology: ("perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively"). Hence, the literature features a lot of variants, all of them belonging to the concept of digital competence: *digital literacy, digital skills, digital intelligence, digital fluency,* etc. McGarr and Mcdonagh (2019) considers that" the use of the term competence to signify a more holistic meaning however may reflect more significant differences in the terms." (McGarr & Mcdonagh, 2019:9). In this paper, we will consider the concept of digital competence, as a central concept: all the other concepts, identified in the reviewed articles, we consider as deriving from it.

21.2.2 Types of Digital Competence

The definition of Ferrari (2012) includes a typology to the digital competence that the author considers necessary to the whole population: perform a task, solve problems, manage information, or create and share content. Other authors focused on the educational system and proposed digital competencies that are specific to the teaching staff and the students. Thus, Instefjord and Munthe (2015) speak of three categories of digital competencies: technology proficiency, pedagogical compatibility, and social awareness, while Zhao et al. (2002) recommend three knowledge areas associated with teachers' digital competence are necessary—technology proficiency, pedagogical compatibility, and social awareness. Koehler and Mishra (2005) consider that at the level of the population of teachers there should exist the following types of digital competencies: technological content knowledge, technological pedagogical knowledge, pedagogical content knowledge, and, finally, technological pedagogical content knowledge. In Romania, Tudor (2016) makes the following classification: *knowledge* (understanding and knowledge of the nature, of the role and opportunities of ICT, computer utilization, opportunities and potential risks of the Internet and communication using electronic media); *abilities/skills* (to access, explore, and use services on the Internet, to use ICT to support critical thinking, creativity, and innovation, to use the information in a critically and systematically way, to search, collect, and process information, to use techniques for the production, presentation or understanding complex information); *attitudes* (critical and reflective attitude towards available information, the responsible use of interactive media, interest to get involved in communities and networks for cultural, social, and/or professional purposes). The type of digital competencies regarded as necessary for the educational staff is listed in documents of strategy, such as DigCompEdu (Redecker, 2017): professional competencies; pedagogical competencies, and learners' competencies.

A synthesis of the main types of digital competencies which we will use in this paper includes: (a) performing tasks and solving problems; (b) communication, collaboration, and inclusion; (c) managing information, creating and sharing content, building knowledge.

21.2.3 Dimensions of the Digital Competences

The digitization of the educational system is an opportunity to improve the quality of education and the performance of the system, but it requires additional effort on behalf of the educational system, in general, and of the teacher's staff and students, in particular: acquisition of new and varied competencies, development of the capacity to integrate the new technologies in the teaching–evaluation process, adaptation of the traditional techniques, and methods of teaching–evaluation to the new contexts, etc. As other studies showed," education is an area which, it would appear, does not change quickly" (Tomczyk, 2020:201) but ICT requires the system to change its pace. As most of the concept's definitions highlight, the process of educational digitization must consider not just the capacity of using ICT (the cognitive dimension) but also the readiness of the didactic staff to apply the new instruments in their teaching activity in the class, their beliefs and values (attitudinal dimension), as well as the critical and responsible use of ICT within the educational process (ethical dimension).

The highly different socio-demographic and psycho-intellectual characteristics of the population or the segments of the population may favor or obstruct the formation of digital competence and ITC use within the educational process. Several studies reviewed the relation between ITC and the socio-demographic characteristics of the teacher's staff and students and showed that the teaching experience (Hinojo-Lucena et al., 2019; Moreno et al., 2020), gender (Roussinos & Jimoyiannis, 2019), or degree of urbanization (Velicu, 2021) is factors with important impact.

The gender influences the level of digital competence and the availability of using ITC in the class (Guillén-Gámez, 2020), the women teachers and students displaying a lower level of confidence in their capacity to use ITC in the class, compared to males. Ionescu-Feleaga et al. (2021) noticed significant differences between men and women in their evaluation of the training for ITC within the educational process: the women teachers consider more than the male teachers that they need more continuous training in ITC, and they have a lower level of trust in their digital competence than the male teachers.

Some researchers (Oleksiuk & Oleksiuk, 2020; Luke, 2018; Perrotta, 2012; Chee et al. 2005) consider that age is a variable that influences strongly the level of digital competence and the attitude towards it. Thus, the young teaching staff not just have a higher level of digital competence but they also have a more open attitude towards the new technologies and tend to implement more often innovating technologies in the class, compared to their older colleagues. It was also found (Sang et al. 2009), that there is a major difference between having, possessing digital competencies and being able to teach others: the limited didactic experience makes the young teachers less confident in their capacity to use ICT within the educational process, even though they possess a high level of digital competence, compared to the teachers with more teaching experience, but with a lower level of digital competence.

Romanian researchers (Rus, 2019) found that the use of ITC in the educational process is very useful for teachers with longer work experience and older ages because it helps them value their teaching experience. In another research (Tudor, 2016) on teaching staff from level ISCED 0–2, with at least 15 years of working experience, the results have shown that they possess basic digital competencies—use of the internet and digital platforms—which they use in the class but they prefer the traditional methods of teaching–learning.

The level of education where the didactic staff teaches, as well as proper training in ITC during their studies, also proved to be important variables (Guillén-Gámez et al., 2021; MacCallum et al. 2014): the teachers with a high level of education and who acquired digital competencies during their formation display a higher readiness to use ITC in class and to develop this type of competence in their students, compared to the teachers with a lower level of education and to those who did not attend ITC courses either during their initial period of training or during the continuous training; the teachers who teach at higher levels of education (ISCED 5–8) use more frequently ITC during the educational process than the teachers teaching in the basic levels (ISCED 0–3).

In Romania, researchers (Velicu, 2021) identified as a determinant of the level of digital skills, the degree of urbanization: teachers and students in rural areas have both a lower level of digital competencies and more limited access to ICT compared to those from small towns and cities.

Other researchers (Mama & Hennessy, 2013; Lai & Lin, 2018) paid special attention to the values and beliefs of the teaching staff with ITC and show that they influence both the level of digital competencies that they possess, and their availability to use ITC in the class. Rus (2019) analyzes the relation between ITC and the education system from a psycho-behavioral perspective. This perspective on ITC reveals a lack of trust in the modern means of teaching–learning that may influence the level of digital competence not just of the teachers but also of the students: if the teachers possess digital competencies and use ITC instruments in the class, then they can establish this type of competencies in the students too. On the contrary, if they do not possess digital competencies, they will not use ITC in the class and the students will not benefit from formal education.

21.2.4 Measuring the Digital Competencies

As ITC continuously advances in the field of education, among others by determining fields of study that belong to the national curriculum of many educational systems, it was necessary to identify and define systems of measuring indicators. At the level of EU-28, DigCompEdu Framework (Punie, 2017:8) proposes 3 distinct fields that cover six areas—educators' professional competence (professional engagement), educators' pedagogic competence (digital resources, teaching and learning, assessment and empowering learners), and learners competence (facilitating learners' digital competence)—measured by 22 specific indicators. DigCompEdu Framework includes both objective and subjective indicators. The researchers can use, in their analyses, the indicators proposed by the official national or international documents, or they may build their own set of indicators—quantitative and/or qualitative—adequate to the objectives of their study, to the methodology they use, and to the target population.

In Romania, the indicators for ITC are included in the National System of Indicators for Education (SNIE), developed in the early 2000 years by a team of specialists from the Ministry of Education and Research. ITC specific indicators are included in the chapter "Material resources of the educational units" and in the chapter regarding the "Indicators for lifelong learning" (Bârzea et al. 2005; Jigău et al. 2014). Guran (2003) proposes the evaluation of ICT in the Romanian education system through three types of indicators—accessibility, use, and human resources—on a four-level scale: early stage (stage I) followed by two intermediate stages—growth stages (stage II) and consolidation stage (stage III) and highest level—the stage of maturity (stage IV). In both situations, the indicators were developed mainly based on quantitative information derived from statistics collected and processed by relevant national institutions (INS) or by international institutions (Eurostat, OECD): number of computers in schools, number of schools connected to the internet, number of students per one computer unit, etc. The application of these indicators (Neagu, 2013) led to the conclusion at the level of digitization of the education system in Romania is at most stage II. In recent years, especially in the last 2 years, the situation of ICT in the national education system has changed or national programs are underway aimed at increasing the level of digital skills among both teachers and students (”Relevant Curriculum, Open Education for All” Program, for example). To understand the impact of change, evaluations and analyzes using different methodologies are needed.

21.3 Methodology

In this chapter, from the methodological point of view, we decided to make a systematic review of the literature. A standardized search strategy was used for the search articles published between 2000 and the present. Regarding the language in which the articles were written, we opted for Romanian, English, and French. Regarding the time interval, we justify our choice by the fact that our objective is also to support the decision-makers in understanding the importance of ICT for education and the understanding of the issue is easier by relating to the contemporary context.

The procedure to select studies and to analyze these are described below. To search for relevant studies, a comprehensive search was performed using “ANELIS PLUS”in July and August 2020. This browser includes many databases such as ERIC, Proquest, Sage, Emerald, etc. To search for potential references, the term “digital competence” was combined each time with the following terms: “teachers”, “Romania”, “Romania education system”. To avoid eliminating the articles written in Romania, in Google Scholar, we also searched articles using the same terms in Romanian: “competențe digitale” combined with “România”, “cadre didactice”, “sistem de învățământ”. The terms in Romanian used to identify the articles will be translated into English.

To select relevant studies for this review, a study had to conform to the following criteria: (1) published between 2000 and 2021; (2) published in a scientific journal; (3) open access to the full text; (4) contained empirical data; (5) focused on digital competence of students from ISCED 4–8 (the inclusion of level 4 took into account the fact that some teachers start their training from the secondary level of education by attending Pedagogical High Schools). The study selection (Fig. 21.1) was made in three steps.

First, the titles of all retrieved articles were screened for eligibility for the abovementioned inclusion criteria. Second, the abstracts of all initially relevant articles were screened for eligibility by applying uniform criteria. Finally, the full text of all remaining publications was analyzed. After applying the selection criteria, 16 studies were selected for this review.

Table 21.1 shows an overview of the selected studies. The analyses conducted by the Romanian authors cover ISCED 4–8 level of education and report results of national and international researches which included the population of teachers and students from Romania. Most studies rely on quantitative researches (N-13) with the questionnaire, but the samples of teaching staff and students are not representative of

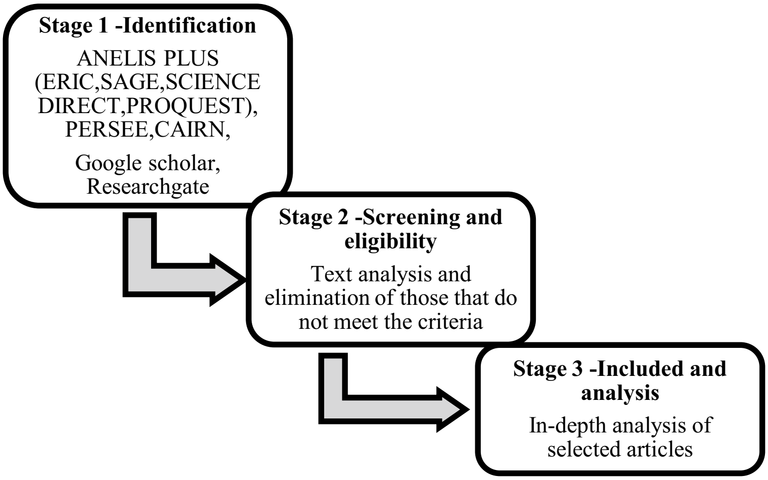

Fig. 21.1 Document selection process

these segments of the population. The qualitative researches are fewer (N-3) and use direct interviews, semi-structured, or group discussions. Most authors constructed their instruments to measure the level of digital competence, using both objective indicators and indicators of perception or state. Most analyses used Likert scales of 5 or 10 points and the conclusions were given either in terms of percentages or in terms of mean scores and standard deviations. The percentages were used in different ways: level of digital competence or attitude of the teaching staff and the students towards ITC: they decided to calculate the percentages above or below the average (for instance, 40% of the teaching staff/students have a particular type of competence/display a specific aptitude and 60% of them do not have this type of competence/do not display this type of aptitude). The same situation exists for the papers which presented the results using means or standard deviations: the results are shown as favorable/positive when the mean is 3.5 or higher on a Likert scale of 5 and negative/unfavorable if the mean is 2.5 or lower (5.0, vs. 4.5 on a scale of 10).

In terms of the year of publishing, we may notice (Table 21.1), that most articles are recent—2014—and very recent—2021. This is because of the epidemics, which made ITC the main means of making education not just in Romania, but in most foreign countries too. The interest of the Romanian researchers for the relation between ITC and education resides in the fact that the public space hosted many debates on the capacity of the national system of education to ensure access to education through ITC to all the children under pandemic conditions. The fact that the national system of education is still in its early stages of implementing ITC is also shown at the level of scientific production: most articles have a general character, they focus mainly on the cognitive dimension, they approach in a general manner the difference between teachers and students in terms of digital competences (use or do not use ITC in the class, for instance).

Table 21.1 Summarizing overview of the selected studies (N-16)

Author (s)	Type of research	Research tools	Sample[a]	ISCED 0–8	N/I[b]
Lupu, O. and Mitrea, E. C. (2021)	Quantitative (N-1851)	Questionnaire	B	ISCED 5–6	A
Draghicescu, L. M. & Stăncescu, I. (2021)	Quantitative (N-256)	Questionnaire	B	ISCED 5–6	A
Goanță, I. and Tripon, C. (2021)	Quantitative (N-705)	Questionnaire	B	ISCED 5–6	A
Miulescu, M. L. and Matei F. L. (2021)	Qualitative (N-22)	Direct interviews	B	ISCED 5–6	A
Ionescu-Feleaga et al. (2021)	Quantitative (N-1179)	Questionnaire	B	ISCED 5–8	A
Alexandru, M. et al. (2020)	Quantitative (N-438)	Questionnaire	B	ISCED 5–6	A
Fleacă et al. (2019)	Quantitative (N-78)	Questionnaire	B	ISCED 5–6	A
Cismaru et al. (2018)	Quantitative (N-98 students)	Questionnaire	B	ISCED 5–6	A
Mureșan, M. (2015)	Quantitative (N-135)	Questionnaire	B	ISCED 5–6	A
Oproiu, G. C. (2015)	Quantitative (N-52)	Questionnaire	B	ISCED 5–6	A
Dina and Ciornei (2015)	Quantitative (N-80)	Questionnaire	B	ISCED 5–6	A
Duţă and Martínez-Rivera (2015)	Qualitative (N-90)	Direct interviews	B	ISCED 5–6	A
Munteanu et al. (2014)	Experiment	Tests	A	ISCED 3–4	A
Chicioreanu T. D. and Amza C. Gh. (2014)	Quantitative (N-82)	Questionnaire	A	ISCED 5–6	A B
Andronic, R. L. (2012)	Quantitative (N- 405 students, 904 graduates and 825 employers.)	Questionnaire	B C	ISCED 5–6	A
Istrate, O. (2009)	Quantitative (N-1588 teachers; N-3953 students; N-505 teachers)	Questionnaire	A B	ISCED 2–8	A

[a](A) Teachers; (B) Students; (C) Other categories of the population;
[b](A) National level-N; (B) Romania in the international context-I

21.3.1 Research Limits

This paper has several limitations and the results must be interpreted with this in mind. First, the inclusion criteria that guided the selection of studies for this review may have influenced the results obtained. Some relevant studies may have been excluded. Second, the 16 articles that were included in the final selection were not distributed so as to reflect the situation at the level of the education system: levels of education or student population, etc. Third, for those articles that included distinct categories of the population (students, teachers, employees), it was not always possible to distinguish between respondents based on the data presented by the authors.

21.4 Results

After drawing up the overview in Table 21.1, the results of the studies were described in more detail.

Table 21.2 Overview of studies reporting variables related to teachers and students digital competencies (N-16)

Author (s)	Digital competences	Variables
Lupu and Mitrea (2021)	Perform tasks Communicate Collaborate	Year of Study/Type of specialization/Degree of urbanization/Gender
Draghicescu and Stăncescu (2021)	Perform tasks Communicate Collaborate	Age/Gender/Degree of urbanization/Year of study
Goanță and Tripon (2021)	Perform tasks Communicate Collaborate	Age/Year of study/Type of specialization
Miulescu and Matei (2021)	Perform tasks Communicate Collaborate	Age/Level of education/ Type of specialization
Ionescu-Feleaga et al. (2021)	Perform tasks Communicate Collaborate	Gender/Age/Level of education/Type of Institution
Alexandru et al. (2020)	Manage information	Age/Level of education/Type of specialization/Gender
Fleacă et al. (2019)	Perform tasks Communicate Collaborate Create and share content	Level of education/Type of specialization/Gender

(continued)

Table 21.2 (continued)

Author (s)	Digital competences	Variables
Cismaru et al. (2018)	Perform tasks Communicate Collaborate	Gender/Age/ Type of specialization /Level of education
Mureșan, M. (2015)	Perform tasks Communicate Collaborate	Level of education
Oproiu, C. (2015)	Perform tasks	Level of education
Dina and Ciornei (2015)	Perform tasks	Age/Level of education/Degree of urbanization
Duţă and Martínez-Rivera (2015)	Perform tasks Communicate Collaborate	Age/Level of education
Munteanu et al. (2014)	Perform tasks Communicate Collaborate Create and share content	Level of education/Type of specialization
Chicioreanu and Amza (2014)	Build knowledge	Level of education
Andronic, R. L. (2012)	Perform tasks Manage information	Level of education/Type of specialization/Occupation/
Istrate, O (2009)	Perform tasks Communicate Collaborate	Level of education/Degree of urbanization

21.4.1 Terminology and Typology

Most of the authors of the selected papers use the concept of *digital competence* (Draghicescu & Stăncescu, 2021; Fleacă & Stanciu, 2019), but we also noticed other concepts deriving from it: *digital intelligence* (Cismaru et al. 2018), *digital learning* (Oproiu, 2014; Gonță & Tripon, 2021; Lupu & Mitrea, 2021; Andronic et al. 2012), *Internet of Things—IoT* (Ionescu-Feleaga et al. 2021), or *digital literacy* (Mureșan, 2015). In some articles, we may notice two or more concepts—digital competence and digital literacy or digital learning and digital competence, for instance—but irrespective of the used concept or irrespective of the combination of concepts, all of them are used with the same significance. To explain the meaning of the concepts they used, most authors gave the acknowledged definitions of the digital competencies (DigCompEdu, 2017; Ferrari, 2012), or analyzed this type of competences within the context of the eight key competencies—Mureșan (2015), for instance. However, there are situations when the authors decided on their interpretation of the concept. For Fleacă and Stanciu (2019) "digital competence is understood as a set of knowledge, attitudes, and skills that all citizens need in a rapidly evolving digital society" (Fleacă & Stanciu, 2019:1053). Ionescu-Feleaga et al. (2021) have a different perspective on the concept of digital competence. They analyze it in terms of the *Internet of Things—IoT* which is the "open and comprehensive network of intelligent objects that can self-organize, share information, data, and resources, reacting and acting in front of situations and changes in the environment, facilitates the communication and transmission of information" (Sula et al., 2013, apud Ionescu-Feleaga et al. 2021:344).

21.4.2 Indicators Measuring the Digital Competencies and Level of Digital Competences

The next step of our analysis is to identify the indicators that the Romanian authors used to measure the level of digital competence and for the level of digital competencies of students. Table 21.2 shows the types and levels of digital competencies we have identified in the selected papers. SNIE is used in just one of the selected papers—Istrate (2009)—but the author also adds his indicators, subjective ones. Cismaru et al. (2018) propose four categories of indicators: *operational skills* (orientation skills), *informational skills* (critically assessing information and the trustfulness of the online sources/messages), *strategic skills* (the individuals' ability to take advantage of social media and reach specific goals), and *digital fluency* (socio-emotional involvement or understanding of the fact that the online environment can be fully controlled and that some behaviors of the potential contact users can be negative). For each of these categories, they use the Likert scale of 5 points. The indicators used by Fleacă and Stanciu (2019) in their paper are *information and data processing* (browsing, searching and filtering data, information and digital content; evaluating data, information and digital content; managing data, information and digital content; interacting through digital technologies), *digital communication* (sharing through digital technologies; collaborating through digital technologies; managing digital identity), *digital content creation* (developing digital content; Integrating and re-elaborating digital content; copyright and licenses), and *digital problem-solving* (identifying needs and technological responses; creatively using digital technologies). (Fleacă & Stanciu, 2019:1053) The authors used a Likert scale (based on non-comparative technique), as well as the nominal scale (frequency distribution). A survey conducted by Chicioreau et al. (2014) among the population from higher technical education showed the situations when ITC is used in the class, focusing on a particular digital instrument: augmented reality (AR).

The indicators they used to cover various types of digital competencies: *perform tasks* and *communication/collaboration/inclusion* (recommending that the students use, within the electronic resource portfolios using the AR; posting didactic materials containing AR markers on the faculty eLearning platform) or *manage information/create and share content/build knowledge* (creating AR resources, for instance). Draghicesc and Stăncescu (2021:60) used a questionnaire in which the digital competencies are measured by indicators targeting (1) involvement of the students in online educational activities, (2) efficiency, and (3) quality of the educational activities in which the modern methods and means, based on ITC, prevail over the traditional methods and means, (4) proposals and solutions to improve eLearning.

To measure the level and type of digital competence by indicators of perception or by indicators of satisfaction, the authors used mainly qualitative methods of investigation or a methodological mix (group discussions and experiments). Duţă and Martínez-Rivera (2015) conducted direct interviews with the students to measure their perception of using ITC in education and on the most suitable digital instruments to conduct educational activities in the class. Based on the collected data, the authors propose the following indicators of perception: *a tool for communication and interaction improves learning, facilitates autonomous and independent learning, assume different roles, fosters knowledge of the contents of the field,* i*ncreased motivation, follow-up, innovation, and integration, developing skills in finding the information, creativity.* Mureșan (2015) measured the degree to which the students are satisfied by the use of ITC in the process of education in terms of the level of digital literacy and of the progress in using digital instruments in the process of teaching–learning. Ionescu-Feleaga et al. (2021) use a quantitative methodology based on a questionnaire that contains five sets of questions related to IoT technologies measured on a scale of 5. The indicators that measure the perception of the students on IoT are the usefulness of IoT technologies in the learning process; ease of using IoT technologies in the learning process; intention to use IoT technologies in the learning process; facilitating conditions for the use of IoT technologies; and training in the use of IoT technologies (Ionescu-Feleaga et al., 2021:348).

21.4.3 Factors that Influence the Relation of ITC with the Education

In their actions related to a particular situation, to their strategies and behaviors, the people also take into account their conviction, their view on the situation or situations that they encounter. The convictions, beliefs established by the contact with various situations, by how the people interpret and understand the information, subsequently turn into filters used to redefine or reshape the subsequent information or situations. (Lai & Lin, 2018:3) Speaking strictly about the digital competencies of the teachers, a positive perception of ITC and a positive experience in the contact with digital instruments lead to favorable actions such as the acquisition of digital competencies, the inclusion of ITC in the educational process, attendance of training courses, etc. On the contrary, negative perception and experience increase the distance between the individual and ITC, increase the odds of rejecting the digitization process, stress the mistrust in ITC and in own capacity to cope with the new teaching technologies, and this state passes on to the other categories of the population involved in the educational process, students, parents, etc. In terms of the socio-demographic characteristics, age (Cismaru et al., 2018), gender (Ionescu-Feleaga et al. 2021), level, and type of education (Oproiu, 2015) are most often analyzed concerning the digital competencies of the teaching staff and students. The psycho-attitudinal characteristics of the teaching staff and students and their impact on the level of digital competencies are less often analyzed by the Romanian authors (Ionescu-Feleaga et al., 2012, for instance).

21.5 Discussions

The concept of digital competence is defined in the papers of the Romanian authors from various perspectives and using various terminologies, but they share the view that this type of competency does not merely consist of technical abilities and does not involve merely a cognitive dimension. For the Romanian authors, to be digitally competent means possessing not only a set of technical abilities and skills but also the capacity to access, identify, understand create, and/or communicate information and data from various sources. A digitally competent person is a responsible person who understands how to use the online content, how to select content in agreement with the needs, age, and intellectual particularities of the population with which this person works. The Romanian authors highlighted the importance of the types of competencies that the didactic staff must possess and which they must form in the young people: at least basic digital competencies for the elementary and middle school (ISCED 0–2), as well as highly complex digital aptitudes for ISCED 5–8. Fleacă and Stanciu (2019) focused on the population of students from level ISCED 5 and noticed high values for most types of digital competencies which the students consider they have: to adapt search strategies to a specific search engine (3.38), ability to edit information through email, presentations in slides, and social networks (3.48), digital content creation (3.53), digital problem-solving skills and to integrate it into own learning environment (3.99) (Fleacă & Stanciu, 2019:1054). Another survey conducted at the same level, (Muresan, 2015:28) showed that the students have a high level of satisfaction in terms of digital literacy (87% rated this aspect with the highest value), while 80% of the students rated similarly the applied use of ITC knowledge too. However, Mureșan (2015) showed that the level of satisfaction of the students is much lower when they have to evaluate the digital competencies related to managing information/creating and sharing content/building knowledge. (Mureșan, 2015:24). The same conclusion is also shared by Alexandru et al. (2020) who consider that content creation and the responsible attitude towards the online content must be essential conditions for future professionals in education, but just 14.4% stated that they can select the most suited online platform for a particular didactic activity, and just 16.6% stated that they can select the most suited digital educational application for a particular didactic activity (Alexandru et al., 2020:151). Duţă and Martínez-Rivera (2015) used qualitative research to investigate the opinions of students (ISCE D 5–8) regarding the level of digital competence. The results show that part of the students has a level of self-evaluation much above the average: *a tool for communication and interaction* (91%, 82 responses), *improves learning* (87.7%, 79 responses), *facilitates autonomous and independent learning* (80%, 72 responses), *assume different roles* (75%, 68 responses), *fosters knowledge of the contents of the field* (63.3%, 57 responses), *increased motivation* (58%, 52 responses). On the other hand, the values for other types of digital competence, such as *follow-up* (46%, 41 responses), *innovation and integration* (39%, 35 responses), *developing skills in finding the information* (34%, 31 responses), and c*reativity* (31%, 28 responses) are below the average.

Both the quantitative data and the qualitative data analyzed by the Romanian authors show that, although these abilities are interconnected, they are not fully present among the population of students: the ability of task solving or communication are not accompanied by the skills for content creation of information management, for instance. The analysis of the selected papers shows that although the students have a high level of evaluation regarding their digital competencies, subsequently, as future teachers, their level of confidence decreases sharply (Mureșan, 2015). Thus, although most of the population of students is considered to be "native digital", the fact that as the level of complexity of the digital competencies increases, their level of self-evaluation decreases, placing it far from the image built around it. The contradiction between the high self-evaluation of the level of digital competence and the actual practice is explained by the researchers (Loureiro et al. 2012) by the fact that the teaching staff working with students have a lower level of digital competence and, therefore, may have a much higher positive perception on the level of their students. Another explanation is that the digital competencies for which the students are highly satisfied may have no relevance for their future responsibilities, or their perception may be wrong because they do not understand and they were not taught what digitally competent means. The teaching staff has the obligation of adapting the formation of the future specialists to the current and prospective needs of the society and economy and to explain what being digitally competent means.

The results of the Romanian researchers also support the idea that possessing digital competencies is a much more complex problem that does not mean merely technical aspects but also involves understanding what means to be digitally competent. As some researchers (Wiljer et al. 2019; García-Pérez et al. 2016) highlight one needs an increased focus on the emotional, attitudinal, or creative facets of digital competence. To meet these requirements, the teaching staff must be digitally competent.

Given the complex relationship between ITC, the teaching staff and the students, the levels and types of digital competence for the population of didactic staff were determined by different approaches and depending on the level of education: using digital techniques such as augmented reality (Chicioreanu & Amza, 2014) or using educational platforms (Oproiu, 2015).

Analyzing the situation in the entire education system (ISCED 2–8), Istrate (2009:4) noticed that the digital competencies are higher for situations such as: reading the school legislation or internet news (54,4%), creation of worksheets for the students, information materials, drawings, evaluations (50,1%), browsing for information to help students with their homework (46,4%). The level of digital competencies is much lower when the level of complexity increases. Thus, a study

(Istrate, 2009:3) found out that the new technologies are little used to create educational programs (56.9% of the respondents said they don't use all computers for this activity), to communicate with the students after school hours (49.2%) or with their families (64.7%).

Chicioreanu and Amza (2014) analyzed the digital competencies at the higher level of education (ISCED 5) using teaching–learning methods that involve ITC: augmented reality (AR). The authors found the highest values for posting didactic materials containing AR markers on the faculty e-Learning platform (87% of the teachers) and recommended that the students use, within the electronic resource portfolios using the AR (82%). The digital competencies related to management scored much lower values: creating AR resources (23%) and using the AR within the course (42%).

It is very important the opinion of the students regarding ITC in general, and the digital competencies, in particular. The inclusion of both categories of the population—teachers, and students—in the research has the advantage of providing a much more complete image of the current situation and the prospects. Lai and Lin (2018) consider that the beliefs of the didactic staff, including those related to the methods and techniques of teaching–learning used in the class start to form when they are students (Lai & Ling, 2018:10). The Romanian students have high expectations from their teachers and the research conducted by Romanian authors showed that the "online activity needs improvement for the teachers' part. According to the opinions expressed by students, during the online activity, it is desirable that the teachers: interact more actively with the students during the teaching process, involve them more actively, communicate more with them" (Gonta & Tripon, 2021:87). Ertmer et al. (2012) think that the students consider themselves, and many times are, more digitally competent than the teachers, which may be a good thing: it determines the latter to take into consideration the changes in the young population and try to improve their techniques and methods of teaching, adapting them to the current realities (Ertmer et al. 2012:432).

In Romania, most of the teachers, especially at pre-university levels, did not have access to ITC and, therefore, they do not know what means to be digitally competent, and they have difficulties in teaching this to others. The competencies acquired during the training period risk being devalued if they are not used in the profession that people practice after leaving the education system. This is why the Romanian authors consider that "ITC is good for all age categories because it can adapt to the teaching experiences of the teachers with a long working history and older, but also to the young people who are opened to the new. However (…) there is the risk that the continuous development of ITC might put the older people in difficulty" (Cismaru et al. 2018:14). In other words, the socio-demographic and behavioral–attitudinal particularities might either hinder or support the formation and development of the digital competencies, irrespective of the category of the population. The Romanian authors produced different opinions regarding the relationship between age and level of digital competence, as well as regarding the attitudinal–behavioral dimensions towards ITC. Some authors (Cismaru et al. 2018) reached the opposite conclusion: the level of digital abilities decreases with the age, while other authors (Mureșan,

2015) consider that the socio-demographic characteristics of the teachers have no influence on their perception or attitude regarding the use of online applications in education.

Although age is not always associated with the professional experience—for the teachers—or to the learning experience—for the students—the results of the researches conducted by Romanian authors revealed certain peculiarities, especially concerning the students. Oproiu (2015) observed that the young students are less familiarized with some ITC applications that might help them with learning compared to the students from the upper years of study: almost half of the students in the first year (45%) did not work of learning online (Oproiu, 2015:429). Ionescu-Feleaga et al. (2021) also identified differences generated by the identical learning experience, but only regarding the use of IoT in the educational process, the intention to use IoT, and the continuous formation, for which students' opinion enrolled in the bachelor degree, differ significantly from those in the master and Ph.D. studies (Ionescu-Feleaga et al. 2021:352).

The age and the learning experience support the confidence in their own digital competence: the Romanian students over the age of 25 consider that they have a high level of digital competence (3.8 on a scale of 5), compared to the younger students (Cișmaru et al. 2018). One of the explanations of the authors regarding this fact is that the older students have a previous learning experience, can work better individually or in small groups. Istrate (2009) compared the students from different levels of education, basic level and high level, both regarding the access to ITC equipment (computers, internet connexion), and regarding the digital competence, and found out that most of the students who work alone on a computer are high-level students (67.8%), and only 25% are basic level (Istrate, 2009:4).

An important criterion of analysis of the level of digital competence is the degree of urbanization, particularly in the countries where there are significant differences between rural and urban areas, such as Romania. Istrate (2009) noticed that the average scores are higher for diversified activities in urban schools, especially concerning those activities that encourage creativity and for activities that use the Internet. Miulescu (2001) noticed that most ITC applications and most digital instruments are specific to the urban education institutions and higher education institutions, which shows that the level of digital competencies differs with the degree of urbanization.

The proportion of each category of characteristics is different in terms of the level of digital competencies, but the personal characteristics are dominant. The results of the Romanian authors are close to researches conducted in other systems of education (Guillen-Gamez et al. 2021), who noticed that young teachers and students are more open to the implementation of teaching methods and techniques that use ITC. In the articles in which the authors analyzed the relation between the gender of the teaching staff or the students and the level or type of digital competence, we noticed that men are more confident in their digital abilities, are more open to ITC utilization in their educational activity compared to women. This conclusion is in agreement with the reports of other studies (Guillén-Gámez et al. 2021a) who showed that the male teachers obtained higher scores than the female teachers, particularly for the higher level digital competencies (information management, digital flow).

21.6 Conclusions

Competencies, whatever their nature, presume the use of knowledge, aptitudes, and attitudes to solve concrete, clear problems (OECD, 2021). To do this, the population must have the possibility to form a set of competencies: institutions of education that have ITC equipment, teachers having digital competencies and are willing to form their competencies in their students too, continuous training courses to develop, and perfect this type of competencies, etc. The results of the review of the scientific literature published in Romania over the past two decades on the subject of digital competencies reflect the existence of common points between the teaching staff and the students, between different categories of students (different as age, gender, etc.) but also of diverging opinions on specific aspects of the digital competencies. Similar results have also been reported by other researchers (Tomczyk, 2020:208), which show that the teaching staff and the students have different opinions regarding this problem, and are not always favorable to the new technologies.

The relevant aspects, specific to the national system of education, highlighted by the Romanian authors, are:

- Romanian authors use the concept of digital competencies to cover a wide range of meanings: from the ability to use a device to the ability to create educational content;
- At the level of the national education system, the digital competencies related to *perform tasks* and *communicate/collaborate*; the highly complex digital competencies (mainly related to *content creation or manage information)* are less common;
- The influence of the socio-demographic and psycho-intellectual particularities is modest and very similar to the situation observed in other educational systems. This means that the development of continuous formation for the students and easy access to ITC equipment may prove to be measures that alleviate the influence of age, gender, and professional experience on the level of digital competencies;
- The national system of education needs a system of indicators measuring the digital competencies which include both objective and subjective indicators, and which to be a landmark both for the teachers and for those who are responsible for the development of support policies.

The key people in the field of educational policies should consider the fact that the teaching staff and students from Romania, irrespective of the level of education, requires continuous formation which includes not just technical skills to use ITC equipment, but also the formation of behavioral attitudes about ethics, to the responsibility of using ITC. The system of indicators measuring the digital competencies should be accompanied by a monitoring system and by support mechanisms without which many of the objectives and projects targeting the digitization of the national system of education lack sustainability, as mentioned by the authors of the reviewed papers and by the state reports of the system of education (Balica et al. 2018). This study, although focusing only on one dimension of the issue of digital skills, is a starting point in analyzing the level of digital competencies of Romanian students. Such studies, which include other dimensions of ICT issues, support decision-makers in their quest to achieve the objectives set out in the strategy documents.

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Chapter 22
Analysis of Teachers' Needs Related to Their Professional Digital Skills: Reflection on the pre-Corona State in Slovakia and Impact of the First Wave of the Pandemic on These Needs

Alena Hašková and Ján Záhorec

Abstract The paper presents in short philosophy on which professional profile of a teacher in Slovakia, within which teacher's digital skills are included as a part of one of the profile's key competences, and strategies of teachers' digital competences development based on the national school policy. In more details, there is assessed the state of Slovak teachers' level of digital literacy and teachers' needs regarding their further education in the concerned area before the Corona pandemic has appeared. This assessment is done in two focuses. One of them is focus on in-service teacher population and the other one is assessment of pre-service training of teacher trainees and needs of its continuous innovation. Following the pre-Corona research findings there is a proposal of recommendations creating a basis for designing an optimal basis of pre-service teacher training on shaping teacher trainees' professional digital literacy. However, in the last part of the paper these recommendations are re-evaluated due to the challenges related to teachers' professional digital literacy, which have occurred under the influence of the Corona pandemic situation on all forms of education.

Keywords Pre-service teacher training · Curricula innovation · ICT skills monitoring

A. Hašková (✉)
Faculty of Education, Constantine the Philosopher University in Nitra, 949 74 Nitra, Slovakia
e-mail: ahaskova@ukf.sk

J. Záhorec
Faculty of Education, Comenius University in Bratislava, Račianska, 59, 813 34 Bratislava, Slovakia

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22.1 Framework of Teacher's Professional Profile and Key Competences in Slovakia

The government declaration from 2006 became the fundamental stimulus towards legislative dealing with the issue of professional profile of a teacher in Slovakia. The then government declared its obligation to prepare the law on pedagogical employees that would have stimulated their career growth via motivational salary system directly connected to their professional development (Programme declaration of the Slovak government, 2006). Conceptual stepping stone to this law (Act No. 138/2019 Coll. on Pedagogical Employees and Professional Employees) should have been in the form of created system of professional teachers' standards.

In 2007, the methodology for creation of professional standards was approved and based on this methodology the official proposal regarding professional profile of a teacher was completed (professional standards proposal). The Oser's model of teacher's competences (Oser, 2001) has become a basic platform in Slovak environment (Kasáčová, & Kosová, 2007). This model defines the teachers' standards in five different groups:

- competences oriented on a teacher themself,
- competences oriented on a school, cooperation within school environment and also with the public,
- competences oriented on a pupil as an individual human being, pupils diagnosis and the interventions supporting strategies of their learning that result from that diagnosis; competences oriented on teacher–pupil relationship,
- competences oriented on pupils as a group; competences oriented on how to solve problems regarding discipline; competences oriented on supporting pupils social behaviour,
- competences oriented on teaching strategies, management and organization of educational process, deployment of teaching aids and supporting material and general didactic and subject-didactic competences.

The final version of approved Slovak model divides professional competences of a teacher into three dimensions:

- dimension of competences oriented on pupils (their input characteristics and conditions for further development),
- dimension of competences oriented on educational process (mediation of the educational content, didactic transformation for particular needs of pupils and for creation of adequate educational conditions),
- dimension of competences oriented on professional and personal development of a teacher.

In most countries, which have defined teacher professional competences, the standards focus mainly on the quality of teacher training and the quality of teachers in a general level. The specificity of the Slovak model is its interconnection with the teacher career system. This means that the Slovak system defines degree, quality and scope of the relevant key professional competence fulfilment depending on the career level of the teacher's career path.

All the mentioned dimensions of professional teachers' competences were also accepted as a starting point within the research oriented on identification of the key competences regarding teacher's profession and designing tools for their evaluation, that was carried out under the leadership of Gadušová (Gadušová et al., 2019). Based on the research outcomes, the following ten competences (stated without hierarchical order) were defined within the three above-mentioned dimensions as the key ones for successful professional performance of every teacher (Magová et al., 2016):

1. ability to identify learner's developmental and individual characteristics;
2. ability to identify psychological and social factors of learner's learning;
3. ability to develop learner's personality and competences;
4. ability to create and maintain positive atmosphere in the class;
5. ability to plan and implement (carry out) teacher's own professional development;
6. subject related professionalism of teachers (knowledge of the subject content and its didactics);
7. ability to plan, project and manage educational process;
8. ability to choose and use relevant teaching approaches, methods, techniques and forms;
9. ability to use material resources (teaching aids) in teaching process;
10. ability to evaluate progress and outcomes of teaching process and learners learning and learning achievements.

Didactic–technological competences of a teacher in the mentioned set represent the ability to use material resources (teaching aids) in teaching process. Didactic–technological competences can be defined as the skills and abilities of a teacher to deploy material didactic tools in educational process within particular school subject. In regard to the newest digital technologies, didactic–technological competences of a teacher can be defined as the set of professional skills in the field of digital literacy that are used intentionally during the implementation of a digital teaching tools into various educational situations within particular school subjects. Didactic–technological competences nowadays represent more and more dominant part of the professional teachers' profiles because they undoubtedly support the quality and attractiveness of educational activities of teachers. Practically, all institutions of higher education that participate in the process of preparation of future teachers for primary and secondary levels of education (ISCED 1–3) have incorporated such school subjects into their curricula that are oriented on forming and development of didactic–technological competences of teacher trainees. However, there are some differences in quantity of those school subjects, the way of their implementation into the school curriculum for tertiary education and also differences in their content and weekly time allocation. Besides some others, the analysis of these differences was done in the research work by Tóblová and her colleagues (Tóblová, 2018; Tóblová, Nagyová, & Záhorec, 2017). In respect of the common roots of the Czech and Slovak educational systems and especially of preparation of teachers, her research team focuses their attention to the concept of teaching study programmes (or the implementation of educational disciplines oriented on deployment of digital technologies in educational processes into the undergraduate preparation of teachers) at the institutions of higher education both in Czechia and Slovakia. The object of their analyses was 25 subjects of the appropriate study programmes in Slovakia (2 in the master's study programmes and 23 in the bachelor's study programmes) and 30 subjects in the Czech Republic (4 subjects in the master's study programmes and 26 in the bachelor's study programmes). As the analysis findings showed out, there are more or less the same numbers of the subjects focused on the use of digital technologies in teaching and learning processes, and development of relevant competences of teacher trainees included in their study programmes at both levels. The same finding was obtained also in the analysis related to curricula (syllabi) of the given subjects (issue of heterogeneity and scope of the taught topics), and the way the subjects have been included in the study programmes (whether are they compulsory or optional, in which term of the study they are taught and with what time allocation). Differences, which have occurred within the stated analysis, were rather insignificant. In Slovakia as well as in the Czech Republic, the given subjects are usually prescribed as compulsory ones (40%). In Slovakia, quite often they are taught also as optional, while in the Czech Republic more common is that they are included among compulsory optional subjects. The observed subjects are usually taught two lessons per week, equally in Slovakia as in the Czech Republic. A slightly significant difference between Slovakia and the Czech Republic occurs in case of these subjects' position within the study programmes. In Slovakia, they used to be incorporated into the second or third term of the bachelor's study programmes, while in the Czech Republic, they used to be set into the third or fourth term of the bachelor's study programme.

As to the time allocation (the numbers of lessons per week) of these subjects, there are no significant differences either within the Slovak Republic or between Slovakia and the Czech Republic. The most frequent time allocation for these subjects is two lessons per week. In Slovakia, these lessons are taught dominantly in the second and third semesters of the higher education while in the Czech Republic in the third and fourth semesters. Another research question of the analyses was the question how many credits according to ECTS students can obtain for their passing. According to the analysis results, almost 65% of the subjects are assessed continuously (continuous assessment during the term). Passing the completed subject, students are given either three of four credits. In both Slovakia and the Czech Republic, dominantly preferred form used for teaching these subjects are seminars (SK-64%; CZ-56%). Another form, which occurs in some cases is a hybrid form consisting of lectures and seminars (SK-32%; CZ-10%).

At this point, it is necessary to notice the fact that there are also cases of underestimation of the teacher trainees' professional digital competence development. In general, not all higher education institutions (in Slovakia not very often case) pay adequate attention to the issue of didactic–technological preparation of teacher trainees and have had included this preparation in appropriate scope in the pre-service study programmes of teaching, offered by them to students. The scope and content of the didactic–technological preparation, in frame of which professional competences related to teacher trainees' digital literacy are (or should be) developed is very often eliminated to formation teacher trainees' skills to the use of Internet for searching teaching and learning materials on Internet. Such training, of course, does not reflect to the real needs and requirements of pedagogical practice. Moreover, in its consequence teacher novices, who passed such kind of their pre-service preparation, enter to their job career de facto unprepared to use adequately digital means in their teaching career, to take benefits which these means offer both them as well as their pupils and students. But the guilt cannot be given exclusively to the providers of the pre-service training of teacher trainees (means higher education institutions offering study programmes of teaching). One has to have in his mind that it is necessary to give these institutions a clear idea how the concept of the didactic–technological teacher trainees preparation (including their professional digital literacy development) should look like so that it would reflect to the continuously changing and increasing needs and requirements of pedagogical practice.

22.2 Where We Are—Assessment of Slovak Teachers' Key Competences

OECD and UNESCO already in 2001 (OECD, 2001; UNESCO, 2001) pointed out that expectations on teachers became higher every day, and that there was a growing demand for higher qualifications and competences as well as a higher need for continuous updating, both in the didactic expertise and in the teachers' knowledge. For schools, the stated was considered to be essential, because to provide tomorrow's world with the knowledge and skills on which economic and social progress so critically depend, educational institutions and teachers need to respond by developing and delivering appropriate educational content (UNESCO, 2001). Both OECD and UNESCO highlighted the necessity to complement the teachers' disciplinary command with pedagogical competence to facilitate the development of high-level competencies in their students.

As follows from the research of the teacher key skills, Slovakia needs to increase quality of both pre-service as well as in-service teacher training and at the same time also to motivate teachers to increase their competences in these skills. The research, dominantly aimed at the primary school teachers, was a part of a broader scaled national project *Programme for the International Assessment of Adult Competences* (PIAAC). The PIAAC international survey was designed to provide insights into the availability of some of the key skills in society and how they are used at work and at home (OECD, 2013). It directly measures proficiency in several information-processing skills, e.g. reading comprehension, search for information mainly in its electronic form, skills and abilities to use computers and to solve tasks and problems in a technology-rich environment. It is the largest and most comprehensive survey aimed at mapping and evaluating the level of competencies of adults aged 16–65, conducted under the auspices of the OECD. At the same time, it is also the first international research focusing on the use of respondents' skills at work and at work. It verifies abilities and skills of adults, which are necessary for their application in everyday life (e.g. reading comprehension, search for information mainly in its electronic form, skills and abilities to use computers and to solve tasks and problems in a technologically advanced environment). Purpose of the project is to assess efficiency of education and vocational training systems and to set education policy tools for development of those key competences (including digital competences) which support employment in the labour market and society, as well as for development of key competences necessary for inhabitants' everyday life.

In Slovakia, the research has been carried out under the patronage of the National Institute for Certified Educational Measurements (NÚCEM—*Národný ústav certifikovaných meraní vzdelávania*). In the first cycle of the survey (2008–2019), three separate rounds of data collection have been undertaken. In the first round within three waves of data collection (2011–2012) in Slovakia, more than 950 teachers of primary schools and 8-year grammar schools from all over Slovakia took part in the research (Bunčák et al., 2013). From the total number, more than 80% of respondents were women. Teachers could apply voluntarily, with registration being motivated by a financial reward. The research did not confirm the assumption that the highest level of skills will be achieved by teachers aged 25–35, as was the case in the data collection in PIAAC 2012. On the contrary, the results showed that older teachers aged 44–54 years achieved significantly better scores than younger teachers under 35, without any signs of declining trends. However, at a narrower focus on teacher digital skills, one could see that these were a domain, especially of the younger generation, who achieved better results in solving tasks using information and communication technologies (ICT) compared to more experienced teachers. NÚCEM stated that although the precondition for working with ICT on the basis of research was good, in regional education there was a lack of teachers, especially over 45 years of age, who were digitally skilled and competent. But the approach of the respondents towards digital online tools in general was quite positive. From the part that focused on the behaviour of the teachers involved, it became clear that their dominant aspect was conscientiousness. It grew with age and was associated with features such as organization, reliability and self-control. However, curiosity was less important for the participating teachers. Respondents felt to be moderately creative and innovative. For women, researchers noted greater generosity and sociability, while men saw greater intellectuality and curiosity. A very positive finding was that primary school teachers showed a high interest in continuing education. On the other hand, the teachers pointed out different obstacles of their further education, as the biggest ones they consider to be high financial demands, absence of incentives, lack of suitable offers as well as lack of time caused by family responsibilities. According to NÚCEM, the project results pointed out a low rate of intergenerational progress. This could also be affected by the weak efficiency of the education system, so the further training of future teachers, was therefore be necessary to strengthen development of their key skills, analytical and critical thinking and the correct processing of information gained from different contexts and sources. The state should has focused its attention on the introduction of elements of curiosity and creativity, not only in training but also in the continuous education of teachers. The stated was to be reflected not only in pre-service teacher training but as well in teacher continuing professional development (CPD). Taking into account the above-mentioned identified obstacles of teacher further training, NÚCEM recommended making educational activities of teacher further training financially accessible, for example, by means of vouchers or through direct supporting of the educational institutions themselves. NÚCEM also advised to diversify the offer of education, especially with courses or seminars, conferences on education and mutual education of teachers. However, according to NÚCEM, quality and motivation of teachers was not only related to further education possibilities but also to their social status and financial evaluation.

In a PIAAC survey focused on teachers' key competences in the above-presented areas carried out by NÚCEM in 2018, NÚCEM addressed 2000 teachers of lower level of secondary education (ISCED 2, in Slovakia so-called second level of a primary school) and 8-year grammar schools to participate in the survey (Wirtz, Zelmanová, & Galleé, 2020). The invitation to participate in the survey was accepted by 670 of them, from which 18% were man and 82% were female. Average age of the respondents was 43. As to their majors, 49% of the participating respondents taught mathematics, informatics or natural science subjects (physics, chemistry, biology, ecology) and 52% of them taught other subjects (Slovak language and literature, foreign languages, social sciences, art and culture, physical education, religion and/or ethic education and others.

As the results showed, 36% of the respondents had low or no need to educate themselves in the possibilities of the ICT use in their teaching practice, while even 63% stated an average or even high need. Beside that, 27% of the respondents expressed no need and even 73% average or even high need to educate in teaching cross-curricular skills. It was confirmed that the teachers with a lower score in the category of problem solution via ICT had slightly higher need of further education in the field of ICT in their teaching activities. No relation was confirmed between the need of further education in teaching cross-curricular skills and the level of abilities to solve the problems with ICT. The teachers with a strong need of further education in the field of ICT had the tendency to deploy ICT in the lessons more frequently. Out of those teachers who showed the interest in further ICT education, 70% let their students themselves often use ICT during the lessons. On the other hand, there was no relation confirmed between the need of improving teachers' further education in cross-curricular skills and the fact how often the teachers let their students use ICT in the lessons. Considerably significant relation was confirmed between teaching natural science subjects and the need of the teachers to improve their ICT abilities and skills in their teaching practice. When compared to the teachers whose majors are in the other science fields, the teachers who teach natural science subjects reached significantly better results related to their mathematical literacy and ability to solve problems with ICT.

It was shown that significantly more teachers who teach natural science subjects let their students use ICT practically on daily basis (in every lesson). It was also confirmed that natural science teachers who always let their students use ICT reached significantly higher score in the category of mathematical literacy (in comparison to the other subjects' teachers). Finally and fully logically, considerably more of teachers from the group of teachers of natural science subjects confirmed their interest in further ICT education when compared with the teachers of any other subjects.

The main and the most important result of this survey is the finding that majority of participating teachers expressed higher need of further ICT education (education in the area of the ICT use in their teaching practice) as well as the need of education in the field of teaching cross-curricular skills. Teachers with a strong need of further ICT education also had a tendency to use ICT more often in the lessons. We definitely need to ensure a system of ongoing professional education also to make teachers feeling themselves to be ready to fully integrate ICT into their teaching process and thus make it more attractive and superior. Some results of research abroad emphasize the fact that so-called single (one-time) training or workshop on ICT skills in teaching is just not sufficient enough (Trucano, 2005).

OECD (2016) believes that the most effective ICT methods are those that help to develop thought and mental processes of pupils, stimulate their critical thinking as well as they can change the traditional educational style by diverting the concentration from a teacher onto a pupil. Besides targeted and continuous education in the field of ICT use, it is necessary to provide adequate support for all teachers in the form of professional discuss forums, websites or particular supporting platforms and the last but not the least support from the side of school management towards implementation of ICT-supported teaching methods into the teaching practice. It is also needed to emphasize the benefits that result from ICT use so that teachers are not afraid of ICT implementation and they can bravely start to use them as an effective educational tool in their lessons. Already in the pre-service preparation of teacher trainees, it is necessary to apply an integrated approach that would connect ICT—technical knowledge with pedagogical knowledge and also with concrete knowledge within the particular school subject.

The second cycle of the PIAAC international survey is planned for 2023.

Beside participating in PIAAC international survey, there is also in Slovakia an official evaluation of ICT skills and digital literacy of pupils, students, teachers and the wide public within so-called *IT Fitness Test*. *IT Fitness Test* is a part of the European Committee' campaign *Digital Skills and Job Coalition.* Its preparation and execution are since 2009 provided by the National Institute for Certified Educational Measurements (NÚCEM) in cooperation with IT Association of Slovakia. The test is not focusing on just diagnosis of theoretical knowledge in the field of information technologies (IT), it also monitors IT skills of the respondents (e.g. ability to choose an appropriate digital tool for practical solution of particular situations). In 2019, a year before the worldwide pandemic COVID-19 appeared, there was the eighth annual testing of the *IT Fitness Test* 2019 (Kučera, & Jakab, 2019). As to the target group of primary school pupils, there were 13,348 pupils participating in this testing. Significantly the best score was reached in the digital literacy category of *Internet* (exactly as the year before) in which pupils reached the overall average score 70.5%. Within this category, the two most successful tasks (traditionally) were—search for a video and check the content of the video within a limited time. Small improvement was recorded in orientation on a map and the same level of success rate had the activity—processing and understanding information in foreign language. In two other categories—*Collaborative tools and social networks* and *Complex tasks* approximately similar numbers were recorded (51.0% and 51.6%, respectively). The lowest success rate was recorded in categories *Safety and computer systems* and *Office tools* (43.2% and 41.9%, respectively).

Based on the given results, the primary schools were recommended to focus more attention on the development of pupils' skills to work with Office tools, especially with text editors and spreadsheet programmes (concentrate more on solving practical tasks by means of these tools than on the software environment itself and its functions).

In the target group of students (age category of 15+), overall success rates in the particular categories of the digital literacy were the following ones:

- *Internet* *58.42%*
- *Safety and computer systems* *57.68%*
- *Complex tasks* *47.25%*
- *Office tools* *35.36%*
- *Collaborative tools and social networks* *46.35%*

As regards teachers' successfulness, this in the particular categories was:In the target group of students (age category of 15+), overall success rates in the particular categories of the digital literacy were the following ones:

- *Internet* *67.62%*
- *Safety and computer systems* *71.15%*
- *Complex tasks* *66.23%*
- *Office tools* *36.51%*
- *Collaborative tools and social networks* *61.80%*

Teachers reached the highest success rate in the category *Safety and computer systems*. They showed a solid knowledge in basic theoretical knowledge, still there were some significant gaps when they were asked to apply the particular theoretical knowledge in practice. Generally, teachers did not have problems to find information on internet, surprisingly they failed when they were asked to find specific piece of information in more complicated structures (e.g. tabulated data). In comparison with previous year, they also reached better results in orientation on a map (use of *Street view* function) and searching for pictures. Some improvement was confirmed in two other categories—*Complex tasks* and *Collaborative tools and social networks*. Paradox was, that despite the content orientation of didactical-technological part of pre-service teacher training (as stated in previous part of this chapter), the lowest success rate of teachers was recorded in category *Office tools* (they have obvious problems with, e.g. identification of tables without deployment of visually visible borders).

22.3 Strategy of Teachers' Digital Competences Development

Support of broadening of digital literacy of teachers in the context of their professional digital competences and their capability to use effectively various modern didactic tools and software applications during educational activities to make the whole teaching process more effective is fully in concord with obligations of the Slovak Republic resulting from the strategy *Europe 2020* that was approved by European Council in June 2010 (Úrad vlády, 2011) as well as from the document *Strategic Frame of European Cooperation in Education and Vocational Training "ET 2020"* (EC, 2020). In the second mentioned document within the strategic goal to increase quality and efficiency of vocational teaching and training, there is explicitly stated, as one of the key competences, the competence of effective work with digital technologies in educational environment. The European Union defined the digital education as one of its priorities. For example, in the framework of vocational education and training it emphasizes importance of digital competences through the Bruges' communiqué on reinforcement of European cooperation in the field of vocational education and training (Černá et al., 2020) where in the part *Reinforcement of human position*, competences in the field of digital technologies are strongly supported. Just digital technologies should be used in a way that makes vocational preparation easily reachable, supports active learning and helps to develop new methods in practical and theoretical parts of education (EC, 2021).

Intentions to increase digital competences of pedagogues are incorporated among priorities that are declared in *National Reform Programme of the Slovak Republic 2011–2014* that was approved by the Slovak government on 20 April 2011 (MF SR, 2011). In part 6.1, *Education, Science and Innovations*, there is stated as a challenge for Slovak economics to increase quality of education, what should be reached through complex digitalization of schools and by using digital technologies in teaching processes at every level of educational system. In this context, the aim of a fully functional electronic educational system and a reform of the state educational programmes is to improve digital competences of teachers that are needed for searching and effective processing of information that are usable both in their pedagogical practice and in everyday life. As European committee announced (Europe 2020), one of the key measures to reach the required aim has become establishment of modern digital classrooms containing complex interactive teaching solutions (interactive whiteboards, laptops, tablets, intelligent mobile devices) and their authorial software environments.

Ministry of Education, Science, Research and Sport of Slovak Republic (MŠVVaŠ SR) has been supporting the idea of implementation of digital technologies into teaching processes through several national projects. Two good examples are: *Modern Education—Digital Education for Subjects in General* (CVTI SR, 2016) or *Support of professional orientation of primary school pupils towards vocational education and training through development of polytechnic education oriented on the* *improvement of working skills and work with gifted youngsters* (known as Creative Workshops, ŠIOV, 2013), co-financed from the funds of EU.

A document of MŠVVaŠ SR called *Concept of informatization of educational sector by 2020* (so-called DIGIPEDIA 2020) is considered to be the engine and conceptual platform for implementation of digital tools into the educational system in Slovakia. All the main intentions regarding informatization and digitalization of Slovak educational system are specified in the above-mentioned document (MŠVVaŠ SR, 2013) and they include five strategic areas: development of infrastructure, optimization of electronic services, digitalization of school curriculum, digital skills and cooperation with employers. Within the mentioned areas, the following actions should have been done for pupils and students of primary and secondary schools: innovative forms and methods of teaching, increase of motivation towards learning natural science and technical school subjects and financial support for new interactive classroom establishing.

Another activity of MŠVVaŠ SR was ratification and consequent start of a national project *Electronization of Educational System of Regional Schools* (MŠVVaŠ SR, 2014) with the aim to modernize education through the implementation of digital technologies into Slovak schools and to increase the digital literacy of pupils and students. In cooperation with Methodology and Pedagogy Centre and with the use of the financial support within the operational programme *Informatization of Society,* the ministry started to support digital education to make the teaching processes at schools more attractive and more effective. The starting point for reaching the goals and fulfilling the stated priorities was to provide adequate technical material equipment to schools.

However, neuralgic point of the overall efficiency of any implementation of all the stated programmes, intentions and strategies were the teachers, and especially the level of their professional performance. And this is crucially influenced or interconnected with further (continuous) education and as well as pre-service teacher trainees preparation. Result of practically any school reform or change within the system of education (curricular, structural, organizational or legislative) is ultimately contingent upon the quality of teachers who are trained by higher education institutions (Gogová, 2015).

Issue of further education of in-service teachers was solved in frame of several development projects of MŠVVaŠ SR, e.g. *Transformation of tertiary education of teachers in context of the regional education system*, *Innovation of professional practical preparation of teacher trainees* (MŠVVaŠ, 2013; Kosová, Tomengová et al., 2015) or some years before there was the project *Concept of lifelong education of teachers* (Kasáčová et al., 2006). This is a problem also in some other OECD countries, where the concerned authorities are afraid of insufficient number of new fully qualified teachers in the future. Already at the level of pre-service teacher trainees preparation in the field of didactic–technological competences, it is necessary to improve the future teachers’ skills regarding critical thinking and judging suitability of particular didactic tools, awareness of necessary standards of behaviour required or expected in online environments, critical consideration of possibilities how to use the shared social networks and so on. In this context, a digital literate teacher, with regard to his/her professional digital competences, is that one who fulfils three basic conditions—s/he can master variety of digital tools, is a critically thinking person and, lastly, must be socially interested. As it was already stated, digital tools and aids are subordinate to extremely quick developmental and innovation changes. From these results, that the 'life expectancy' of the curricular content of the pre-service preparation of teachers in the area of their didactic–technological competences is becoming more and more shorter and here is arising a new urgent need for more and more frequent innovations of the particular curricula within the teaching study programmes.

22.4 pre-Corona Needs of Teachers' Digital Competence Development

Development of new digital means, digital teaching materials and aims pose teachers to a challenge to be able to utilize all these newly occurring means. This means to up-grade continuously the level of their whether didactic technological, or more specifically digital competences so that they would know how they can be applied and utilized in education to support achievement of expected pupils and students' learning outcomes, and so that they would not be afraid to use them within their lessons (Kosová, et al., 2012). Because of that, it is necessary to include didactic–technological preparation of an adequate sustainable quality in pre-service teacher training. To ensure the adequate sustainable quality of this pre-service preparation of future teachers, beside the unceasing development of whether the new or innovated kinds of digital means and their application, requires continuous innovation of the teaching study programmes. In particular, the innovations have to be done in relation to the structure and curricula of the subjects in frame of which teacher trainees' didactic technological competences, including their digital competences are formed. The aim of these curricular innovations should be to offer to teacher trainees knowledge on the newest didactic technical or digital means and familiarize them with potential benefits of their application in teaching and learning their majors (teaching and learning subjects which the teacher trainees are going to be qualified to teach) (Petrová, & Duchovičová, 2013; Kosová, & Tomengová, et al., 2015). Already in the first sub-chapter, it has been stated that the institutions, which are providers of the pre-service training of teacher trainees, should have a clear idea how the concept of the didactic–technological teacher trainees preparation should look like. In the context of here mentioned necessity to innovate continuously structure and content of this preparation at this point, a necessity of creation of some guidelines, based on which these innovations would be prepared in an optimal way, arises. Under the optimal way of the innovation preparation should be understood such aspects as selection of technologies and applications on use of which in education the curricula should be focused, or which purposes of their use in teaching the particular subject should be emphasized in the curricula). Just before the outbreak of the Corona pandemic, in

Slovakia a broad-scaled research focused on necessary needs of the didactic–technological teacher training curricula innovations was done (Záhorec, Hašková, & Munk, 2020).

The aim of the research was to develop based on its results a basis on which it would be possible to create a proposal of an innovated optimal scheme of pre-service teacher training in the area of development of teacher trainees' didactic–technological competences, especially in the focus on formation their professional digital literacy. Aspects that were to be innovated were in two dimensions. One dimension was related to the relevant subject contents (curricula) and the other one was related to time allocation of these subjects. The research was carried out from 2017 to 2019, with participation of representatives of Faculty of Education of Comenius University in Bratislava and Faculty of Education and Faculty of Natural Sciences Constantine the Philosopher University in Nitra. Research questions were related to the following issues:

- identification of current needs of pedagogical practice with regard to formation of professional digital literacy of teacher trainees from the point of view of teachers;
- identification of current needs for innovation of pre-service teacher preparation in the area of formation their professional digital literacy from the point of view of teacher trainees;
- analysis of incorporation of the particular subjects focused on application of digital technologies in educational processes into the teaching study programmes;
- formulation of recommendations creating a basis to design a scheme of optimal pre-service teacher training to develop teacher trainee digital literacy (required knowledge and skills to be able to act successfully in their consequent teacher career).

With respect to the first particular task, the aim of the research was to identify which software applications in-service teachers use most frequently in their teaching practice, for which purposes they incorporate them into the teaching process and how competent the teachers are in the use of these means. However, the main research question in this part of the research was, whether the purposes for which the teachers implement and utilize certain software applications in their lessons are the same for all teachers regardless on the subjects they teach, or whether it depends on the taught subjects. As such a comparative research is no very often (usually the stated aspects are monitored and evaluated in a narrow focus to one particular school subject, without any systematic comparison with the rest of the subjects), hereinafter there are presented main findings resulted from it.

22.4.1 Teachers' Attitudes to Incorporation Digital Means in Teaching Process in Relation to the Subjects They Teach

As it is above stated, the research question of this part of the research was whether the purpose for which teachers incorporated digital means and different software applications does or does not depend on the subject they teach.

The research sample consisted of 156 teachers—participants of teacher continuous education carried out from December 2017 to October 2018. The participants were primary and secondary school teachers from three of eight regions of Slovakia (Nitra region, Trnava region and Bratislava region, regions for participants from which the continuous education was done). From this number, 68 respondents were teachers of primary schools (ISCED 1), 69 teachers of lower secondary education (ISCED 2) and 19 teachers of upper secondary education (ISCED 3). From the total number, 50.29% of the respondents had the pedagogical practice within the scale from 5 up to 20 years.

As to the character of the subjects, these were classified into five categories:

- natural science subjects,
- foreign languages,
- social science subjects,
- artwork and educational subjects,
- professional (vocational) subjects.

From the research sample of the 156 respondents, 133 of them taught natural science subjects, 108 social science subjects, 107 foreign languages, 100 artwork and educational subjects and 18 professional (vocational) subjects. Some of the respondents have taught only one subject but many of them have taught two subjects—that is why the sum of here presented numbers is higher than the total number of the respondents the research sample consisted of.

Collection of necessary research data was done through personal inquires, what means that as a tool for the data collection a questionnaire was used. Within the personal inquire, the respondents responded de facto to the main research question:

> *In which part of the lesson (in sense of for which purpose) do you most often use interactive education activities (supported by digital means)?*

choosing one from the five offered alternatives answers, the one that corresponded mostly to their teaching experiences:

(a) *to invoke greater motivation to learn,*
(b) *to explain and exemplify new subject matter,*
(c) *to fixate new subject matter,*
(d) *to apply acquired knowledge,*
(e) *to diagnose and grade pupils /students.*

Table 22.1 Relative frequencies of the particular responses stated by different subject teachers. *Source* own research

	Relative frequencies of the particular responses				
Teachers of	natural sciences	social sciences	foreign lang	artwork, educ. subj	profess., vocat. subj
a—*to invoke greater motivation to learn*	39.85	30.56	44.86	60.00	33.33
b—*to explain and exemplify new subject matter*	50.38	43.56	28.97	17.00	16.67
c—*to fixate new subject matter*	4.51	15.74	15.89	15.00	38.89
d—*to apply acquired knowledge*	3.76	9.26	9.35	6.00	11.11
e—*to diagnose and grade pupils / students*	1.50	0.93	0.93	2.00	0.00

Respondents who have taught only one subject or two subjects, but both of the same character, stated one answer (responded to the stated question only once). The rest of the respondents, i.e. those who have taught subjects of different character (e.g. physics and English), stated two answers—one for each of the two subjects they have taught. These differences in the numbers and characters of the subjects taught by the particular respondents are repeatedly a reason why the sum of the respondents in the particular sub-groups according the taught subjects in Table 22.1 is higher and not equal to the total number of the respondents. Dividing the respondents into the given sub-groups according the given five subject categories offers on overview of the whole research sample of the involved teachers according their majors (subjects they are qualified to teach, or which they teach at their schools as unqualified teachers, without having qualification necessary to its teaching).

The data presented in Table 22.1 point on the reasons for which teachers of different majors incorporate digital means and interactive activities relevant to them into the lessons they teach with the aim to enhance effectiveness of their teaching and pupils and students' learning achievements and differences among these reasons (purposes) in dependence on the category of the teachers' majors. Foreign language teachers and artwork and educational subject teachers usually incorporate the digital means in teaching their majors following the goal to increase interest of their pupils and students in the subject matter, which they are going to present and explain. At the same time, in this way, they try to increase pupils and students' motivation to learn and to acquire a new knowledge and information. The second most frequently occurred reason to incorporate digital means and to them relevant interactive activities into the lessons taught by teachers of foreign languages, artwork and educational subjects is to support explanation and exemplification of the new subject matter. Results recorded for the sub-groups of teachers with natural science majors and social science majors show that the order of the most often reasons why these teachers incorporate digital means in teaching their majors is opposite one. In their case, the most frequently occurred reason is to support explanation and exemplification of the new subject matter. To increase the pupils and students' motivation is for these teachers only a secondary purpose for which they use digital means during their lessons.

Natural science subjects are very demanding as they require to have developed skills of abstract thinking and abstract imagination. The use of digital means in teaching natural science subjects can contribute to elimination of the stated skills insufficiency, as the digital means illustrate the subject matter, bring it closer to students and help them to understand the explained issues, facts, phenomena, relations, etc. Moreover, natural science subjects belong at schools in general to the unpopular ones, what has been confirmed through a lot of research (Akarsu, 2017; Lamanauskas, 2013; Odcházelová, 2014; Yazachew, 2013). That is why we consider to be very important, that teachers of these subjects utilize all available possibilities, including new digital technologies to increase their pupils and students' interest in natural sciences, and to motivate them to learn the natural science subjects.

The sub-group of teachers whose majors are professional or vocational subjects is a very specific one. Teachers of these majors most frequently state as a purpose for which they incorporate the observed didactic means into their lessons teaching fixation of the new subject matter. As the second most frequent reason in case of teachers of this sub-group was recorded the answer *a*—to increase pupils and students' motivation to learn, which is one of the two mostly stated reasons at all the other groups of teachers. At the group of teachers whose majors are professional or vocational subjects the difference between the values of the relative frequencies recorded at the two most frequently stated responses *c* and *a* is 3.5%. However, due to the small total number of teachers falling into this category of respondents taking part in the carried out inquire, the recorded difference of the relative frequencies is too small to be significant. For that, the two reasons why the teachers whose majors are professional or vocational subjects incorporate in teaching their subjects the digital means (to invoke greater motivation to learn and to fixate new subject matter) can be taken to be equally frequent. As to the first reason (to invoke greater motivation of pupils and students to learn), here has been proved correspondence with the other groups of teachers (teachers of other subjects). But as to the other reason (to fixate new subject matter), here has been found out a significant differentness of professional and vocational subject teachers in comparison with teachers of the other subjects (all other category subjects). Teachers of professional and vocational subjects incorporate digital means into their lessons dominantly in effort to support pupils and students' fixation of the new subject matter, and they do it very rarely because of supporting explanation and exemplification of the presented new subject matter (a minor reason). As regards all other subjects, the situation is exactly vice versa, what is a very surprising finding. It is surprising taking into consideration 'the great gap' between the values of relative frequencies recorded at the dominant and minor purposes stated by the teachers why they incorporate digital means into their lessons (professional and vocational subject teachers: *to fixate new subject matter*—38.89%, *to explain and exemplify new subject matter—16.67%*; other subject teachers: *to explain and exemplify new subject matter*—50.38, 43.56, 28.97, 17.00%; *to fixate new subject matter*—4.51, 15.74, 15.89, 15.00%). Of course, the results cannot be generalized, mainly because of the small number of the respondents falling into the category of professional and vocational subject teachers. However, a tendency that teachers of these subjects appreciate contribution of the digital means for fixation of the new subject matter and do not attach any significant importance to their contribution to the subject matter explanation and exemplification occurs here—contrary to the teachers of other majors, characterized by a vice versa tendency. This can be a consequence of two facts. One could be that teachers of professional and vocational subjects prefer to support their explanation of the subject matter by real objects, which they describe in their subject matter presentation, to mediated forms of the concerned objects. And the second one could be that in frame of professional and vocational subjects the final focus is usually not on the new knowledge acquisition but on formation and development of skills and abilities subsequently linked to the theoretical knowledge obtained within the new subject matter presentation.

Speaking, based on the obtained results, about dominant and minor reasons we are pointing on the fact, that in most of the distinguished sub-groups of teachers (based on the category of their majors), there have been recorded two purposes as prevailing ones and two as of a lower importance (purposes with recorded values of relative frequencies equal or below 2% we consider to be insignificant, without any impact on incorporation of digital means into the teaching and learning processes). Following the data presented in Table 22.1, one can conclude that for the natural science teachers, social science teachers and foreign language teachers, identically for all of them, significantly dominant reasons to utilize digital means in their teaching practice is their potential to increase pupils and students' motivation to learn and to contribute to easier understanding of the explained new subject matter. As minor reasons for them is a possibility to support through these means fixation of the presented new subject matter and application of the newly acquired knowledge. To the stated groups of teachers, we can add also the group of artwork and education subject teachers. However, at this group, there is one slight distinction in comparison with the other ones. According to the results presented in Table 22.1, artwork and education subject teachers are characterized by having only one dominant reason to incorporate digital means into their teaching activities, and it is to evoke greater motivation of pupils and students to learn. Partially a reason (a minor reason) to do that, for these teachers might be to support explanation and exemplification of the new subject matter and to support fixation of the new subject matter (with the almost identical significance of 17.0 and 15.00%). As another reason occurs at these teachers also the reason to support application of the newly acquired knowledge. But taking into consideration the low value of its relative frequency (6.00%, significantly less than the above-mentioned two values and quite close to the value of 2%, below or equal to which we consider the other reasons to be insignificant), we evaluate this reason to be insignificant (at least in case of artwork and education subject teaching). Special feature of the group of professional and vocational subject teachers is that they are, in contrast to the other subject teachers, utilizing digital means in education with respect to a broader scope of purposes (see in Table 22.1 values of relative frequencies of the particular responses recorded at this sub-group of the respondents, which are much more homogeneous as the other ones). Taking into account the small number of the respondents in this teacher category, the differences between the recorded values of relative frequencies of the dominant and minor reasons can be evaluated even as insignificant (at least of a very low significance). For that, the given four purposes can be consequently all perceived as 'routine' reasons because of which digital means are used in teaching professional and vocational subjects.

Another aspect of the recorded results that can be considered as a surprising finding are differences among the particular results reported at the professional and vocational subject teachers and natural science subject teachers. Natural science subjects, mathematics and technology are used to be put together as so-called STEM subjects, with 'a hidden' informatics here. Interesting would be to analyse also other distinctions among 'purely' natural science subject teachers (i.e. teachers whose majors are physics, chemistry, biology, geography, ecology), mathematics teachers and technology and informatics teachers (i.e. professional and vocational subject teachers).

Findings resulted from the carried out survey prove positive influence of the use of digital means in teaching all kinds of subjects on invoking and increasing pupils and students' motivation to learn. This impact has been proved also in frame of many other research works (Bártek, Nocar, & Wossala, 2016; Brotánková, 2016; Clarke, & Svanaes, 2014; Klement, 2014; Olofsson, Lindberg, Fransson, & Hauge 2011; Harris, 2010). With respect to lower level of secondary school teachers in the Czech Republic as the most frequently occurred reason why teachers incorporate digital means in their teaching practice was identified presentation of illustrative materials, film sequences and task assignments (Brotánková, 2016). With respect to upper level of secondary school teachers in the Czech Republic as the most frequently occurred reason (a dominant one) why teachers incorporate digital means in their teaching practice was identified presentation and explanation of new subject matter. As a quite frequently occurred reason (a minor reason) were identified diagnosing and grading students' knowledge (Hladký, 2018). In our research, this reason was proved neither as a dominant one nor as a minor one, it was identified as a completely insignificant one. And this was found out in case of all teachers, which we observed, regardless their majors. This contradiction might be a consequence of the fact that in Hladký's research and our research the research samples were not equivalent. In Hladký's research, the research sample consisted exclusively of upper level of secondary school teachers, while in our research, the research sample was a mixture of teachers, from primary school teachers, through lower level of secondary school teachers up to lower level of secondary school teachers. In particular, it consisted of 68 primary school teachers, 69 lower level of secondary school teachers and only 19 teachers from upper secondary schools. In our opinion, the contradiction of the achieved results has been caused by a high percentage mainly of primary school teachers involved in our research sample. One can logically assume that digital means are not just the right tool to diagnose primary school pupils, but at upper level of secondary schools, the use of digital means may be very matching for the given purposes.

The final results of the presented research and from them derived findings have confirmed some differences of reasons for which different subject teachers (or more precisely teachers of different character subjects) incorporate digital means on teaching their majors (in relation to the aspects of teaching and learning processes which within the given subject teaching can be influenced by this incorporation mostly). These results should be taken into consideration at creation curricula of teacher trainees' didactic–technological preparation as well as at creation curricula of professional development courses focused on upgrading in-service teachers' didactic–technological competences (Záhorec, Hašková, & Munk, 2018; Záhorec, Hašková, & Munk, 2019; Záhorec, Hašková, Záhorec, & Hašková, 2019).

22.4.2 Summary of the pre-Corona Research Findings and Proposed Recommendations

Digital technologies are an important resource of possibilities to increase teaching efficiency and support sustainable quality of education. That is why schools should be appropriately equipped by these facilities, and moreover, these facilities at schools should be continuously upgraded. However, digital technologies offer only potential possibilities to contribute either to enhancing teaching efficiency or keeping its quality. To transfer these potential possibilities into the practice must be done by a teacher. The teacher has a key role in this transformation process. The teacher's personality, skills and abilities are prerequisites on which depends whether the potential offered by the digital technologies will or will not be utilized in practice, or to which measure it will be utilized. Because of this reason, it is so important to keep the sustainable appropriate quality teachers' didactic–technological competences, including appropriate quality of their professional digital literacy (Brečka, & Valentová, 2019; Kostolanský, Šebo, & Tomková, 2019; Kuna, Kozík, Kunová, & Šebo, 2018). The results of the presented research indicated several requirements for innovation of the content of the didactic–technological preparation included in teacher trainees' study programmes. Based on these requirements, there was created the intended basis for designing an optimal scheme of pre-service training of teacher trainees to support development of their digital literacy. The basis consists of a set recommendations directed to the following aspects:

Recommendations related to the relevant subject content (subject curricula):

- Recommendation to incorporate into the relevant subject issue of effective processing and formatting teachers' own text documents and tabulated data usable within the work of the pedagogical staff, and issue of designing didactic presentations of teaching materials supporting teacher's activities and learners' learning achievements.

- Recommendation to put focus on different ways and purposes in which digital voting systems can be used in teaching to support its efficiency of the teaching.
- *Recommendations related to the scope of teaching the relevant issues:*
- Recommendation to consider critically incorporation of the issues of teaching the use of *Microsoft Word, Microsoft PowerPoint* and *Microsoft Excel* as one-semester subjects dealing separately with each of them (following some students' demands), or as special additional courses or optional subjects (following formal profiles of high school graduates, according to which these skills belong to the output standards).
- Recommendation to consider incorporation of the issues of the use of the software applications listed in Table 22.2 into the curricula of a one-semester subject.

Table 22.2 Overview of the software products—learning topics integration of which into the curricula of teacher trainees didactic–technological preparation was investigated. *Source* own research

Software Product/Learning Topic
ActivInspire, SMART Notebook or Flow!Works software applications used to create different electronic educational activities, interactive teaching and learning tasks and educational/knowledge games
Prezi software applications used to create nonlinear dynamic presentations with educational - but not only—content applicable in teaching and learning activities
FreeMind, Mindomo, XMind applications used to create mind maps usable in teaching and learning activities intended also for pupils with special needs
ActivExpression2, SMART Response 2, TurningPoint modern interactive voting systems through which it is possible to ask questions, to diagnose, test and assess pupils and students' knowledge during teaching
Socrative 2.0 internet application to diagnose, test and assess pupils and students' knowledge on-line either during or out of teaching
Google Docs modern tools for collaborative creation and management of electronic online documents based on the use of current possibilities of the Internet in the Web 2.0 category
Microsoft PowerPoint software applications usable for creation of didactic presentations of educational content with the application of feedback and multimedia elements supporting the teacher's explanation of the subject matter and systematization of pupils/students' knowledge
Microsoft Excel software applications used to process tabulated data usable in the field of work of teachers
Microsoft Word software applications used to process and format teachers' own text documents connected with their professional work and activities

As it has been mentioned above, elaboration of an analysis of incorporation of the particular subjects focused on application of digital technologies in educational processes into the teaching study programmes was one of the integral parts of the research we carried out. One of the aspects, from point of which the analysis was processed, was content (curricula) of the relevant subjects. The analysis did not reveal any subject in content of which would be reflected different majors of the teacher trainees. This means that all subjects related to the didactic–technological preparation of teacher trainees are offered to students in the same identical form, regardless of the majors, to teach which the teacher trainees are prepared. But the above-presented results of our research clearly show, that the subject specialization of teachers (in meaning of the character of the subject a teacher is qualified to teach) has an impact on the way and purposes for which the teachers incorporate digital means in teaching their subjects. In our opinion, this finding should be also reflected within the didactic–technological preparation of teacher trainees (as well as it should be reflected also in further education of in-service teachers). On this aspect is focused the next recommendation.

Recommendation(s) related to the reflection of teacher trainees' majors in the relevant subjects:

- Recommendation to adjust the offer of subjects so that it would reflect the teacher trainees' subject specialization (e.g. to provide didactic–technological training to teacher trainees separately in dependency on the character of their majors).

Recommendation(s) related to incorporation of the relevant subjects into the teacher training study programmes:

- Recommendation to change incorporation of the subjects focused on didactic technological preparation of teacher trainees into their study programmes—to move them from the bachelor degree study programmes to the master degree study programmes.

Recommendation(s) related to incorporation of new subjects into the teacher training study programmes:

- Recommendation to incorporate new compulsory or compulsory-optional subjects, one focused on creation of interactive forms of teaching materials, interactive technologies of voting and evaluation in teaching, and one focused on applications of pedagogical software in teaching.

The presented survey was carried out in the academic year 2018/2019, before the Coronavirus pandemic occurred. In that time most of us had no experience with online teaching forms. Didactic–technological preparation of teacher trainees was focused mainly on different ways of the use of some technical equipment and software applications in teaching and learning activities. When the Corona pandemic occurred, all of us (equally teachers as students) had to adapt to the new conditions under which education has continued. Under the pandemic conditions, it was found out that may be even more important than to be trained in the use of different digital means in teaching and learning processes is to be trained to work with different online systems and to be familiarized with appropriate methodologies of online teaching. These facts affect the scope to which the achieved research have been still valid, as beside the presented findings also the new (Corona) conditions should be taken into consideration with respect to upgrading teacher preparation related to their didactic–technological (digital) competences.

22.5 Teachers' Digital Competence Needs Under the Corona Pandemic Situation

Coronavirus pandemic has completely changed the functioning within educational environment of the whole schooling system—from primary schools up to universities including the system of further education. From 16 March 2020, about 450 thousand pupils of primary schools, 200 thousand students of secondary schools and almost 100 thousand university students were forced to stay at home due to prevention measures against insidiously spreading virus on the territory of Slovakia (Burgerová, 2020). An emergency situation was suddenly here and as it was shown really soon, the Slovak educational environment was absolutely not ready for such critical situation. In the chaotic situation regarding distribution of competences among the ministry of education, school providers, management of particular schools and the teachers, there were no rules given regarding responsibility. The only logical consequence was that everybody was waiting for decisions done by those others. Schools tried to keep the situation under control and step by step started to activate the online learning via the Internet.

Analysts from the Institute of Educational Policy (IVP) warned already in April that there was considerable part of students excluded from the learning process due to using distance form of education at primary and secondary schools. According to their estimation, there were some ten thousands of children (32.000 pupils without Internet connection) especially from the socially disadvantaged environment who could not participate in the distance form of learning (Bednárik et al., 2020).

Despite the warnings by the analysts from IVP, the situation was not as bad and dramatic as it might seem at first sight. It was much better especially thanks to the positive approach of many teachers who started to improvise according to particular conditions of their schools and also their pupils and students. The heaviest burden was just on the shoulders of teachers who started to provide distance learning either from classrooms or if not possible, directly from their homes. They had to prepare new materials and teaching aids that are suitable just for this form of education. If there was no chance of working on computer connected to the Internet, then a teacher had to walk from one mail box to another and personally deliver homemade materials and tasks for their pupils (this happened especially in cases of teachers and their pupils from the countryside).

Due to Coronavirus pandemic, the schools experienced an emergency situation where they were forced to start using online education via the Internet. The overall functioning of this educational environment depended on existing technical equipment of schools and pupils and their level of mastering digital skills. Analysis of practical experience that teachers gained during the emergency state announced by the Slovak government showed the following findings (Hašková, Havettová, & Vogelová, 2020):

- Initial problems were of technical character, e.g. low accessibility of computers for teachers, teachers were not familiar with new programmes, they have to become familiar with them and only then they could to start to work with them.
- Much worse situation regarding technical equipment was on the side of pupils and students, especially from the socially disadvantaged environment (insufficient number of technical devices, siblings and parents were forced to share one computer, WI-FI problems, insufficient prepaid data and the like). In many cases, teachers experienced the reluctance of pupils and students, even if they did not have any objective reason to defy the authority of the teacher.
- Serious problem among pupils was the low level of digital literacy (also in some cases of secondary school students)—insufficient computer skills, they could not download documents, learning materials, could not find information on the websites. Some did not show any interest in participation at the online lesson and completely ignored all activities in the virtual classroom.
- In the first phase of distance learning, we witnessed the phenomenon of overloading the pupils and students by extreme amount of homework and extra tasks. As the time was passing by, teachers realized the real possibilities of their pupils and students and started to unburden them from that uselessly big amount of tasks so that everybody could have participated and above all—so that everybody understood the content and message of particular online lecture or exercise. Of course, according to the current situation, they modified traditional way of creating particular texts and material for pupils and students in such way so that they were not too long and were understandable.
- In connection to the new phenomenon of using the online education systems in teaching process, and also creating teaching materials and aids for distance learning, teachers learnt step by step how to cooperate and help each other.
- Teachers found an agreement on the fact that the online education is much more time consuming and difficult (assignment of homework, corrections, informing on evaluation and also on mistakes and errors) than traditional form of teaching. They confessed they missed the direct face to face contact with their pupils and students, explanation of new topics that pupils/students did not understand at first time was more complicated since there was no space to show or demonstrate the explained matters as in case of traditional classroom. Another extra problem was the contact with online teaching ignoring pupils and students, what caused huge workload and stress among many teachers, as the teachers had contact those pupils/students via mails, social networks or simply by phoning them, and repeatedly asked them to cooperate but in many cases some pupils and students never responded.
- The feedback from the side of pupils and students was utterly disparate. Some started to cooperate automatically from the very beginning, some excused for

weak internet connection and as it was mentioned, some never appeared in the virtual lessons.

- Another huge problem was also related to classification of pupils and students. Teachers emphasized that the objectivity of classification was extremely low and doubtful because there were multiple new factors and persons entering the virtual educational process and there was no guarantee that pupils/students understood all that was said in the lesson and also nobody could be sure whether sent homework were done by pupils and students themselves. In one word, the key disadvantage here has been the low level of verification.
- Many parents (especially those who had to go to work) contacted the teachers for two reasons. They either asked about attendance of their children and whether they were active and behaved well in lessons, or if they wanted to excuse the absence of their children. The usual reasons were that children could not connect to the Internet or they had some technical problems on their devices.

In an online survey done by the Focus Agency for a daily newspaper *Denník N* (Gdovinová, 2020), the parents of pupils from primary schools were asked to express their opinions regarding quality of distance learning during the crisis. Seventy-six per cent of participating parents reacted in a positive way regarding satisfaction with provided distance learning, 62% said that the teachers repeatedly only assigned homework to their pupils (e.g. via *EduPage* portal) and there was no online education, 19% of the parents said that teacher really had the interactive contact with pupils during the lesson and 12% said that teachers just said what they had to say and then assigned some homework (e.g. via EduPage portal). Communication between teachers and pupils on daily basis was confirmed by 58% of the parents.

Results of another survey, done by the Dionýz Ilkovič Foundation (Dionýz Ilkovič Foundation, 2020), showed the extreme overloading of those teachers who carried out distance learning in the form of online education. The research was focused on particular experience regarding teaching during pandemic and there were 570 participating teachers of natural science and technical subjects from primary and secondary schools. The findings were unambiguous—teachers were left to oneself and could rely only on their own skills. Even 77% of teachers said that they used their own technologies and up to 90% of teachers created their own educational content. The same teachers (those 90%) confirmed that preparation of teaching materials and teaching aids for online lessons is much more difficult than it is in case of traditional lessons. For this reason, the asked teachers agreed in one crucial thing—the situation could be much easier manageable if they had at disposal adequate accessible content that could be used in online education environment. The most frequently used virtual tool in the online education environment was *EduPage* platform and the teleconference tools *Zoom*, *MS Teams* and *Skype*.

As it was stated previously, the time of pandemic showed how important it is for teachers to be trained not only to use various software products in teaching their majors but also to use online education systems. When evaluating online teaching during the COVID-19 pandemic, we must take into consideration that majority of teachers have never had any such experience. They were not trained how to master the online teaching. The fact that the teachers succeeded in this battle largely goes to the credit of their involvement and inventiveness. According to the teachers' opinions (Dionýz Ilkovič Foundation, 2020), to teach online at the same level as in real classroom, they need adequate technical equipment, particular computer skills, a special content that is available and enough time for preparation. Ninety per cent of teachers believe that the work with online education systems should be incorporated in the pre-service preparation of future teachers at faculties of education.

When the first wave of Corona pandemic was over, MŠVVaŠ SR initiated a questionnaire research on the distance learning in the school year 2019/20 at primary and secondary schools. This research was done by the Institute of Educational Policy (IVP). Further analysis showed that 82% of pupils and students had ensured at least a partial compensation of the traditional teaching by means of the online education process. According to estimations done by the head teachers and teachers, about 52.000 pupils and students of primary and secondary schools were excluded from the learning process provided via online environment what makes 7.5% of learner population; 18.5% of pupils and students had absolutely no access to the online education so they were learnt asynchronously, e.g. by means of work sheets. Respondents of the survey stated that in comparison to the traditional way of teaching both online and offline (worksheets) education were definitively less effective. It seems that just one fifth of secondary schools handled the online education without any bigger troubles and up to one quarter of students experienced extremely decreased quality of learning or they had no education at all during the recent pandemic (Šimečka, Fishbone Vlčková, & Šedovič, 2021).

Since we do not have any other similar information regarding the school year 2020/21, we cannot estimate whether the situation got worse or better and what the current numbers of such pupils and students are. The former school head inspector Viera Kalmárová even estimates that it is just only about one fifth of schools that can provide online education without any bigger problems.

Provision of education and involvement of university students in learning process during the first wave of pandemic was evaluated through a representative inquire that was organized by the Student Council of Higher Education Institutions. Based on the findings of this research, one can state that the pandemic impact on accessibility and quality of higher education was less serious than it was in case of secondary schools. Fifty-seven per cent of respondents expressed general satisfaction with the way how their higher education institutions managed the pandemic situation. Lack of lessons and weak information transfer to students were present, especially in the beginning. By the end of the semester (June 2020), students felt already a significant improvement regarding the provision of education (Šimečka, Fishbone, Vlčková, & Šedovič, 2021). Despite this fact, there is the same conclusion for the higher education institutions as it is in case of primary and secondary schools—online learning is not as efficient and it cannot be considered to be a full-fledged substitution for traditional form of education. Students perceive online education as just an add-on to traditional form. At the same time, principally every other tertiary student accepted the possibility to participate in the educational process through combined model (online and present forms together) after the end of the pandemic.

University students participating in this survey did not specify any extreme technical obstacles related to the used of the ICT and e-learning tools, but they expressed criticism towards the quality of pedagogues and their preparedness for online teaching. As the main defects were stated, problems with provision of technical support from the side of teachers and quality of online education, plus they also missed institutional support of particular tools for online learning. Different faculties and departments, even departments within one faculty used different online tools what many times caused chaos and students often had troubles when trying to connect to the online lessons.

The key point in this publication is the discussion about digital literacy of teachers, but digital competences of teachers, or possibilities of the use of digital competences of teachers within their teaching activities are closely connected to digital competences of pupils or students (their ability to work with digital tools that are used in education process). In the subchapter 22.2 of this chapter, there is mentioned the *IT Fitness Test,* a project for testing IT skills of pupils, students, teachers and the public in Slovakia, main goal of which is to monitor the level of digital skills of graduates from primary, secondary and higher schools. In 2020, already the ninth anniversary testing was organized and it was carried out already in restricted conditions caused by the Corona pandemic. Despite this fact, the overall results were positive as there were recorded increments in pupils and students' digital skills in comparison with the previous year (Kučera, & Jakab, 2020). Analysts connected this positive finding with the fact that the transition of education from the traditional forms towards digital online teaching had positive effect on digital skills of pupils and students. Analysis of the next *IT Fitness Test* cycle (in 2021, after the second wave of the Corona pandemic) brought surprising news—digital competences of pupils and students from primary and secondary schools got worse in comparison with the year 2020 (Kučera, & Jakab, 2021). Those schools, which had good results in 2020, showed a less dominant decrement in their success rate in the test. On the other hand, schools with low success rate in 2020 reached serious decrement in their test results. An evident deterioration was recorded in basic IT skills and knowledge, and also in their connection to practice. Students do not have sufficient practical experience, they do not understand the structures of text documents, their work with interactive graphs, understanding of displayed information and searching according to given criterion is insufficient.

As to the digital literacy and digital competences of teachers, results of their test successfulness in years 2020 and 2021 approximately copy the above-mentioned results of pupils and students. Table 22.3 shows a comparison of teachers' results in three consecutive years, 2019 (pre-Corona era), 2020 (after first wave of the pandemic) and 2021 (after second wave of the pandemic).

Analysts think that the main reason behind worse results recorded in 2021 is the extremely high increment of participants in 2021 testing, many of which have never had any such experience (2019–24.000 respondents, 2020–21.000 respondents, 2021–45.000 respondents). In our opinion, the increased number of participants from this year offers a more realistic or adequate view on the reality at Slovak schools, i.e. we consider the results recorded in 2021 to be much closer to the real situation.

Table 22.3 Teachers' successfulness in particular categories of digital skills

	Year of testing		
Category of task/digital skills	2019 (%)	2020 (%)	2021 (%)
Internet	67.62	86.17	62.96
Safety and computer systems	71.15	74.20	56,24
Complex tasks	66.23	61.30	39.86
Office tools	36.51	76.24	54.46
Colaborative tools and social networks	61.80	54.85	47.63

22.6 Conclusion

The key competences in the context of European education framework are closely connected to the ability to succeed on labour market within many different positions. As the current society becomes more and more digitalized, one can feel increasing interest in digitally literate specialists. This logically widens the spectrum of requirements regarding digital competences within particular professions. And the stated pertains teachers, too. Just like engineers, lawyers, doctors or clerks who must be handy users of certain digital kinds of digital technologies and software applications to perform successfully their jobs, also teachers must master some IT skills that are usable in their profession and that define their digital literacy. There are six spheres specified within European framework of teachers' digital competences (EC, DigCompEdu, 2017) that are connected with particular professional activities of teachers:

1. deployment of digital technologies for communication, cooperation and professional development,
2. gaining, creating and sharing of digital sources,
3. management and organization of deployment of digital technologies in education and in learning process,
4. deployment of digital technologies and strategies to support evaluation processes,
5. deployment of digital technologies to support inclusion, personalization and active inclusion of pupils into educational activities,
6. support of pupils in their creative and responsible deployment of digital technologies for informational and communicational purposes, problem solution, creation of various contents and living conditions improvement.

In contrast to other professions, the digital literacy of teachers should be perceived from two points of view. The first one, let us call it classical, is represented (as in case of many other professions) by the ability of teachers to use digital technologies within their professional performance. The second point of view on the professional digital literacy of teachers is specific because it is connected to digital competences that all good teachers must have (see the point 6) so that they could develop and improve the digital literacy of their pupils and students. Additionally to that, the use of digital technologies (ICT) in the classroom puts the teacher into a position of manager what must be contained in the wider perception (the above-mentioned two points of view put together) of the digital literacy of teachers.

Digital professional literacy of teachers can be characterized as an ability of teachers systematically and rationally to use information and communication (or digital) technologies for pedagogical-didactic purposes. This all should be done while watching one clear goal that is the increase of the knowledge level of pupils or students. The teacher must be able to make adequate decisions about what digital resources should be used in a given situation, how they should be used and why. And it is necessary to start preparing the teacher to master all the tasks already during his/her pre-service training future teachers must learn to apply the acquired theoretical knowledge to pedagogical practice and specifically to the teaching of their majors already during their pre-service training. However, the curricula of didactic–technological training of teacher trainees are (or were in the period before the pandemic) predominantly based on the development of common user skills to work with a narrow range of software applications. This is usually (or it was) to work with Microsoft Word, PowerPoint, Excel, Moodle applications, or to search for information on Internet. The development of professional digital literacy with a focus on subject/branch didactics (the use of ICT tools in teaching the given subject—major) is completely neglected.

As to the current Coronavirus pandemic situation, expectations that thanks to the successful development of vaccines, the situation from 2020 with its restrictions of the traditional teaching would not be repeated again, have not been fulfilled. Due to the third wave of the Corona pandemic that came by the end of 2021, particular EU countries were forced to declare so called hard lockdown and to cancel the traditional face-to-face forms of education again. The full-fledged distance online education still remains a challenge for the sector of education and teachers must accept the fact that the hybrid form of education step by step becomes a self-evident part of their everyday school practice. That is why every teacher must be trained and prepared for the hybrid form of education, must develop his/her professional competences in this area and must be able fully to utilize potential of the digital technologies. The institutions providing pre-service preparation of teachers and the further continuous education of in-service teachers are expected to design adequate didactic technological preparation of teacher trainees as well as further (continuous) training of in-service teachers in agreement with these needs and requirements on successful teaching profession performance.

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Chapter 23
Systematic Review on Digital Competence in the Spanish Context

Antonio-José Moreno-Guerrero, José-Antonio Marín-Marin, Jesús López-Belmonte, and Prathamesh Churi

Abstract The widespread use of information and communication technologies has accelerated profound changes in society. This has prompted education systems to adapt to these changes. These responses focus on digital competence. The general objective of the study is to analyse the evolution of digital competence in the Spanish context. This study has followed a bibliometric methodology. An analysis of 286 documents extracted from Web of Science has been performed. The results show that only two lines are observed that stand out from the rest. These are the cases of "digital competence-ICT-students" and "teacher-education_educational-technology_teacher-digital competence." This indicates that over time the research focus has shifted to the use of technological resources in students and teachers. It can be concluded that the subject of study focused on digital competence in the Spanish field is being established from 2018 to the present, with its lines of research focusing on pedagogical teaching methods, technological resources and on the agents involved in training processes. This refers to the skills required by students and teachers for them to be able to successfully conduct training processes using technology. This study has been funded by the project Socio-economic impact of COVID-19 on Andalusian university students. Reference: CV20-01,248.

Keywords Systematic review · Spain · Web of science · Digital competence · SciMAT · DIGCOMP · Digital skills

A.-J. Moreno-Guerrero (✉) · J. López-Belmonte
Faculty of Education, Economics and Technology of Ceuta, University of Granada. Cortadura del Valle, 51001 s/nCeuta, CP, Spain
e-mail: ajmoreno@ugr.es

J. López-Belmonte
e-mail: jesuslopez@ugr.es

J.-A. Marín-Marin
Faculty of Education Sciences, University of Granada, Campus de Cartuja, s/n, 18071 Granada, CP, Spain
e-mail: jmarin@ugr.es

P. Churi
NMIMS University, Mumbai, India
e-mail: prathamesh.churi@ieee.org

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23.1 Introduction

Since the second half of the twentieth century, successive improvements in the field of computing and the emergence of the Internet have accelerated the avalanche of scientific and technological change. This has made it possible to globalize important aspects of society as the economy, culture and politics. Social agents have not remained indifferent in the face of these developments, as they realize how they affect citizens and how they must prepare themselves to deal with these advances from a critical point of view. As early as 1996, UNESCO (Al Mufti & Delors, 1996) proposed the need to promote lifelong education based on four pillars: learning to know, learning to do, learning to live together, and learning to be. These would be the precursor principles of competence-based education and would enable everyone to lead a personally and socially valuable life in a modern democratic system.

In this context, it would be necessary to define what is meant by competence and the elements that define it in order to be able to delve deeper into the different typologies that exist. To this end, some of the most relevant definitions that can shed light on this construct are presented. For Mertens (1996, p.66), "competence refers to certain aspects of the stock of knowledge and skills: those necessary to achieve certain results required in a given circumstance. It is the actual ability to achieve a goal or outcome in a given context". On the other hand, Ibarra Almada (2000) conferred it the productive capacity of an individual that is defined and measured in terms of performance, constituting the integration between knowing, knowing how to do, and knowing how to be. Along the same lines, Le Boterf (2001) proposed the term competence as a construction based on a combination of personal resources (knowledge, know-how, qualities, or aptitudes) and environmental resources (relationships, documents, information, and others) that are mobilized to achieve a performance. Pozo Flórez (2015, p.132) reviewed some of them and defined the concept of competence as the "productive capacity of an individual that is defined and measured in terms of real, demonstrable performance in a given work context". Thus, the OECD defined competence in the executive summary of the DeSeCo Project (OECD, 2003) as "the ability to respond to complex demands and to carry out diverse tasks adequately". This involved a combination of practical skills, knowledge, motivation, ethical values, attitudes, emotions, and other social and behavioural components that are mobilized together to achieve an effective action in formal, non-formal, and informal educational contexts. Parallel to the OECD, but from a more educational perspective, the European Parliament and the Council issued Recommendation 2006/962/EC on 18 December 2006 on key competences for lifelong learning. Through this programme, the EU sought to support efforts by Member States to ensure that, by the end of initial (basic) education and training, young people acquired key competences to the extent necessary to prepare them for adulthood and to lay the foundations for further learning and employment. From this perspective, competences were defined as a combination of knowledge, skills, and attitudes appropriate to the context that will enable each citizen to adapt flexibly to a rapidly changing world, enabling personal fulfilment and development, active participation in society, social inclusion, and employment.

Among the different definitions of competence, it is possible to note the presence of three important factors when understanding the concept of competence (Pozo Flórez (2015): capacity, action, and context. Capacity is the combination of knowledge, skills, abilities, and attitudes that enable to perform a particular task. Action in relation to the need to put into practice in real situations so as to successfully achieve the desired professional result. Finally, the context, where the capabilities must be mobilized according to changing work situations depending on the circumstances. Thus, it could be specified that a competence is the integration of a set of capabilities that are put into action in a given context to solve a problem.

From this definition, it is possible to group competences based on their capacities and their graduation. Thus, the specialized literature suggests three main groups of competences: basic, transversal, and specific competences. Basic competences refer to the basic training on which all other learning is based. Transversal competences are wide-ranging skills that can be generalized to different situations. Finally, specific competences are those that mark the differences between different scientific and professional fields. This paper will develop the basic competences that enable lifelong learning and underpin other more specific and complex learning.

In this sense, and within the categorization of basic competences, the document "Key Competences for Lifelong Learning—A European Reference Framework" (Recommendation 2006/962/EC and its update Recommendation 2018/C 189/01) establishes eight key competences as a reference instrument for basic training in the member countries:

1. Communication in the native language.
2. Communication in foreign languages.
3. Mathematical competence and basic competences in science and technology.
4. Digital competence.
5. Learning to learn.
6. Social and civic competences.
7. Sense of initiative and entrepreneurship.
8. Cultural awareness and expression.

These competences have two characteristics in common: they overlap and intertwine between them supporting certain essential aspects of a field and are of equal weight.

Although it has already been stated that there are no competences that are more important or relevant than another, in this work we will focus our attention on the study of digital competence as it is directly linked to the acquisition of knowledge, skills, and attitudes related to information and communication technologies (ICT). Thus, the European reference framework defines it as the competence that involves the confident and critical use of information society technologies (IST) for work, leisure, and communication. It is underpinned by basic ICT skills such as the use of computers to retrieve, evaluate, store, produce, present, and exchange information, and to communicate and participate in collaborative networks via the Internet.

Accordingly, as a result of the needs detected in the different studies conducted to support the European Commission in its task of understanding the use of the potential of digital technologies to improve access to lifelong learning and to address the growth in new digital skills and competences for employment, personal development and social inclusion (Carretero et al., 2017). The first version of the European Framework of Digital Competences for Citizenship, also known as DigComp, emerged in 2013, which is presented as a tool designed to improve the digital competences of citizens. Subsequently, in 2016, the Joint Research Centre (JRC) released version 2.0 and the following year published a revision of the same (2.1) updating the terminology and the conceptual model, as well as the case examples of its implementation at European, national, and regional level, seeking the development of the three initial levels of competence, to give way to a more detailed description in 8 levels of competence, with examples of use of each of them.

DigComp 2.1 is composed of five dimensions (Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Security, and Problem Solving) and twenty-one competences structured in eight-graduated proficiency levels that represent a cognitive challenge and increase in complexity as the level increases. In addition, each level contains knowledge, skills, and attitudes, described in a single descriptor for each level of each competence and articulated through 21 learning outcomes (168 descriptors). This instrument has enabled the different member states of the European Union to articulate in their context the initiative to encourage their citizens to acquire the digital competences that will allow them to maximize the impact of the use of digital tools on economic growth and development and on labour activity, corporate social responsibility, social inclusion (closing gaps of gender, age, origin, or financial situation), and the well-being of citizens.

In Spain, because of the COVID-19 crisis, the Recovery, Transformation, and Resilience Plan (2021–2026) has been drawn up to channel the funds earmarked by Europe to repair the damage caused by the pandemic. This plan acts as a roadmap to identify the necessary measures to ensure that all citizens have the necessary tools to acquire and develop digital skills, in a context of dual digital and green transition. A five-year project is structured around four main lines of action that act on a set of challenges such as (Government of Spain, 2021, p.1):

(a) Cross-cutting digital training for citizens (digital citizenship), with an emphasis on digital training for women and girls, so that everyone can, among other actions, communicate, shop, conduct transactions, or interact with the Administrations using digital technologies with autonomy and sufficiency (with an investment of 20.4% of the Plan's total).
(b) The development of digital skills for education, from the digitization of schools to universities, including Vocational Training (with an investment of 39.2% of the total Plan).
(c) Training in digital skills throughout working life (upskilling and reskilling, both for the unemployed and the employed), with a focus on the development of digital skills for SMEs (with an investment of 34.9% of the total Plan).
(d) The promotion of ICT specialists (with an investment of 5.2% of the total Plan).

Overall, the development of digital skills in education and throughout working life accounts for ¾ of the total investment of the amount allocated to the development of this Plan. It represents a firm and decisive commitment on the part of the public administration to alleviate the lack of digital skills in human capital, both basic and advanced, which slows down the digital transformation of Spanish society and economy as well as the country's ability to adapt new economic, social, and environmental demands. The COVID-19 pandemic has highlighted realities such as the fact that 8% of the population has never connected to the Internet (Eurostat, 2021); that 45% of the Spanish population has insufficient digital skills; that the digital divide is not only an age gap, but also a gender gap; or that 34% of the working population in Spain has insufficient digital skills and around 40% of people without basic digital skills are unemployed (Government of Spain, 2021). All of these realities make it essential to promote a model of training that can correct and equip citizens with the necessary digital skills to participate actively in a globalized and digital world.

23.2 Justification and Objectives

At present, the research that has been carried out on digital competences in Spain has mostly been related to the diagnosis of the digital competence of teaching staff, both in future education professionals (García-Vandewalle García et al., 2021; Pérez-Navío et al., 2021) and those currently working in this field (Cabero-Almenara et al., 2021a; 2021b; Garzón Artacho et al., 2020; Grande-de-Prado et al., 2021; Mercader & Gairin, 2021; Pérez-Calderón et al., 2021). Specifically, the topics addressed by these studies in the educational field review specific aspects such as cybersecurity through educational video games (Gordillo et al., 2021), the influence of online communication and the use of social networks in elementary school students (Cabezas-González et al., 2021) and the detection of training needs (Fombona & Pascual, 2020). They also report innovative proposals for the development of digital competence in vulnerable students (Casillas-Martín et al., 2020), the impact of the application of active methodologies and the development of digital competences with mobile devices (Agila-Palacios et al., 2021; Moreno-Guerrero et al., 2021). The studies also focused on the design of various scales and questionnaires to assess digital competence both in students (Iglesias-Rodríguez et al., 2021; Usart Rodríguez et al., 2020) and the capacity of virtual environments to promote it (Viñoles-Cosentino et al., 2021). These articles were also concentrated on comparative studies between different national policies for the development of teachers' digital competence (Guitert et al., 2020; McGarr et al., 2021; Ortega-Sánchez et al., 2020), the incidence of gender in the acquisition of digital competence (Guillén-Gámez et al., 2021; Jiménez-Hernández et al., 2020; Pérez-Escoda et al., 2021; Zhao et al., 2021), the review of studies on digital competences in education (Marín Suelves et al., 2021; Zhao et al., 2021) and the study of the ethical dimension of digital competence in teacher training (Novella-García & Cloquell-Lozano, 2021).

Outside the formal educational field, studies on digital competences have focused on areas as different as the assessment of digital competences in future tourism professionals (Infante-Moro et al., 2021), on assessing and accrediting the digital competence of the digital profiles of entrepreneurs and distance workers (Bartolomé et al., 2021) and specific studies on the development of digital competence in women workers in the Spanish context (Prado et al., 2021). As can be seen, the amount of research on this subject is much more extensive in the field of education than in other spheres of social life. Hence, it is necessary to conduct a more detailed study on the trajectory followed by researchers in the Spanish context in order to determine the path and future lines of work that are in accordance with the National Digital Skills Plan for the period 2021–2026.

The increasing importance that technology has taken on in different areas of people's lives (Blanco et al., 2015; Ortiz-Echeverri et al., 2018) is due to the need for people to be able to function effectively in an increasingly technological society (López-Belmonte et al., 2020). In short, the development of digital competence is essential, both in the personal and professional environment (Soler-Costa et al., 2021).

Nevertheless, this need is not only a consequence of the implantation and development of the technology (Rodríguez-Reséndiz et al., 2012; Rodríguez-Ponce et al., 2015) but also because of how COVID-19 has affected the lives of people. Having to adapt their way of life to the new demands derived from the pandemic (Corell-Almuzara et al., 2021).

This study focusses on analysing the evolution of digital competence in the Spanish context (DICOM-SP). The analysis takes into account the volume of publications, their evolution, the most prominent topics and authors, as well as their prediction in the coming years.

Due to bibliometrics, both the progress and the current situation of a subject or area of study can be presented to society (Herrera-Viedma et al., 2020). This research methodology involves the analysis of a variety of variables, such as the name of the authors, the keywords contained in the publications, the journals in which the works have been published, the countries that have supported the research, the languages used by the authors, and the source of origin of the texts, among others (López-Belmonte et al., 2020).

An essential aspect in this type of work is the database under study. For this particular work, the Web of Science (WoS) database was used. To give more details about WoS, it is postulated as a world repository of scientific documents that covers a large volume of high-impact publications (Martín-Martín et al., 2018).

23.3 Method

As has been established, in this work the related literature on DICOM-SP in the WoS database is analysed from two well-differentiated bibliometric aspects. On the one hand, the study of documentary evolution is conducted and, on the other, the study of co-words, as a newer publication analysis technique (Moreno-Guerrero et al., 2020).

In this work, the guidelines set by the experts in this field of study was followed, in order to conduct a work free of biases and to obtain more precise results (Cobo et al., 2011). Moreover, for the presentation of the results, a model presentation of findings was used that has already been validated by the scientific community, as it has been collected in previous impact studies (Segura-Robles et al., 2020).

23.3.1 Research Design

For the implementation of this research, a design that combined investigations focused on searching for documents, registering them, analysing their content and metadata, for their subsequent establishment of the state of the art and prediction of future publications was developed (Mac Fadden et al., 2020; Moreno-Guerrero, 2019a).

To achieve the different goals set in the study, this approach is necessary. Apart from these actions, the analysis of co-words (Hirsch, 2005), different indices such as h, g, hg, and q2 have been taken as the object of study (Soler-Costa et al., 2021).

With these analytics, maps were made whose interior is made up of nodes to symbolize the conceptual subdomains of the different publications on DICOM-SP. In turn, the maps made reflected the projection of the topics during time intervals, established by the researchers (López-Núñez et al., 2020; Martínez et al., 2015).

23.3.2 Procedure

This work has been based on the research procedure followed in previous studies to minimize the appearance of biases that may condition the results (López-Belmonte et al., 2021). Based on these studies, this research has been structured in distinct phases:

- Phase 1: Select a database to extract the literature: WoS.
- Phase 2: Establish a field of study to analyse: Digital competence in Spain.
- Phase 3: Build a search equation to report accurate results on the state of the art: "digital * competence *". This equation was applied in the Title search metadata.
- Phase 4: Refine the results obtained by selecting WoS categories (Countries/regions: Spain) and selecting the following WoS indices: SCI-EXPANDED, SSCI, A & HCI, CPCI-S, CPCI-SSH, BKCI- S, BKCI-SSH, ESCI, CCR-EXPANDED, IC.

At first, 609 publications were reported. These results were limited to the Spanish context, obtaining a total of 297 documents. Next, the documents were reviewed and those improperly indexed (n = 7) and repeated (n = 4) were eliminated. After this refinement process, a final unit of analysis of 286 publications was obtained.

Despite the decline in documentation after refining the results, various requirements have been defined to contemplate the results in this work. All of this is to establish in this study those publications that meet the following criteria:

(a) Language of studies ($x \geq 10$)
(b) Knowledge areas ($x \geq 14$).
(c) Type of documents ($x \geq 7$).
(d) Institutions ($x \geq 16$)
(e) Authors ($x \geq 8$)
(f) Sources of origin ($x \geq 8$)
(g) Country ($x \geq 11$)
(h) The four most cited documents.

23.3.3 Data Analysis

Analyse Results, Creation of Citation Report, and SciMAT were the tools used to perform the data analysis of the recovered documents. Experts' considerations for an efficient use of the resources have been incorporated into this analysis (López-Robles et al., 2019; Moreno-Guerrero, 2019b).

Specifically, for the study of co-words, it was necessary to establish the following guidelines:

- Recognition: 822 keywords were reported that were analysed and refined. After the debugging process, they were reduced to 767 keywords. The maps were then designed to represent the co-occurrence nodes, as well as a normalized conceptual connection structure of those words with contiguity. In addition, the most relevant topics were grouped together using a clustering algorithm.
- Reproduction: Both the strategic maps and the thematic network were established. The strategic maps were configured in four areas depending on the relevance or degree of projection of the issues. In turn, density and centrality were considered as elementary principles for thematic cataloguing.
- Determination: The reported publications were organized in three time periods (P1 = 2010–2017; P2 = 2018–2019; P3 = 2020–2021). The authors' study was conducted in a single time period (PX = 2010–2021). To establish the strength of connection between such periods, the number of keywords or themes in common was taken as a reference.
- Performance: In this process, the following indicators were established with their respective criteria (Table 23.1).

Table 23.1 Production indicators and inclusion criteria

Configuration	Values
Analysis unit	Keywords authors, keywords WoS
Frequency threshold	Keywords: P1 = (2), P2 = (2), P3 = (2)
Network type	Authors: PX = (2)
Co-occurrence union value threshold	Co-occurrence
Normalization measure	Keywords: P1 = (1), P2 = (1), P3 = (1)
Clustering algorithm	Authors: PX = (2)
Evolutionary measure	Equivalence index: eij = cij2 / Root (ci - cj)
Overlapping measure	Maximum size: 9; Minimum size: 3

23.4 Results

23.4.1 *Scientific Output and Production*

The scientific production collected on digital competence in Spain (DICOM-SP) has been included in the Web of Science database since 2010. From that date until 2016, the volume of production was not high, not exceeding the figure of 20 manuscripts per year. From 2017 to 2020, the production has increased considerably. The peak of production occurred in 2020. At least until August of 2021, production is on par with 2019. Until the end of 2021, the production volume is expected to reach at least that of 2020 (Fig. 23.1).

The language used by the scientific community to display DICOM-SP's scientific output is Spanish. It is closely followed by English (Table 23.2).

The main area of knowledge covering studies on DICOM-SP is Education Educational Research. It is followed by other areas of knowledge, but with significantly lower values (Table 23.3).

Researchers often use research articles to present their results on DICOM-SP-related studies (Table 23.4).

Several institutions produce an equal volume of DICOM-SP studies. These institutions include the University of Seville, the University of Granada, and the University of Salamanca (Table 23.5).

Among the main authors, in terms of volume of production, two stand out: Palacios-Rodríguez, A. and Cabero-Almenara, J. Their volume of production exceeds ten manuscripts (Table 23.6).

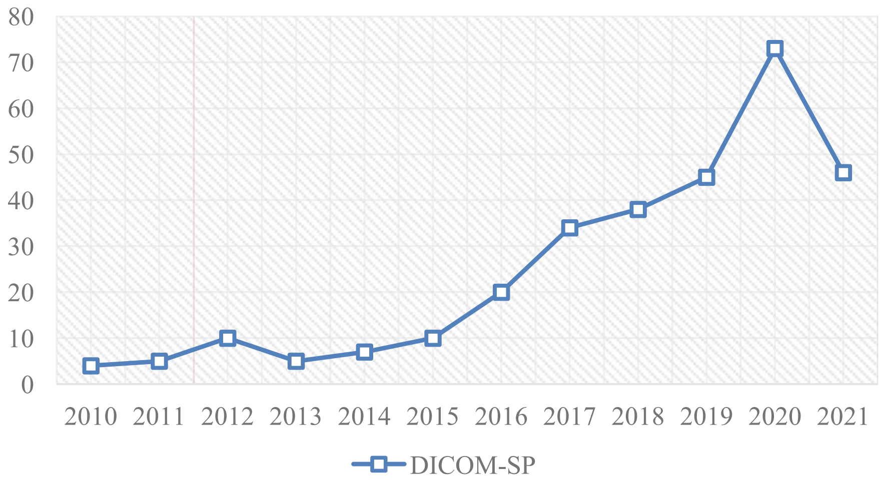

Fig. 23.1 Evolution of scientific production

Table 23.2 Scientific language used

Denomination	n
Spanish	149
English	146

Table 23.3 Areas of knowledge

Denomination	n
Education educational research	213
Environmental science	21
Communication	17
Environmental studies	17
Green sustainable science technology	17
Computer science interdisciplinary applications	15

Table 23.4 Type of document

Denomination	n
Article	247
Proceedings paper	35
Early access	9
Review	8

The main source of production of DICOM-SP studies is Sustainability, from the MDPI group, which is also the one with the best quality indicators among the top six (Table 23.7).

Table 23.5 Institutions

Denomination	n
University of Sevilla	28
University of Granada	26
University of Salamanca	25
University Rovira I Virgili	23
University of Murcia	17

Table 23.6 Most prolific authors

Denomination	n
Palacios-Rodríguez, A	12
Cabero-Almenara, J	11
Cervera, M.G	9
Guillen-Gámez, F.D	9

Table 23.7 Source of origin

Denomination	n
Sustainability	17
Revista Latinoamericana de Tecnología Educativa-Relatec	14
Education Siglo XXI	10
IEEE Revista Iberoamericana de Tecnologías del Aprendizaje	9
INTED proceedings	9
Pixel-Bit. Revista de Medios y Educación	9

Among the various manuscripts dealing with DICOM-SP, the most cited is that of the authors Gutiérrez & Tyner (2012), whose volume of citations exceeds one hundred. It is closely followed by the study by Touron et al. (2018), whose volume of citations stands at 64 (Table 23.8).

23.4.2 Structural and Thematic Development

The evolution of keywords, shown in Fig. 23.2, shows the level of coincidence of keywords between the established periods. In this case, it can be seen that the highest level of coincidence occurs between the years 2018–2019 (second period) and the years 2020 and 2021 (third period). This shows that the lines of research on DICOM-SP are settling in these last four years. Between the first and second period, the level of overlap is moderate, because the foundations of the current research lines were still being laid.

Table 23.8 Most cited articles

References	Citations
Gutiérrez, A., & Tyner, K. (2012). Media Education, Media Literacy and Digital Competence. *Comunicar, 19*(38), 31–39. https://doi.org/10.3916/C38-2012-02-03	118
Touron, J., Martin, D.R., Navarro, E., Pradas, S., & Iñigo, V. (2018). Construct validation of a questionnaire to measure teachers' digital competence (TDC). *Revista Española de Pedagogía, 76*(269), 25–54. https://doi.org/10.22550/REP76-1-2018-02	64
Dura, M., Gutiérrez, I., & Prendes, M.P. (2016). Conceptual analysis of digital competence models of university teacher. *Revista Latinoamericana de Tecnología Educativa-Relatec, 15*(1), 97–114. https://doi.org/10.17398/1695-288X.15.1.97	41
Guzman, F., García, E., & López, I. (2017). Undergraduate students' perspectives on digital competence and academic literacy in a Spanish University. Computers in Human Behavior, (74), 196–204. https://doi.org/10.1016/j.chb.2017.04.040	40

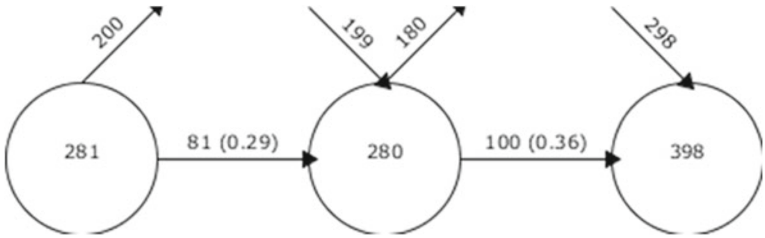

Fig. 23.2 Keyword continuity between contiguous intervals

The academic performance of each of the established period's shows that in the first period (2010–2017) "digital competence" showed the highest values in the various bibliometric indicators. In the second period (2018–2019), it is "ICT". In the third period, it is "students" and "integration" (Table 23.9).

The interval diagrams provide relevant information on the value and interest of the scientific community in the diverse topics. In the first period (2010–2017), the themes "technology", which is related to "innovation", "standards", "Bayesian-analysis", "bayes-factor", "beliefs", "higher-education", "university", and "teachers-digital competence", were considered as driving themes; and "education", which included "media", "teaching", "women-studies", "digital-competencies"; "literacy", "learning", "key-competences", and "digital-divide". In the second period (2018–2019) the driving themes were "integration", which correlates to "inclusion", "barriers", "policies"; "literacy", "technology", "teacher-professional-development", "performance", "meta-analysis"; and "information-literacy", which relates to "technological-literacy", "primary-school", "flipped-classroom", "perceptions", "students", "higher-education", "DIGCOMP", and "media-literacy". In the third and final period (2020–2021) the driving themes were "e-learning", related to "information-literacy", "curriculum", "Spain", "pandemics", "training", "sustainability", "sustainable-development", and "motivation"; "computer" which relates

Table 23.9 Thematic performance in DICOM-SP

Interval 2010–2017						
Title	**Work**	**H-index**	**G-index**	**Hg-index**	**Q^2-index**	**Citations**
Primary school	5	5	5	5	7.42	69
Competence	5	2	4	2.83	8.49	41
Technology	6	2	4	2.83	7.87	44
Education	7	3	6	4.24	8.83	166
Teacher-education	7	4	6	4.9	7.75	53
Digital competence	28	7	11	8.77	9.17	142
Digital literacy	4	3	4	3.46	4.24	20
Interval 2018–2019						
Title	**Work**	**H-index**	**G-index**	**Hg-index**	**Q^2-index**	**Citations**
Integration	4	2	3	2.45	4.9	20
Classroom	5	2	2	2	2.45	6
ICT	20	6	11	8.12	10.68	136
Information-literacy	7	3	5	3.87	4.58	32
Educational-Technology	9	5	7	5.92	5.92	53
Teachers	6	2	3	2.45	3.74	12
Interval 2020–2021						
Title	**Work**	**H-index**	**G-index**	**Hg-index**	**Q^2-index**	**Citations**
Computer	5	3	5	3.87	4.58	30
E-learning	2	2	2	2	3.16	8
Students	50	8	11	9.38	10.2	186
Language	6	1	1	1	1.41	5
Perceptions	6	3	4	3.46	4.9	29
Gender	11	3	6	4.24	6	40
COVID-19	4	1	1	1	1	1
Skills	9	2	3	2.45	2.83	12
Integration	12	7	9	7.94	9.54	102
Quantitative analysis	2	1	1	1	3.46	12
Questionnaire	5	2	4	2.83	7.75	41
Teacher-digital competence	2	1	1	1	2.65	7
Affective-E-learning	2	0	0	0	0	0
Technology-use	2	2	2	2	2	4
Media-competence	2	1	1	1	1	1

to "ICT-use", "early-childhood-education", "online", "self-efficacy", "communication", "proposal", "initial-training" and "ICT-literacy"; and "students" which relates to "education", "social-media", "information", "digital competence", "future-teachers", "ICT", "literacy", and "technology". In addition, in this last period, attention should be paid to the topics "technology-use" and "teacher-digital competence", as they may be the new research trends in the coming years (Fig. 23.3).

As can be seen in Table 23.10, there is no theme that is repeated in the three established periods, confirming the changes in the trends of the studies in DICOM-SP over the 10 years of its existence.

The thematic evolution of DICOM-SP reconfirms the changing trends in research. There is a constant and continuous evolution. Over time, no line of research has

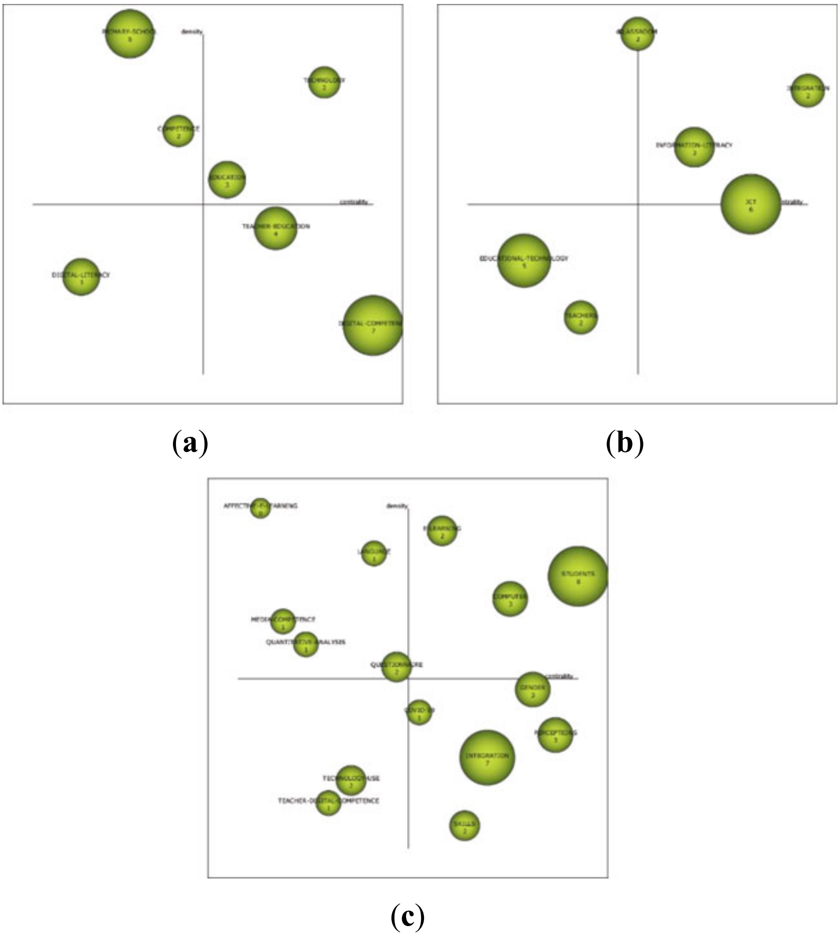

Fig. 23.3 Strategic diagram by DICOM-SP h-index. *Note* **a** Interval 2010–2017; **b** Interval 2018–2019; **c** Interval 2020–2021

Table 23.10 Principal research themes related to DICOM-SP from 2010 to 2021

	P1(2010–2017)	P2(2018–2019)	P3(2020–2021)
Technology	Q1(43.81–31.32)		
Education	Q1(34.82–24.75)		
Primary-School	Q2(26.98–50.34)		
Competence	Q2(31.36–28.94)		
Digital literacy	Q3(23.81–7.95)		
Teacher-education	Q4(35.15–19.41)		
Digital competence	Q4(62.97–5.65)		
Integration		Q1 (67.62–51.54)	Q4(89.2–16.05)
Classroom		Q1-Q2(50.64–60.96)	
ICT		Q1-Q4(61.51–22.97)	
Information-literacy		Q1(53.77–32.11)	
Educational-Technology		Q3(40.49–10.32)	
Teachers		Q3(46.44–5.44)	
Computer			Q1(90.68–31.02)
E-learning			Q1(66.89–39.66)
Students			Q1(167.1–34.79)
Language			Q2(55.54–35.15)
Perceptions			Q4(108.12–16.77)
Gender			Q4(98.28–20.54)
COVID-19			Q4(60–17.67)
Skills			Q4(72.27–4.51)
Quantitative analysis			Q2(24.78–22.92)
Questionnaire			Q2(58.19–21.88)
Teacher-digital competence			Q3(25.36–8.8)
Affective-E-learning			Q2(9.29–44.44)
Technology-use			Q3(37.55–9.72)
Media–competence			Q2(21.25–27.78)

Note (X/Y), X = centrality; Y = density

become established. Only the research lines “digital competence-ICT-students” and “teacher-education_educational-technology_teacher-digital competence” stand out above the rest. In addition, a higher number of broken line connections can be observed than continuous ones. This indicates that there are more keyword matches than thematic matches (Fig. 23.4).

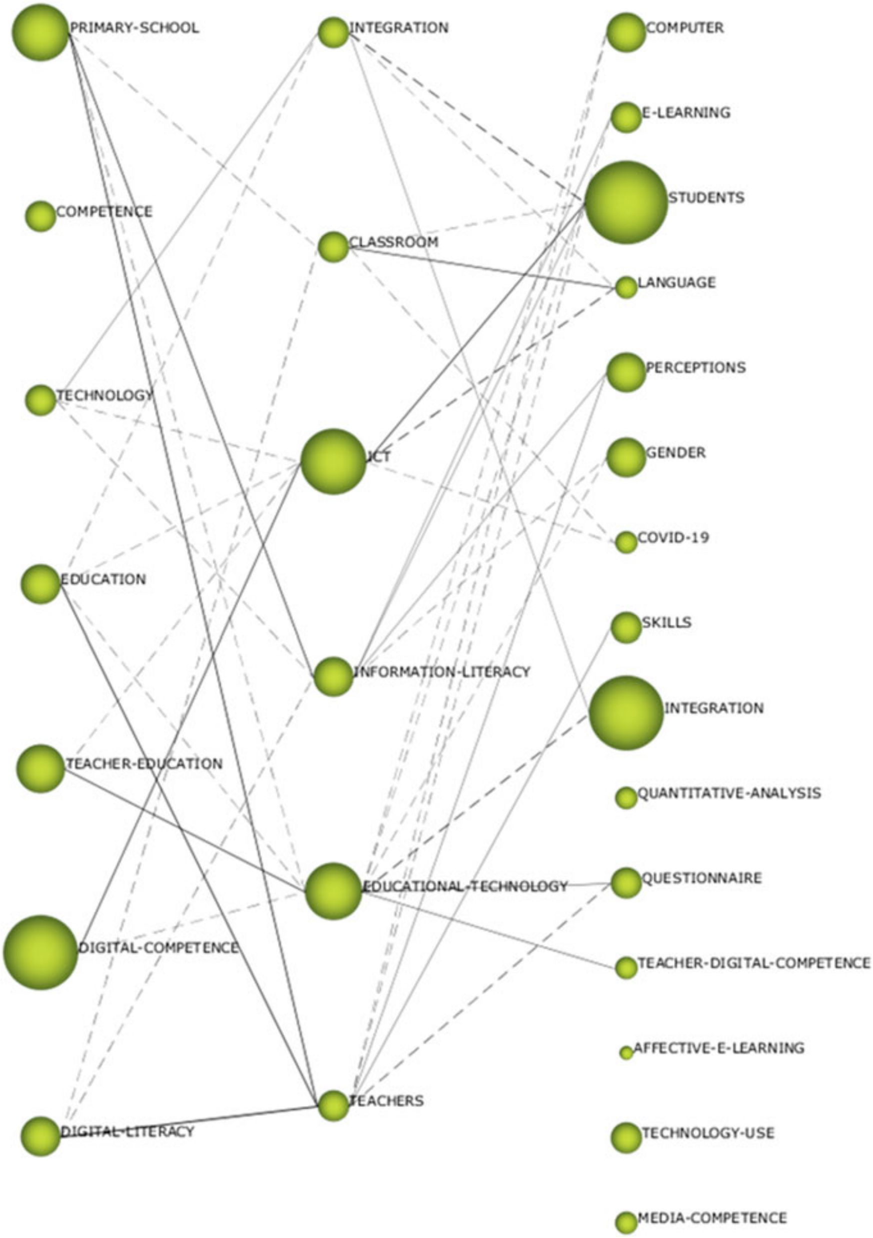

Fig. 23.4 Thematic development by h-index

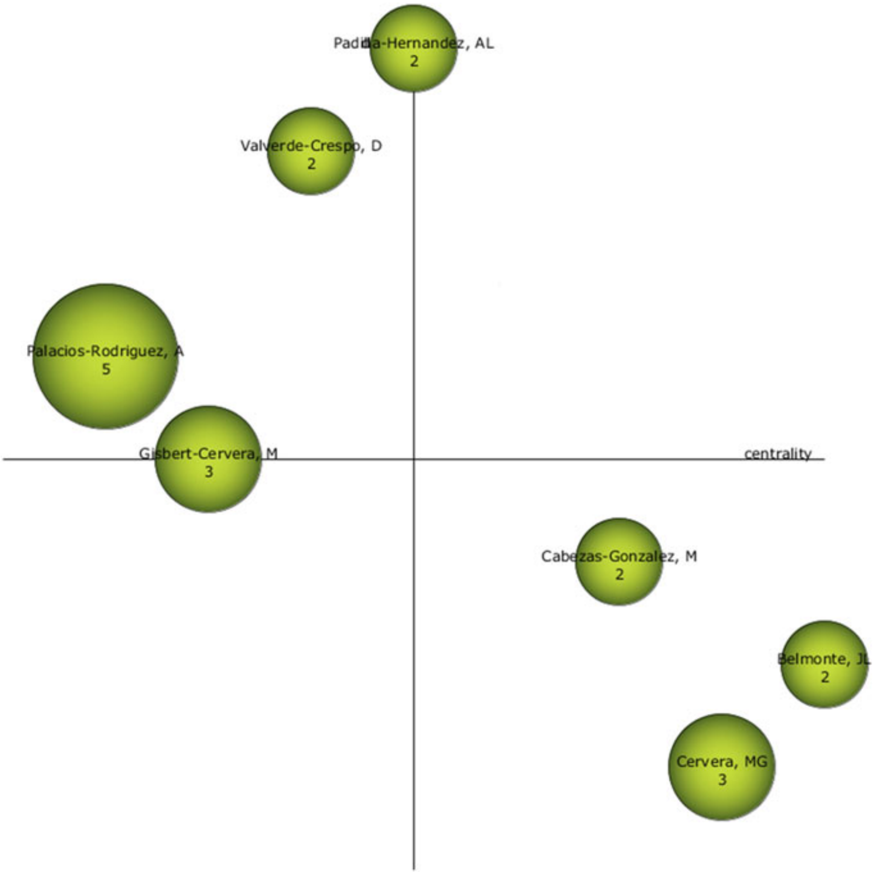

Fig. 23.5 Strategic diagram of authors of all scientific production

23.4.3 Authors with the Highest Relevance Index

There are no authors who are driving forces in the field of study of DICOM-SP. Of all the authors represented in Fig. 23.5, Palacios-Rodríguez stands out for his high h-index in this field of study.

23.5 Discussion

The start of scientific production on digital competence in the Spanish context was in 2010. From that year until 2016, the volume of production is relatively low. The increase in scientific production on DICOM-SP occurs from 2017 onwards. The highest peak of production occurs in 2020. This shows the significance that this field of study is gaining in Spain. The language for submitting manuscripts is Spanish. This is significant, given that the studies included in WoS tend to be mainly English speaking. The area of knowledge that collects the studies on DICOM-SP is Educational Research. In addition, research articles are the main type of manuscript used by the scientific community to present their results. The University of Seville produces the most studies on DICOM-SP. Among the various authors, Palacios-Rodríguez, A. and Cabero-Almenara, J. stand out in terms of the volume of production. In addition, Palacios-Rodríguez, A. is the author with the highest h-index in the field of study of DICOM-SP. Sustainability is the journal with the highest output on DICOM-SP. The most cited study is that of Gutiérrez and Tyner (2012), with 118 citations. The level of coincidence of keywords is over 30% in the last four years, indicating a settled line of research. This shows that there are even research trends. Although, as we will see below, this is not reflected in the choice of driving themes. Academic performance varies considerably from period to period. In the first period, trends were focused on digital competence per se. In the second period, the focus was on information and communication technologies. In addition, in the third period, researchers' attention shifted to learners and the integration of technologies in teaching and learning processes.

The interval diagrams show, as indicated above, a variety of motor themes. These do not coincide between the three established periods, indicating changes in trends and research on DICOM-SP. In the first period (2010–2017) the driving themes were "technology" and "education", focusing mainly on the technological resources needed in educational processes. The second period (2018–2019) focuses on "information-literacy" and "integration", focusing in this case on one of the digital competences and the integration of technological resources in the classroom. The third period (2020–2021), marked by the COVID-19 pandemic, shows that the driving themes were "e-learning", "computer", and "students". This indicates that the focus is on key elements for the development of distance learning, such as teaching methods, technological resources, and the main actors involved in learning, the learners. There is no driving theme that is repeated in the three periods, which confirms the changes in research trends.

The thematic evolution of DICOM-SP reconfirms what has already been established above, that there is no line of research established over time. Only two lines stand out from the rest. These are the cases of "digital competence-ICT-students" and "teacher-education_educational-technology_teacher-digital competence". This indicates that the focus of research over time is on the use of technological resources by students and teachers.

As pointed by the literature, digital competence in Spain has been addressed by the scientific community for more than a decade. As reflected in the publications analysed, the focus of study has varied depending on the needs of society. COVID-19 has recently had a significant impact on the latter (Herrera-Viedma et al., 2020). This pandemic has conditioned our way of life, both personally and professionally. As a result, the society, and the scientific community demands the necessary skills and abilities to function effectively in increasingly dynamic digital environments (Corell-Almuzara et al., 2021). People and education professionals have realized the importance of digital competence in an era where technology is integrated into our lives (Soler-Costa et al., 2021).

23.6 Conclusions

It can be concluded that from 2018 to the present, the subject of study on digital competence is becoming more established in the Spanish sphere, concentrating its research lines on pedagogical education methods, technological resources, and individuals involved in training processes. Specifically, it focuses on the competencies that students and teachers need to possess in order to successfully operate training processes utilizing technological resources. This study has several limitations. The first limitation is the use of the WoS database. There are other relevant databases, such as SCOPUS and Google Scholar, but in this case, the authors opted for WoS because it is the database on which JCR is based. The second limitation is the purification of the database, which requires a great deal of time and dedication in order to adequately select the research presented in this study. The third limitation is the temporal distribution of the periods. In this case, the authors decided to establish the volume of production as a criterion, being equitable between the three established periods. For future research, it may be beneficial to conduct the same study using other databases, such as SCOPUS and Google Scholar.

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Chapter 24
Formation and Development of Information and Communication Competencies of Pedagogical Universities Students: Experience of Ukraine

Larysa Lukianova

Abstract The content of information and communication competence (ICC) is defined by researchers differently. In Ukraine the investigation of its formation in pedagogical university students takes place in the process of studying, systematizing, and generalizing Ph.D. dissertations defended in specialized academic councils of Ukraine. The purpose of this article is to analyze dissertations for the degree of Candidate and Doctor of Sciences devoted to ICC of future teachers during their professional training at pedagogical universities of Ukraine. The research analysis is based on the overview of dissertations for 2010–2020 and is performed according to 5 identified criteria: general characteristics; theoretical framework; research significance; quantitative indicators of the experiment; tools of experimental research. Using a set of methodological approaches, researchers developed proposals for the formation of future teachers' ICC, based on pedagogical experiment results. It is proved that the effectiveness of forming ICC is positively influenced by the following factors: the created innovative models considering the specifics of teacher training in the relevant field; author's methods based on the use of mobile, computer, cloud-based technologies; educational and methodical provision for special courses in the practical application of IC technologies, etc. Particular attention is paid to the justification of appropriate pedagogical conditions and the development and adaptation of diagnostic techniques for conducting the monitoring of components of ICC at different stages of the pedagogical experiment.

Keywords Competence · Information and communication competence · Information and communication technologies · Future teacher · Pedagogical universities

L. Lukianova (✉)
Ivan Ziaziun Institute of Pedagogical Education and Adult Education of the National Academy of Educational Sciences of Ukraine, Kyiv 04060, Ukraine
e-mail: larysa.lukianova@gmail.com

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24.1 Introduction

The permanent transformations associated with the global processes of informatization of modern space have led to the intensive spread of information and communication technologies in all spheres of human activity. In the post-industrial era, informatization is becoming one of the basic components of social progress, and the creation of adequate conditions for its development is one of the national priorities in the developed world. In this sense, Ukraine is no exception. Thus, the problems of ensuring access to information resources, forming information and communication competencies, developing media literacy among a wide range of citizens are of great importance.

According to the results of 2020, despite the fall of the total exports of Ukraine caused by the COVID-19 pandemic, the export of IT services increased by 20%. Moreover, for the first time, it exceeded 5 billion dollars per year, and the share of IT services in total exports was over 8%. In general, since 2013 Ukraine has increased the export of IT services almost by 4 times. However, the possibility of its further increase depends on the rate of increasing the number of IT professionals in the domestic labor market (BRDO 2021). According to the Minister of Digital Transformation M. Fedorov, it is planned to increase the share of the IT sector in Ukraine's GDP from 5 to 10% and to work out a package of solutions to develop partnerships between the state and the IT sector, support IT education and attract new staff (Мінцифри хоче підвищити 2020).

The importance of this issue is confirmed by Ukraine's signing of the Association Agreement with the European Union, which necessitates the harmonization of the basic principles and pace of development of the information society in Ukraine. In addition, the recent adoption of normative legal acts in the field of ICT by the Ukrainian government testifies to the intensification of the issue of digitalization in all spheres of life and the formation of relevant competencies. On the one hand, these normative documents are designed to bring Ukrainian legislation in line with European legislation, and on the other hand, they demonstrate the state's ever-increasing attention to the development of the digital industry.

In particular, there have been approved the following Laws of Ukraine: «Про Концепцію Національної програми інформатизації» (The Law of Ukraine on the Concept of National Informatization Program) (Закон України про Концепцію національної програми інформатизації 1998), «Про Національну програму інформатизації» (The Law of Ukraine on National Informatization Program) (Закон України про національну програму інформатизації 1998) and others. The latter one includes the Concept of the National Informatization Program, a set of other state informatization programs, sectoral programs and informatization projects, regional programs and informatization projects, programs and projects of local self-government bodies informatization.

Confirmation of the seriousness of the state's intentions in this area is the Concept for the Development of Digital Competences until 2025 that was then approved by the Cabinet of Ministers of Ukraine in 2021 and the corresponding action plan for its implementation (Концепція розвитку цифрових компетентностей 2021).

It should be added that the Ministry of Digital Transformation of Ukraine intends to significantly increase the digital literacy of 6 million Ukrainians by 2024. To achieve the goal, there was created the portal "Action. Digital Education" in 2020. It offers a variety of courses in the format of series, which teach digital skills in various spheres of life. In addition, in November 2020, the Ministry of Digital Transformation of Ukraine launched a national test "Цифрограм" to identify the level of digital literacy of Ukrainians. Testing involves checking citizens' basic digital literacy knowledge and skills in 6 areas: basics of computer literacy; information and media literacy; creation of digital content; communication and interaction in the digital society; security in the digital environment;

fundamentals of computer literacy.

With the powerful penetration of information technology in all spheres of life, the need for professionals who can quickly adapt to the growing demands of the information society is growing. This leads to the necessity of solving the problem of modernizing the national educational system related to its informatization and encourages higher education pedagogical institutions to train teachers who can implement radical changes in education.

Today it is especially important to achieve a qualitatively new level of information culture for students of higher education pedagogical institutions. They are expected to actively use their information and communication competence in their further professional, cultural, educational, and social activities with schoolchildren, parents, and other social and age groups of the population.

Analysis of modern state standards, as well as consideration of a wide range of scientific, pedagogical, and methodological sources, shows that the need to improve the professional training of future teachers is associated with the transition of the education system from knowledge (cognitive-informational) to competence paradigm. It means that the new content of education is based on forming competencies that are required forth the successful implementation of pedagogical activities in general secondary education in modern conditions.

The formation of future teachers' information and communication competence (ICC) and their preparation for the use of information and communication technologies (ICT) in education are the main aspects of technological transformations in the modern education system of Ukraine. The process of training new teachers should begin immediately, because their formation as digital professionals, according to experts, will take about 20 years. If the moment is missed, the creation of a knowledge economy in Ukraine may be postponed for an indefinite time (Гуревич 2011).

24.2 The Theoretical Framework of ICC

In the modern psychological and pedagogical literature, there is no single approach to defining the essence of the investigated phenomenon—Information and communication competence. At the same time, the analysis shows that there is a certain relationship between this concept and the related ones, in particular, "computer competence", "computer literacy", "information literacy", "information and computer literacy", "information culture", "computer competence", "information competence", etc.

Neither, there is a single approach among researchers regarding the use of the term "information and communication competence" and the essential meaning of its content, the definition of the structure, and most importantly, ways and criteria to measure its formation and so on.

ICC is mainly considered as follows:

(1) an ability;
(2) a system of knowledge and abilities, but more often as skills;
(3) an integrative, integral, dynamic quality of the personality.

A closer analysis showed that when researchers interpret the future teacher's ICC as an ability, they mean:

Teacher's proven ability to confidently use ICT in practice, as well as to apply innovative methods and creative approaches in teaching professional disciplines (Полюхович 2014);

Ability to autonomously and responsibly apply the acquired theoretical and factual knowledge, skills, and abilities in the field of ICT to solve socially significant tasks, including professional ones (Сороко 2012);

Ability and readiness of dynamic combinations of knowledge, skills, and abilities to perform pedagogical activities with the help of ICT, upskilling training, self-study of informatics and ICT (Петренко 2013);

Ability of the person to use ICT means for satisfying own personal needs, effective realizing professional activity and supporting scientific researches based on formed knowledge, abilities, skills, and attitudes (Топольник 2019);

Mobile ability to effectively use information processes for professional activities, which involves a certain level of ICT proficiency (Закомірний 2019).

When it comes to ICC as a system of knowledge, skills, and abilities, according to researchers it is:

A system of knowledge, skills, personal qualities of the teacher, the formation and development of which will allow him/her to solve typical professional tasks, settle the problems that arise in real situations of pedagogical activity. In addition, it provides the ability to professional growth in the field of ICT (Кривонос 2014);

A system of knowledge and methods of processing various educational information, skills of operating modern information technologies, experience, and positive motivation in their application in the learning process (Семчук 2017);

A perfect ability to navigate in the flow of information and master it accordingly, the personality's ability of dynamic development and self-improvement (Осадча 2010);

An ability to solve relevant tasks using information and communication technologies (Федорук 2015).

As an integral quality of personality, ICC is interpreted as follows:

Dynamic combination of knowledge, skills, abilities, values, experience, and other personal qualities acquired in the process of educational training in a higher education institution, which allows autonomous and responsible use of ICT in practice to solve professional tasks (Шроль 2017);

An integral quality of personality, which determines his/her ability to navigate in a dynamic information space, to search, evaluate, store and perform various types of information activities, to develop communicative qualities of speech and communication and to use ICT (Семчук 2017);

Integrative, the dynamic characteristic of future professionals, presenting their motivation and ability to navigate in the information space, receive and systemize information (Тимофєєва 2017).

Dynamic characteristics a person to navigate in space, receive information, operate on it, have the appropriate level of knowledge, skills, and abilities regarding ICT (Федорук 2015).

It should be emphasized that Ukrainian researchers consider ICC not separately but as a structural component of professional competency; an element of another quality, competence, or a part of professional training (Table 24.1). As it can be seen from Table 24.1, most often researchers consider it as a component of professional competence.

For instance, there is an opinion that the professional competence of future teachers should be considered as a set of key competencies, among which communicative, information, and communication are extremely important (Крижановський 2017; Федорук 2015). Another identical point of view (Куцак 2015), according to which ICC as a component of key competencies is a structural part of the professional competence of teachers and it reflects the teacher's culture. I. Zakomirnyi also considers ICC as a separate but mandatory component of a teacher's professional competence, due to the introduction of ICT in all spheres of human activity (Закомірний 2019). However, there is a slightly different approach, when the ICC is considered as a criterion for the effectiveness of the information

Table 24.1 Information and communication competence as part of another quality of a professional

ICC as a structural component of:	Осадча (2010)	Рафальська (2010)	Осадчий (2013)	Гаврілова (2015)	Куцак (2015)	Крижановський (2017)
Professional competence	+			+	+	+
Computer competence		+				
Professional training			+			

technology support system for future teachers in a pedagogical university (Осадчий 2013).

Both the formation and development of ICC are directly related to information and communication technologies and involve the use of modern ICT, including computer mathematics systems, to solve problems; the selection of modern ICT tools; the application of the gained experience of using ICT means (Рафальська 2010).

The most generalized approach shows that researchers understand the formation of the future teacher's ICC as a purposeful process of quality training of students to use ICT in professional activities based on a set of approaches. In our opinion, the most significant is that the formation of ICC is a continuous process that has its origins at school when studying the discipline "Computer Science", at the university during ICT training and when studying other disciplines, during pedagogical practice according to educational and professional programs at the level of "Bachelor", then "Master" which never stops. On the contrary, it develops and improves during further mastering of pedagogical skills of teachers through their training and self-education (Шроль 2017).

24.3 Research Methodology

24.3.1 Object and Subject of the Research

The purpose of the research is to identify the level of ICC formation of future teachers and students who are studying at pedagogical universities of Ukraine. To achieve it, we have selected and analyzed the dissertations, in which the content, forms, methods, technologies, as well as pedagogical conditions that directly influenced the formation of ICC of future teachers of different specialties, were presented. The selected dissertations have passed the procedure of public defense, and their performers received the degree of candidate or doctor of pedagogical sciences. In addition, the research process allowed us to find out the most effective means of formating the investigated quality, as well as the tools by which it was measured. The purpose of the study was specified by the category of participants—students of pedagogical universities due to specific conditions that can be used in the educational process and by the final result—competencies necessary for the teaching profession, where knowledge is combined with skills (with emphasis on pedagogical conditions).

The object of the research became the dissertations devoted to the problem of forming future teachers' ICC which were chosen by defining keywords and the date of the dissertation defense. The subject of the research was a set of approaches to the process of ICC formation and development of students of pedagogical faculties.

24.3.2 Research Methods

In the process of studying, processing, and preparing the materials for the publication we relied on general scientific principles, forms, approaches to reflecting the reality, namely, empirical methods of pedagogical research such as the method of studying primary sources, rating method, classification, method of generalization of independent characteristics, particularly generalization, comparison, comprehension of the information received through other methods about organizational bases of formation and development of ICC of future teachers at pedagogical universities of Ukraine. We also used methods of analysis and synthesis, theoretical methods related to the study of dissertation research, documents, the method of induction and deduction, the method of abstraction, and concretization.

24.3.3 Test Procedure

To select the objects of the research—the dissertations on the formation of information and communication competence of future teachers, we used the electronic database of the State Scientific and Technical Library of Ukraine and searched its electronic catalogs on the website (https://cutt.ly/qE3LVq9). The choice is explained by the fact that following the procedure for registration of documents related to dissertation defense that are approved by the Ministry of Education and Science of Ukraine, the defended dissertation must be registered in УкрІНТЕІ (Ukrainian Institute of Scientific and Technical Expertise and Information) within 10 days after its defense and e-versions of the abstract and dissertation must be posted on the website of State Scientific and Technical Library of Ukraine within a month.

24.3.4 Research Technique

A systematic analysis of dissertations was carried out, which involved designing a certain algorithm and selecting criteria according to which the analysis and generalization of the research results were conducted. The search was performed according to the following algorithm: the required search area was selected (keywords, year of defense) by which the full-text search was performed; the method of ranking the found documents was applied; the search results were sorted in descending order of priority of primary sources. Within the period from 2010 to 2020, a total of more than 60 dissertations were defended in Ukraine, in which the problems of forming information competence of future specialists were studied. Of these, 29 dissertations were devoted to the formation of competencies of future teachers, which in their content and essence are close to the information and communication competencies. In particular, 11 dissertations are devoted to information competence (2 doctoral and

9 candidate papers); 13 dissertations reveal the problems of forming information competence (2 doctoral and 11 candidate papers); 1 doctoral dissertation concerned digital competence; by one defended candidate's dissertation is available on the problems of art and information; information technology; information-technical and information-digital competence. In addition, during the established period, the questions of forming information and communication competence in future specialists of non-pedagogical specialties were actively investigated: 9 dissertations were defended (4 doctoral and 5 candidate papers). All in all, there were 18 defended dissertations on the formation of the ICC of future teachers. Figure 24.1 represents the scientific works selected for analysis, the year of their defense, and the distribution by level (candidate/doctoral).

The objects of pedagogical influence were teachers of various specialties: masters of education, evening school teachers, computer science teachers, mathematics teachers, music teachers, economics teachers, primary school teachers, natural science and mathematics teachers, technology teachers, philology teachers, preschool education specialists.

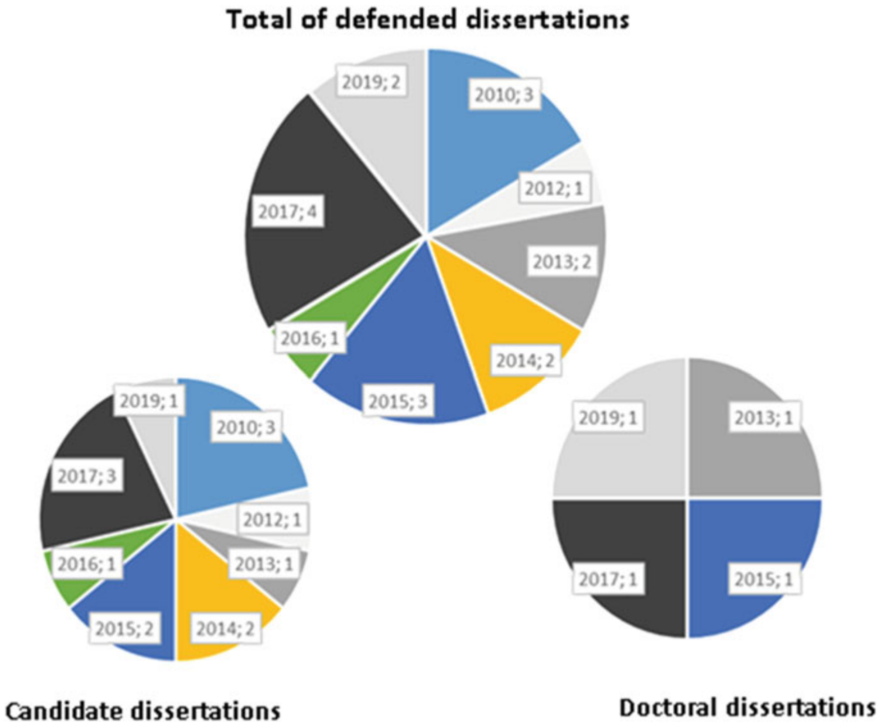

Fig. 24.1 Total of dissertations on forming ICC of future teachers defended in Ukraine in 2010–2020. *Source* own

24.3.5 Research Limitations

The limitations of this paper are primarily related to the analysis of the dissertations that have already been defended in specialized academic councils in Ukraine for the past 10 years. Those researches that have been performed, but not yet defended, have not been analyzed. There are limitations related to the orientation of the analyzed works on (a) a specific subject area, in particular, ICT learning as it is understood as "a computer-oriented component of pedagogical technology, which reflects a formalized model of a particular component of learning content and its methodology in the educational process and which is represented in this process by pedagogical software and involves the use of computers, computer-based learning tools, computer communication networks to solve didactic problems or their fragments" (Биков 2008); (b) preparation of the future teacher for the implementation of such training. Only experimental dissertations were analyzed, review studies and the researches related to the study of foreign experience in this field were not considered.

For in-depth analysis, 9 types of research have been selected. The general topic of them can be formulated as "the formation or development of information and communication competence of the teacher".

24.4 Results

The report included an analysis of 18 dissertations (level of candidate and doctor of science in the field of pedagogy), the purpose of which was to substantiate effective approaches to the formation of ICC of future teachers and determine the level of their formation. The analysis of information on dissertation researches defended during the last two decades was conducted in digital form.

The results of the content analysis showed that in the analyzed dissertations the views of researchers on the components/criteria of the ICC of future teachers differ significantly. We found almost 30 different options. Those that occur more than once can be combined into 6 groups. This led to the conclusion that most often the researchers measure the motivational-value, cognitive, activity-oriented, technological, communication, and reflexive components in their dissertations (Table 24.2).

To analyze the content of the selected dissertations, 5 criteria were identified. Their content is presented in Table 24.3. The most significant for the research are criterion 3 (it reflects the obtained theoretical and practical results) and criterion 5 (the instruments that were used in the process of the pedagogical experiment).

The results of the analysis according to the identified criteria are presented in Table 24.4.

Table 24.2 Structural components/criteria of information and communication competence in the analyzed dissertations

Component/ criterion	Availability in ICC structure										
1.1. Axiological					+						
1.2. Emotional and value	+										
1.3. Value-motivational		+		+				+	+		+
1.4. Motivational						+				+	
2.1. Cognitive		+				+		+	+	+	+
2.2. Cognitive-operational				+							
2.3. Cognitive-cognitive							+				
3.1. Activity-oriented										+	
3.2. Activity-reflexive		+									
3.3. Activity-technological							+				
3.4. Operational and activity-oriented											+
4.1. Operational and technological									+		
4.2. Technological	+					+					
4.3. Technologically effective								+			
5.1. Information and communication						+					
5.2. Typhloinformation (blind aids)			+								
5.3. Communicative						+					
5.4. Social and communicative							+				
6.1. Personality-reflexive				+				+			
6.2. Reflexive						+				+	+

Table 24.3 The content of the identified criteria

No, and the content of the criterion				
1	2	3	4	5
General characteristics: author, the topic of dissertation research; year and place of the dissertation defense, specialty code	Theoretical framework (subject of research; methodological approaches)	Research results: theoretical and practical significance	Quantitative indicators of the experiment: number of institutions; the duration of the experiment; the number of respondents	Tools of experimental research: subject of research; basic empirical methods; results of the empirical research; methods of statistical data processing

Table 24.4 The results of the dissertation research analysis

No	Criteria description
Сороко (2012)	
1	Development of information and communication competence of teachers of philological specialty in the conditions of the computer-oriented environment, 2012, Kyiv, 13.00.10
2	There were studied the content, means, and technologies of developing information and communication competence of philological specialty teachers in the conditions of the computer-oriented environment in postgraduate pedagogical education; methodological competence approach was used
3	The model of development of information and communication competence of philological specialty teachers in the conditions of computer-oriented environment was theoretically substantiated and developed; methodical bases of development of teachers-philologists' ICC were substantiated; the educational and methodical complex of a special course "Fundamentals of information and communication competence of philological specialty teachers" was designed
4	5 higher education institutions took part in the experiment The experimental study was conducted during 2010–2012 483 philology teachers participated in the experimental research
5	There was diagnosed the formation of philology teachers' ICC by determining the levels of forming cognitive, activity-reflexive, value-motivational, creative, and adaptive components of ICC The results of the initial and final sections using the methods of statistical processing and comparative analysis confirmed the positive dynamics of philology teachers' ICC. The influence of computer-based environment on the development of philology teachers' ICC had a positive effect in 69% (EG) and 51% (CG) To verify the reliability of the obtained experimental data, the Kolmogorov–Smirnov λ-criterion and the angular transformation ϕ *—Fisher were used
Кривонос (2014)	
1	Formation of information and communication competencies of future computer science teachers in the process of programming learning, 2014, Kyiv, 13.00.02
2	There were examined the components of the methodical system of forming information and communication competencies of future computer science teachers in the process of programming learning; the methodological activity-oriented and competence approaches were used
3	There were developed and substantiated the components of the methodical system (content, methods, means, organizational forms) of forming ICC; the model of formation of computer science teacher's ICC was theoretically substantiated; educational and methodological provision for the discipline "Programming" and its educational and methodological support were developed and implemented in the educational process. There were created student's textbooks "The beginnings of Algorithmization and Procedural Programming", "The Use of Information and Communication Technologies in Education", "Fundamentals of Standardization of Information and Communication Competencies in the Education System of Ukraine". The ZDU Project website (http://project.zu.edu.ua) was designed, developed, and implemented in the educational process, the use of which helps to increase the level of students' information and communication competencies

(continued)

Table 24.4 (continued)

No	Criteria description
4	3 higher education institutions were involved in the research The experimental study was conducted during 2008–2012 214 respondents took part in the experimental study
5	There were diagnosed the formation of information and communication competencies of future computer science teachers according to 4 components: motivational-value, organizational-semantic, cognitive-operational, personal-reflexive The following empirical methods were used: survey, self-assessment, expert assessment. The result of the experiment. The most significant changes in the experimental groups occurred at high (+3.92%), sufficient (+19.61%), and initial (-22.55%) levels of IC competence. In the control groups, there was a slightly positive trend at all levels of IC competence. To verify the reliability of the obtained experimental data, statistical methods by the Kolmogorov–Smirnov λ-test were used
Федорук (2015)	
1	Formation of information and communication competence of future technology teachers in the process of professional training, 2015, Vinnytsia, 13.00.04
2	There were investigated pedagogical conditions of forming information and communication competence of future technology teachers in the process of learning at higher educational pedagogical institutions; such methodological approaches were used: individual, competence
3	The pedagogical conditions for forming information and communication competence of future technology teachers were substantiated and determined (formation of the need for ICC through the organization of students' activities in the information and educational environment of the educational institution; providing guidance on the formation of the ICC on the basis of an individual approach and the establishment of subject-subject interaction between teacher and students; organization of autonomous students' work with the use of innovative learning technologies); there were designed the model and a technique of forming information and communication competence of future technology teachers; there were developed methods of forming information and communication competence of future technology teachers; the corresponding methodical recommendations for teachers were worked out; diagnostic techniques were developed and adapted for the use in the process of monitoring the components of information and communication competence of future technology teachers
4	5 higher educational institutions were involved in the research The experimental study was conducted during 2010–2014 426 students of the first-the fifth year of study and 12 university teachers took part

(continued)

24.5 Discussion

In the modern Ukrainian psychological and pedagogical literature, there is no established definition of the term "information and communication competence" and quite often it is identified with several other concepts that are related but not identical (computer competence, information competence, etc.). There are also significant

Table 24.4 (continued)

No	Criteria description
5	There was diagnosed the formation of ICC future technology teachers by 3 criteria: motivational-value, information-cognitive, technological-effective. Three levels of formation of the studied quality were determined: elementary-reproductive (low), conceptual-productive (medium), methodological-creative (high) The level of ICC formation was determined by using a set of empirical methods: questionnaires, testing, the method of expert assessment According to the results of the experiment, it was found out that in the experimental group there was recorded a positive trend at all levels of ICC: high − + 8.3; average − + 11.6; low −−19.9. Students of the control groups showed a slightly positive result Pearson's agreement criterion χ2 (Pearson's xi-square) was used to verify the reliability of the obtained experimental data
Петренко (2016)	
1	Delphi system as a means of forming ICT competencies of the future primary school computer science teacher in visual programming learning, 2016, Kyiv, 13.00.10
2	There was investigated the use of the Delphi system for forming ICT competencies of the future primary school computer science teacher in visual programming learning; methodological competence approach was used
3	The model of forming ICT-competences of the future primary school computer science teacher through visual programming was substantiated and developed; the main components of the methodology of using the Delphi system as a means of forming ICT competencies of the future teacher were developed; educational and methodological support for forming ICT competencies of future primary school computer science teachers in visual programming learning, in particular, the educational and methodological provision for the discipline "Visual Programming" was worked out and related electronic educational resources were recommended
4	4 higher educational institutions participated in the research The experimental study was conducted during 2012–2015 The experimental study involved 449 full-time and part-time students in the specialty "Primary School Teacher" (additional specialization "Computer Science")
5	There was diagnosed the formation of information and communication competence of future primary school computer science teachers by motivational, cognitive, informational, communicative, technological, reflective criteria. Four levels of formation of the studied quality were used: reproductive, basic, advanced, creative The level of formation of information and communication competence was determined by using a set of empirical methods, namely: pedagogical questionnaires, expert surveys, conversations with students, teachers, lecturers According to the results of the formative stage of the experiment, it was found out that in the experimental group the number of students with creative (26.83% vs. 10.98% at the beginning of the experiment) and advanced (28.05% vs. 17.07% at the beginning of the experiment) levels of ICC significantly increased. In the control groups, there were also recorded positive results at all levels of ICT competence, but the methods of mathematical statistics proved the insignificance of their changes at different stages of empirical research Pearson's agreement criterion χ2 (Pearson's xi-square) was used to verify the reliability of the obtained experimental data

(continued)

Table 24.4 (continued)

No	Criteria description
Семчук (2017)	
1	Theoretical and methodological principles of forming information and communication competence of future preschool education specialists, 2017, Uman, 13.00.04; 13.00.08
2	There were researched theoretical-methodological principles and pedagogical conditions for forming ICC of future preschool education specialists at higher educational pedagogical institutions; methodological approaches were used: integrative, complex, personality-oriented, reflexive, environmental, system, and activity-oriented
3	There was developed a structural-procedural model of forming ICC of future preschool education specialists, consisting of a set of interconnected blocks (methodical-target, content-operational, effective) and being implemented in three stages; an experimental method of forming the ICC of future specialists in preschool education was developed and implemented; educational and methodical manual “Computer technologies in work with children” was prepared and published; educational and methodical provision of materials in the disciplines of the pedagogical cycle was offered
4	The faculties of preschool education of five universities were involved in the research The experimental study was conducted during 2011–2016 454 students and 126 university teachers took part in the experimental research
5	There was diagnosed the formation of future preschool education specialists’ ICC by criteria: cognitive-cognitive, social-communicative, gnostic-developmental, activity-technological. Four levels of formation of the studied quality were used: low, satisfactory, sufficient, high The level of ICC formation was determined by using a set of empirical methods The formative stage of the pedagogical experiment showed an increase in the levels of ICC forming among the students of the experimental group. 29.4% of students reached a high level of ICC formation (at the beginning of the experiment it was 7.5%); sufficient ——26.0% (at the beginning of the experiment was 9.9%); satisfactory —19.7% (at the beginning of the experiment 17.2%); low —24.9% (65.4% at the beginning of the experiment) in. There were also changes in the control group, but not significant The student’s t-test was used to verify the reliability of the obtained experimental data
Тимофєєва (2017)	
1	Formation of information and communication competence of future educators of preschool educational institutions, 2017, Kyiv, 13.00.08
2	The subject of the research was pedagogical conditions, content, forms, and methods of forming information and communication competence of future educators of preschool educational institutions in the process of their professional training; The following methodological approaches were used: activity-oriented, competence, personality-oriented
3	The method of forming information and communication competence (ICC) of future educators of preschool educational institutions was developed, which included: educational and methodical provision, control, and measuring materials for students of pedagogical specialties

(continued)

Table 24.4 (continued)

No	Criteria description
4	Three universities were involved in the research process The experimental study was conducted during 2011–2017 275 respondents took part in the experimental study: 136 students of the experimental group and 139 students of the control group
5	The formation of future educators' ICC was diagnosed The level of ICC formation was determined by using a set of empirical methods, namely: questionnaires, surveys, testing As a result of the formative stage of the pedagogical experiment, it was found out that in the experimental groups the number of students with creative (up to 16.2%) and productive (up to 64.8%) levels of ICC increased significantly, the number of students with reproductive level v19%. There were also changes in the control group, but not significant Pearson's agreement criterion $\chi 2$ (Pearson's xi-square) was used to verify the reliability of the obtained experimental data
Шроль (2017)	
1	Formation of ICT competence of future mathematics teachers, 2017, Kyiv, 13.00.04
2	There was investigated the formation of ICT competence of future mathematics teachers; methodological approaches were used: activity-oriented, competence, synergetic, systemic, student-centered
3	The model of formation of ICT competence of future mathematics teachers was designed; there was developed a method of forming ICT competence, based on the use of mobile, computer, cloud-oriented technologies in the training of future mathematics teachers to solve professional problems with the ability to create their electronic educational resources; there was introduced educational and methodical provision for the disciplines "Fundamentals of Multimedia", "Packages of mathematical programs" (educational and working programs, educational and methodical manual "Packages of Mathematical Programs in the Training of Future Mathematics Teachers", methodical recommendations "Formation of ICT Competence of Future Mathematics Teachers", "Fundamentals of Multimedia"), methodological and technological support in the form of electronic training courses
4	4 universities were involved in the research The experimental study was conducted during 2013–2017 378 students took part in the experimental study
5	The formation of the ICC was measured by such criteria: value-motivational, cognitive, operational-technological, personal-reflexive The level of formation of information and communication competence was determined by using a set of questionnaires, psychological and pedagogical methods During the pedagogical experiment, the positive dynamics of the general indicator of ICT competence was revealed: the growth of high level among the students of the experimental group took place by 17.1%, CG—by 4.1%; sufficient level increased in the experimental group by 19.0% and in the control group by 6.7% Pearson's agreement criterion $\chi 2$ (Pearson's xi-square) was used to verify the reliability of the obtained experimental data

(continued)

Table 24.4 (continued)

No	Criteria description
Закомірний (2019)	
1	Development of information and communication competence of evening school teachers in the conditions of non-formal education, 2019, Kyiv, 13.00.04
2	The content, forms, and methods of development of ICC of evening school teachers in the conditions of non-formal education were studied; the following methodological approaches were used: andragogical, competence, personal-activity, system
3	The model of developing ICC of evening school teachers in the conditions of non-formal education was designed; the workshop “Development of information and communication competence of evening school teachers” was held, methodical recommendations were prepared and implemented
4	Four evening schools became the participants of the research The experimental study was conducted during 2016–2019 The experimental study involved 290 evening school teachers
5	There was diagnosed the formation of evening school teachers’ ICC according to the criteria: motivational, cognitive, activity-oriented, reflective The level of forming ICC was determined by using a set of questionnaires and the method of expert assessment During the pedagogical experiment the positive dynamics of the general indicator of ICC was revealed: the growth of a high level among teachers of the experimental group—by 17,1%, control group—by 4,1%; the number of teachers at a sufficient level increased in the experimental groups—by 19.0%, in the control group—by 6.7% Pearson’s agreement criterion $\chi 2$ (Pearson’s xi-square) was used to verify the reliability of the obtained experimental data

differences in determining the structural components of information and communication competence of future teachers, that is there is no reasonable set of indicators to be measured. This, in turn, results in a problem of generalizing research results, in particular in determining the effectiveness of the proposed models, methods, educational and methodological provision.

In the vast majority of peer-reviewed studies, the main mechanism in achieving this goal was the pedagogical conditions that directly influenced the process of formation of the future teachers’ ICC. In general, a large number of them were identified, many of which are poorly substantiated and insignificant. Among those that can effectively influence the formation of the studied quality are: (1) the motivation development (the creation of positive motivation of future primary school computer science teachers to study the course “Visual Programming” (Петренко 2016); the increase of positive motivation and interest of future preschool teachers to the formation of ICT in studying the discipline “Computer technology in working with children”(Семчук 2017); providing long-term motivation to learning through shifting the educational process to the realities of future professional activity (Шроль 2017); (2) the focus on the students’ autonomous work (organization of students’ autonomous work by using ICT during extracurricular activities) (Тимофєєва 2017);

organization of students' autonomous work by using innovative learning technologies (Федорук 2015); transforming educational work into creative and research nature tasks, activation of students' educational and cognitive activities, the organization of their autonomous work (Шроль 2017); (3) practical orientation of professional training (ensuring the priority of practical activities; creating an information and educational environment aimed at forming the need for ICC through the organization of students' educational activities and pedagogical practice (Тимофєєва 2017); (4) implementation of subject-subject interaction in the educational process (providing guidance for forming the ICC on the basis of an individual approach and establishing subject-subject interaction between teacher and students (Шроль 2017); providing subject-subject interaction between teacher and students-future school teachers in the process of forming the ICC (Тимофєєва 2017); providing guidance for forming the ICC on the basis of an individual approach and the establishment of subject-subject interaction between teacher and students (Федорук 2015).

In all the reviewed researches there was demonstrated the effectiveness of the created mechanisms, which was confirmed by the growth of a high level of ICC formation in the experimental groups. However, most of the measuring instruments which were used do not have a clear definition and have little correlation with the measured components. Typically, they are usually based on general assumptions and do not fully cover all the characteristics of the measured indicators. It is a system error to determine the level of ICC formation as the average arithmetic means of all measured components, as they are all of the different weights, and therefore, in the calculation procedures, it was necessary to take into account the weighting factor of each indicator. Under such conditions, it is difficult to accurately state a certain level of information and communication competence of future teachers in Ukraine.

24.6 Summary

Ukraine is currently in the process when information technologies are penetrating all spheres of life, thus the need for professionals who can quickly adapt to the ever-growing demands of the information society is increasing. This necessitates the solution to the problem of modernizing the national educational system and encourages higher education pedagogical institutions to train teachers capable of implementing radical changes in the field of education. This, among other things, requires a high level of ICC formation. In general, the analysis of works showed a great increase in interest in this problem and showed that the pedagogical science of Ukraine had accumulated relevant experience over the past 20 years.

There were investigated various aspects of the problem of forming and developing ICC in the system of future teachers' professional training, the most popular of them were:

(1) theory and practice of developing pedagogical software and its implementation in the educational process, principles, and methods of computer-based learning;

(2) peculiarities of using ICT in the educational process at a modern school;
(3) teachers' professional training in the use of ICT;
(4) peculiarities of forming and developing ICC of various specialties teachers.

At the same time, several aspects need further investigation. Powerful processes of informatization of all education levels necessitate the improvement and actualization of future teachers' training, in particular the need to adjust the content of education, to introduce new disciplines, to constantly search for new organizational forms, learning technologies that contribute to forming and developing future teachers' information and communication competence. The future teacher should obtain knowledge of peculiar features of schoolchildren's psychophysiological development, in particular, the perception of the information by a modern student; knowledge of the essence and types of meta-subject ICT skills of students, the stages of their formation; knowledge of ICT tools focused on forming meta-subject ICT skills of students; awareness of innovative educational practices in working with students; knowledge of new educational methods based on the existence of single information and educational environment in the educational institution; knowledge of educational media resources focused on ICT support, etc.

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Chapter 25
Mapping Digital Competency Studies in Preservice Teaching Programs in Uruguay

Mariana Porta, Regina Motz, and Daniel De Queiroz Lopes

Abstract This article shares the results of a systematic mapping of digital competency (DC) studies among preservice teachers in Uruguay from 2000 to mid-2021. The aim of the study has been to have a general view of preservice teachers' DC building as far as it is approached and studied by different national and international academics and researchers. The following specific objectives were established: (1) identifying research teams dealing with DCs in preservice teacher education in Uruguay and their institutional affiliation, (2) identifying methodological approaches, and (3) mapping pre-service teachers' DC-related sub-topics, addressed by researchers. Among other findings, 38% used mixed, qualitative, and quantitative methods, 32% applied qualitative techniques, and 20% reported experiences, either related to classroom practices or to the organization and management of educational institutions. 7% were the result of quantitative studies and 3% were action research projects. Topics addressed are DC and the place it should have in the curriculum, teaching practices to train preservice teachers, preservice teachers' perceptions about their own digital competencies, the level of preservice teachers' digital competencies and public policies regarding DC building. Research results reveal that preservice teachers are currently experiencing an ongoing renewal process, which still shows fragmentation and a variety of approaches to DC training, although some important achievements are also evident. Mostly, these achievements are in reference to the

M. Porta (✉)
CUCEL, CENUR Noreste, Universidad de La República, Luis Alberto de Herrera 639, Melo 37000, Uruguay
e-mail: mariana.porta@cucel.edu.uy
URL: https://www.cci.edu.uy/cenur_noreste

R. Motz (✉)
Facultad de Ingeniería, Universidad de la República, Julio Herrera y Reissig 565, Montevideo 11200, Uruguay
e-mail: rmotz@fing.edu.uy
URL: https://www.fing.edu.uy/

D. De Queiroz Lopes (✉)
Faculty of Education, Universidade Federal Do Rio Grande Do Sul, Av. Paulo Gama s/n, Porto Alegre, RS 90046-900, Brazil
e-mail: daniel.lopes@ufrgs.br
URL: http://www.ufrgs.br

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presence of an initial group of academics who have decided to focus on the topic from the point of view of a situated practice.

Keywords Digital competencies · Preservice teacher training · Systematic mapping · Uruguay

25.1 Introduction

Uruguay has been known for implementing Plan Ceibal (One Laptop per Child model) in 2007, raising great expectations at national and international levels, particularly among researchers who observed and studied both digital inclusion and the use of digital technologies in education. Today, it is possible to observe the process and wonder to what extent this early national public digital inclusion policy paved the way for a successful introduction of digital technologies into teaching practices, beginning with preservice teacher education. One perspective to evaluate this success is to analyze the level of Digital Competence that future teachers in Uruguay display today.

Digital Competence (DC) has been defined from various points of view depending on the frameworks of reference developed by different institutions. The following are the most widely cited in the literature and referenced for the purpose of this article.

INTEF (2017) has been developed by the National Institute of Educational Technologies and Teacher Training (INTEF), which belongs to the Ministry of Education, Culture and Sports (MECD) of the Government of Spain. This framework identifies five dimensions: 1. Information and data literacy, 2. Communication and collaboration, 3. Creation of digital content, 4. Safety and 5. Problem-solving.

UNESCO ICT Competency Framework for Teachers (2018). The dimensions recognized in this case are understanding ICT in education, curriculum and assessment, pedagogy, application of digital skills, organization and administration, and teacher professional learning.

DC model developed by Lázaro and Gisbert (2015) from Universidad de Santiago, Chile and Universidad Rovira i Virgili, Spain, respectively. They distinguish these dimensions: 1. curricular, didactic, and methodological dimensions; 2. planning, organizing and managing digital technology spaces and resources, 3. ethical, legal, and security aspects, 4. personal and professional development.

In all of these cases, the notion of DC comprises an array of concepts that include far more than the instrumental aspect of DC management. From the social and communicational to the political dimension and from the pedagogical to the didactic level, DC building involves the challenge of considering all of these aspects as components of educational practices and teacher training and educational development.

This article shares the results of a systematic mapping of DC studies among preservice teachers in Uruguay from 2000 to mid-2021. The researchers chose distinctive theoretical frameworks for their studies of preservice teachers' DC in Uruguay, which will be duly considered.

The aim of the study has been to have a general view of preservice teachers' DC building as far as it is approached and studied by different national and international academics and researchers. Some of the first questions posted when approaching the problem of DC building among preservice teachers have been the following: Is there research on preservice teachers' DC? What kind of research-based knowledge is being generated? Has preservice teacher DC of Uruguayan teachers-to-be been measured? What challenges do studies identify in preservice teachers' DC building? What does research say about the way preservice teachers are being educated and trained in DC building? Today, in a post-pandemic stage, in which formal education in elementary and secondary school has barely resumed face-to-face classes, it seems like an adequate moment to pose these questions again.

In order to better understand the context where preservice teacher education takes place in Uruguay, a few annotations are needed. The current teacher education and training model in this country is undergoing a profound renewal, characterized not only by divergent perspectives of what teacher education should consist of, but also by conflicting positions that set up the most relevant actors in the system against each other: policy makers and teachers' unions, and various teaching groups.

Rodríguez et al. 2020), account for this ongoing process, which is in part explained by a history of subsequent changes in perspective, which have modified formats, curricula, teacher hiring systems, and even distribution of teacher training centers in the country. The authors identify conflicts and tensions around the design of curricular plans, regulations of training processes, organization and design of teaching practices and articulation of research, teaching and extension. Actually, the fact that teacher education in Uruguay is considered higher education, but it does not have the university status, bears the consequence that teacher educators' positions do not encompass research, extension, and teaching in their job description; rather, they are focused on teaching, and they only partially include the other two functions, basically as a consequence of specific institutional incentives that a few professionals have had access to. These institutional measures to foster research are explained below, associated with some of the findings of our systematic analysis.

This "divorce" between teacher training and systematic research constitutes a strong drawback at many levels, according to Marrero (2017). This situation relates to questions that currently remain unanswered: what should the object of research in a faculty of education be? Or what should be taught in an educational research center? (Marrero, 2017, p.12). Relating those ideas to this particular bibliographic research, the main concern refers to whether DC in preservice teachers is a relevant object of research and who is carrying out this research in our country.

The largest teacher training institution in Uruguay, which receives the name of *Consejo de Formación en Educación* (from now on CFE), which stands for Education Training Council, is a public institution, which has the objective of educating education professionals. It is present in the 19 departments of the country. In 2019, CFE welcomed 29,041 students (CFE/DIE, 2021). The institution educates and trains

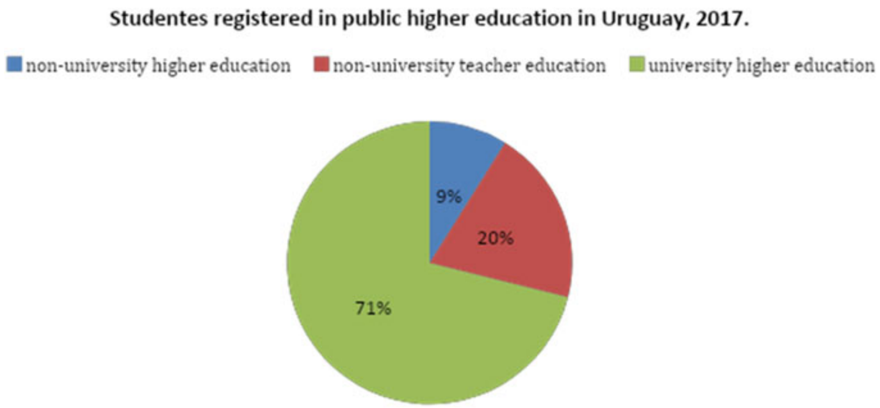

Fig. 25.1 Distribution of students enrolled in public higher education in Uruguay (MEC, 2017)

future preschool, elementary and secondary education teachers. Also, it is responsible for training "technical teachers" who teach at technical schools and "social educators." As explained above, a characteristic of this institution is that it is not a university. Figure 25.1 shows a graphic with the distribution of students enrolled in public higher education in Uruguay. The 20% of public higher education students in the country who are studying to be education professionals (MEC, 2017) will obtain a graduate teaching certificate; however, it will not be a university degree.

25.2 Methodology

The objective of this research is to carry out a systematic mapping of studies that have taken place in Uruguay on the topic of DCs among preservice teachers, from 2000 to mid-2021. Considering the questions stated in the introduction, the following specific objectives were established: (1) identifying research teams dealing with DCs in preservice teacher education in Uruguay and their institutional affiliation, (2) identifying preservice teachers' competency studies in terms of their methodological approaches, and (3) mapping pre-service teachers' DC-related sub-topics, addressed by research teams.

Following the PRISMA methodology (Page et al., 2020), we identified Google Scholar as the most appropriate data source since it allowed us to retrieve different sources: books, book chapters, journal articles, conference presentations, theses, and project reports.

The search strategy had to include "Uruguay" because we were interested in studies conducted in this country exclusively. To describe the concept of DC, we complemented the search by including the terms "teaching practices with digital technologies" and to complement the concept of teachers in training we include the terms: "primary school student-teachers" or "secondary school student-teachers."

On the whole, the search strategy used was: **(“teaching practices with digital technologies” OR “digital competencies”) AND (“preservice teachers” OR “elementary school student-teachers” OR “highschool student-teachers”) AND “in Uruguay”**. Because most of the publications on education in Uruguay are published in Spanish, our search strategy was carried out in English and Spanish too.

The search strategy used in Spanish was: **(“prácticas docentes con tecnologías digitales” OR “competencias digitales”) AND (“estudiantes de profesorado” OR “estudiantes de magisterio”) AND “Uruguay”**. Applying both strategies, a total of 110 records were obtained. The first step was to remove duplicates. Then, the remaining records were examined by title and abstract, and the exclusion rules were applied to decide if the record would be included in the data to be analyzed. The exclusion rules applied were:

R1: the study is not carried out in Uruguay. This rule sets aside studies that are not related to Uruguay, or that simply include a brief mention of the country’s digital policies, or some specific bibliographic references from a study carried out in Uruguay.

R2: the study does not refer to DC. This rule sets aside studies where the data on Uruguay do not refer specifically to DC, but to other variables such as digital inclusion or Plan Ceibal as a national policy for digital inclusion and its implementation.

R3: the study does not refer to pre-service teachers. The application of this rule maintains only the studies that deal specifically with digital competence in the case of future teachers, not in-service teachers.

R4: The publication is less than 4 pages long.

Finally, one more study of a specific institutional repository of theses recommended by expert consultation was added. The resulting number of publications retrieved was 40 studies (see section Data Analyzed). The analysis was performed on these studies, identifying 13 qualitative studies, 3 quantitative studies, 15 mixed studies and 8 studies reporting experiences. Figure 25.2 illustrates how the publications were selected.

25.3 Results

The chronological revision was carried out since 2000. However, the first publication registered dates to 2012. And it is not until 2014 that publications in the area show continuity: 1 in 2014, 2 in 2015, 3 in 2016, 1 in 2017, 4 in 2018, 14 in 2019, 10 in 2020, and 4 in 2021. 3ure 25.3 depicts this chronological production over the total amount of recovered publications aligned with the search.

Considering academic affiliation, 30 of the analyzed papers were published by academics who belong to CFE, 12 involved Uruguayan Universities (UDELAR, Universidad ORT, CLAEH), and 11 were published by foreign Universities.

As for the kind of publications found, 50% belonged to peer-reviewed journal papers, 20% were book chapters, 15% were conference presentations, 10% were

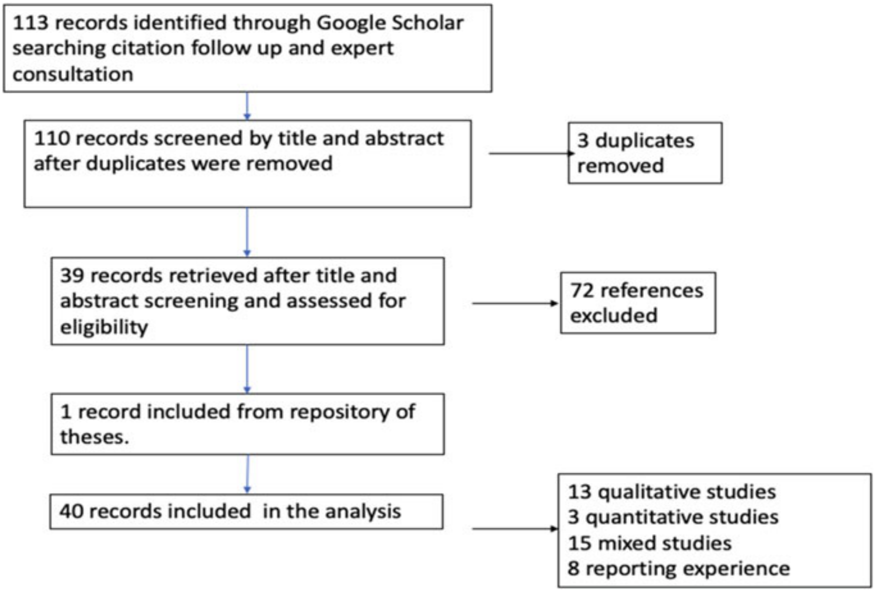

Fig. 25.2 Search and selection processes

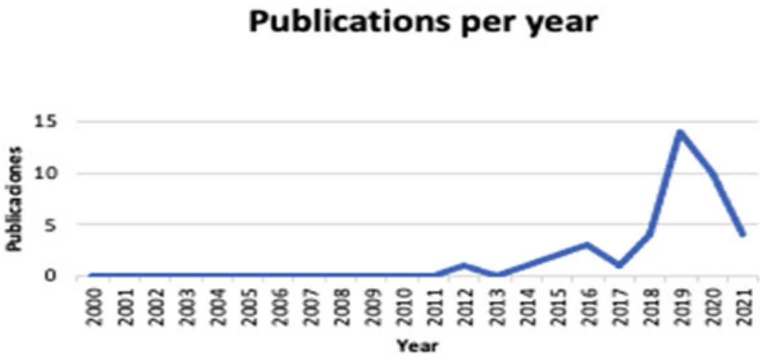

Fig. 25.3 Total number of publications by year

theses and 2% were final reports to the funding agency ANII and a research project carried out on a sabbatical year granted by CFE.

In terms of language used in the article, as the figure below shows, 8% were published in English and the rest in Spanish. All articles published in English were developed in the context of international projects with foreign research partners.

In terms of methodological approaches, 38% used mixed, qualitative, and quantitative methods, 32% applied qualitative techniques and 20% reported experiences,

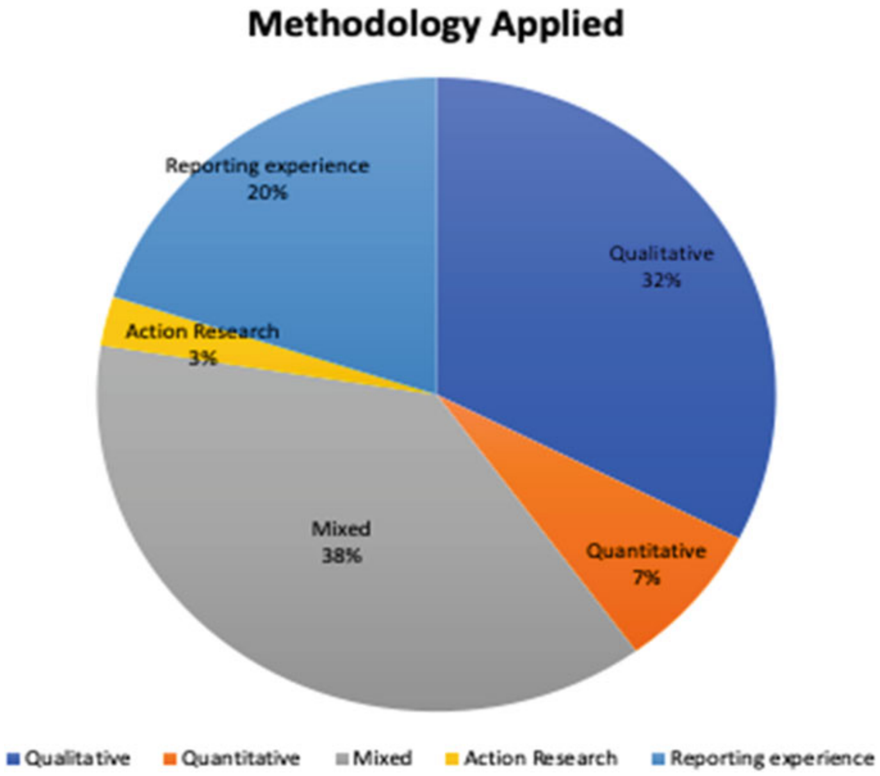

Fig. 25.4 Methodologies applied in the studies analyzed

either related to classroom practices or to the organization and management of educational institutions. 7% were the result of quantitative studies and 3% were action research projects. This is visualized in Fig. 25.4.

As regards the connection between papers produced and authors' affiliations and authorship-related groupings, the first element to observe is that teacher educators get involved in research. Considering institutional affiliations, 30 papers were written by academics from CFE, either alone or as co-authors. They are responsible for educating and training teachers to be, and some of them hold administrative positions. Some of these Uruguayan teacher trainers have published their work in the context of postgraduate studies pursuing a Master's degree (Puglia, 2016; Porley, 2020) in private universities (Universidad ORT and CLAEH). 20 studies were produced exclusively by CFE academics: 7 of these works are journal papers, 6 are book chapters, and 5 are conference papers. 7 papers were published in association with other universities, all of them as journal papers. These CFE researchers seem to confirm the basis of what could be visualized as a network of researchers, who have engaged in research basically focused on topics associated with their own situated practice, either as teacher educators or as administrators. Some junctures of this network are

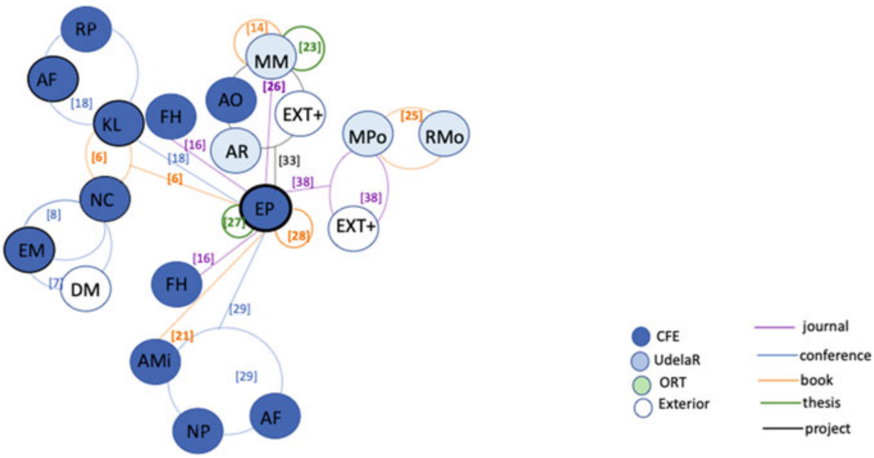

Fig. 25.5 Co-authoring relationships

particularly relevant considering all the connections that they have established with the rest of the academics. Also, some co-authorships can be visualized among CFE teacher educators and university researchers, both at national and foreign universities. Figure 25.5 depicts a subgraph of this network, focusing for example on researchers EP and NC we can appreciate their different coauthoring collaborations.

Together, these works produced by CFE teacher trainers construct a narrative that accounts for a three-pronged process. The steps are: awareness of the need to generate knowledge related to DC integration, identification of a problem associated with their own context of teacher education and training in DC, and generation of knowledge-based either on classical research, educational action research or systematic review of teaching practices and reflection. They account for different perspectives of the institutional process: some from the classroom roles and some from administrative positions in the institution. Five studies described experiences and reflected upon classroom practices (Grilli, 2019; López et al., 2015; Soubirón, 2018) or institutional implementations of teacher training strategies (Milstein & Puglia, 2015; Puglia et al., 2014).

CFE, as the largest teacher training institution in the country, is transitioning a process referred above as “renewal” (Rodríguez et al., 2020). In this process, preservice teacher development of digital competencies has been identified as a need and different academics have approached the topic from diverse perspectives, largely related to the place they hold in the institution. The following analysis shall provide evidence of this narrative that allows a chronologically organized overview of the process of DC appropriation, from 2010 up to these days.

In 2014, a presentation delivered by Puglia, Ferreira, Milstein, and Pizzolanti, all from CEF, shared their experience and achievements as a group of digital technology trainers for preservice teachers. In that presentation, they accounted for the different formats that digital technology-related training had adopted, since 2010.

These academics claimed that they held certain advantages as a multidisciplinary group, which had been involved with teachers in different contexts, from the very onset, witnessing processes and participating in learning experiences related to the integration of digital technology to teaching practices. They expressed that these facts contributed to generating a different perspective to redefine the approach in the treatment of the topic. It is no longer about putting technology in front of the teacher but rather that the teacher, as a person, ponders about his/her relationship with the technology and the context, in order to project his/her work in relation to them (Puglia et al., 2014, p.18).

Two publications from 2015 and 2016 were identified, addressing the topic of DC in the context of preservice teacher development: a conference slideshow (Milstein & Puglia, 2015) and a Master's degree thesis (Puglia, 2016). The conference paper refers to the implementation of a teacher training proposal carried out in CFE, created in March of 2014. Its purpose was to provide a 1-year training and education program, to fourth-year-preservice teachers and their didactics professors. Its main achievements were the development of exploration guides, their work with digital narratives and techno-autobiographies. Presenters expressed that, since the activity was not obligatory, a 40% student completion of the program was considered a positive outcome. The research project revealed interesting findings, particularly a positive attitude of elementary school preservice teachers, professors, and educational community in general towards the use of digital technologies. However, 65.3% of students expressed they did not feel competent in the pedagogical use of digital technologies. Only 11% considered they were very satisfied or satisfied with the training received in reference to digital competencies. Puglia concluded that there has not been enough emphasis on DC development. Rather, the training received was mainly referring to instrumental uses of digital technologies.

These findings coincide with Martinez et al. (2016) who carried out qualitative research with document analysis and focus group discussions. They expressed that according to their findings preservice school teachers state that "they have not had valid models that encourage them to include technologies in their teaching practices" (Martinez et al., 2016, p.88). In addition, they refer to "the lack of technological knowledge, which creates insecurity when considering possible uses of ICT in the design of activities" (Martinez et al., 2016, p.88). The authors referred to a teacher training program that renders obsolete as time goes by, in a context that recognizes the need to include technology but fails to connect this expressed need to practical implications for teacher development. In 2018, another group of teachers that joined CFE and UDELAR academics added to the same perspective after having analyzed teacher training curricula. They saw an absence of common criteria among different curricular designs and even referred to a "setback" when comparing current programs at that moment, with previous ones (Cabrera et al., 2018).

Conversely, another study published in the same year about teachers' digital competencies in initial education curricula, stated that: From the content analysis carried out in the study plans of the countries of Uruguay, Spain, Finland, Switzerland, and Mexico, results were generated that allow us to identify that the acquisition of digital skills is present in the study plans by favoring conceptual, procedural, and attitudinal contents (Navarro, Flores, 2018).

These inconsistencies between both studies should be taken into consideration for the purpose of future research. Would the fact that the first study corresponds to the CFE academics, and the second one corresponds to researchers from foreign ones, account for the difference? Does research carried out by teacher educators who are involved in the same situated practice bear any advantage over that which is carried out by foreign researchers?

In 2019, Campos and Mendez reflected upon the tensions and challenges of confronting opposing views of digital technology: from harsh critics about the category of competence from a purely instrumental perspective to more integral views that consider the concept in its more critical cognitive and inclusive notion (Campos & Mendez, 2019). The same authors approached the topic later with a digital autobiographical narrative approach, showing how the dialogic experience had been able to enlighten a reflective learning process (Campos, Marín, et al., 2020).

In the same year, Campos et al. (2019) carried out research on digital technology guiding teachers' profiles in two different contexts: UDELAR and CFE. This qualitative research was based on guiding teachers' profiles in two different contexts: UDELAR and CFE. This qualitative research was based on a bibliographic revision of institutional documents. They identified seven profiles that pictured knowledge and abilities required, comprising a sound development of digital competencies that involved a critical, safe, and updated use of digital technologies, and a set of more socially related capacities such as leadership, teamwork, and the ability to generate and coordinate institutional actions. The authors stated that CFE was undergoing a process of generating a framework to develop a professional profile for the educational digital technology guiding teachers. Later, the same year, Lopez et al. (2019) presented the process by which two new profiles of *DT guiding teachers* were created and implemented by the *Department of Digital Technologies and Education* in preservice teacher education. The study framed the project within a broader institutional process that aimed at unifying projects, work areas and resources dealing with digital technologies that were originally dispersed within the institution.

In 2019, a case study article about the conditions of preservice teachers in different Latin American and European countries stated the following about the case of Uruguay: up to 2016, teacher education and training in digital competencies was approached in a rather fragmented, uncoordinated manner. In 2016, a new perspective emerged with a focus on integrating technologies into actual teaching practices. The central idea was to unify criteria towards a *competency-based* approach (Tomczyk et al., 2019). At that time, the following priorities were established by the article authors:

(1) guaranteeing the cross-disciplinary character of digital technologies, (2) counting on qualified teachers for the new teaching curricula of the new plan, (3) fostering multidisciplinary teamwork with orienting teachers and (4) connecting theoretical knowledge imparted in class to practical implementation and teaching in the actual classes in the territory (Tomczyk et al., 2019, p.21).

Continuing with this narrative that combines research and administrative-related reflective action, a more recent publication by Puglia and Morales (2021) accounts for qualitative multilevel research that analyzed institutional documents and teachers' perspectives. The authors state that efforts have been made to invest in infrastructure and in educational resources and teacher training. However, these training efforts do not seem to be enough. They express that although there has been progress, it is necessary to make explicit in educational policy the reference to the development of teachers' DC, as well as to reformulate physical spaces, train teachers, and design study plans based on its development. The approach continues to be instrumental and/or didactic-pedagogical without considering the holistic approach. The creation of specific agents in the field of Educational Technology stands out (Puglia and Morales, 2021. p. 46).

Another group of publications analyzed shares the characteristic that their authors are mainly university researchers, with some participation of CFE academic professionals. A certain continuity of scientific production in the area can be observed in the publications of a group of researchers who joined efforts to present a project through the *Sector Fund for Education (Digital Inclusion, 2016)*, called "Comparative Study to Learn and Teach Pre-Service Teachers in Uruguay and Chile," funded by the National Agency for Research and Innovation in Uruguay and Ceibal Foundation. This group's production reflects the results of a research project that involves theoretical elaboration, research tool development, research tool validation, and digital competency measurement in two different national contexts. It involves a 3-year span of academic production, including publications in Spanish and in English.

Juan Silva Quiroz et al. (2016) started by creating a theoretical construct of teachers' digital competencies that would allow the definition of indicators to evaluate the level of development in preservice teacher education and training (Quiroz, Miranda, Gisbert, Morales, & Onetto, 2016). The steps followed involved validating the tool that would allow measuring, comparing, and creating a final matrix that would include four dimensions: 1: curricular and methodological didactics, 2: planning, organization, and management of digital resources and environments, 3: ethical, legal, and safety-related issues, and 4. personal and professional management. These dimensions were fleshed out into 14 indicators.

The results of this research were documented in a final report (Salinas et al., 2017) and two journal papers (Silva, Morales, et al., 2019). The objective of this study was to measure and compare DC in preservice teachers in their fourth year of studies in Uruguay and Chile. This study involved the four dimensions explained above. Researchers concluded that the study showed a *low level* of development of digital competencies. *One of the most interesting results stated that the dimension with the lowest level of achievement in Uruguay was planning, organization, and management of digital resources and environments, which scored 46% of the achievement.* This study constituted the only quantitative measurement of preservice teachers' digital competency in Uruguayan preservice teachers, based on a randomized sample of students. Some recommendations for the case of Uruguay focused on the need for a centralized articulation that develops a viable middle and long-term plan so that teachers have a specific education in digital technologies. This would involve developing curricula that integrate digital technologies with an emphasis on general didactics and discipline-specific didactic models.

The researchers stated that the aim would be to develop teachers' digital literacy and digital competencies to influence teachers' practices. Other recommendations involved creating an institutional repository, identifying methods to develop formative evaluation in digital environments and designing assessment tools. This academic production was written by 10 researchers, 3 of whom were Uruguayan. They belonged to two national institutions (CFE and UDELAR) and two foreign Universities (Universidad Rovira i Virgili, Spain and Universidad de Santiago, Chile). Five papers were identified that included each other's references.

Regarding the studies whose authors' affiliation is the largest public university in Uruguay, UDELAR, five of the six published papers are based on research projects financed by ANII and Ceibal Foundation (FSED). Two Uruguayan researchers involved are part of a permanent research group, Observatic, UDELAR. One of them developed her Doctoral Thesis, in the context of Universitat Rivira i Virgili, in Spain, an analysis of the initial teacher training in Uruguay in relation to the development of the digital teaching competence, (Morales, 2019). This thesis experience seems to be the beginning of an association among researchers of these universities, also joined by the University of Santiago. The other two works analyzed were produced in the context of an international project, carried out by a consortium of 12 universities from Latin American and European countries, which took place between February 2019 and July 2021. The project, Smart Ecosystems for Learning and Inclusion (SELI), also financed by ANII in Uruguay, did not have teachers' digital competencies as its focus, but since the topic was strongly related to the development of smart learning environments and their ecosystems, some research was carried out on the topic. These studies involved researchers from the Faculty of Engineering at UDELAR and an interdisciplinary research group working on Open Educational Resources (Núcleo REAA, Interdisciplinary Space, UDELAR). The research produced by this team covers both quantitative and qualitative studies, and the two publications analyzed are in English. The first one is about styles of using ICT by Uruguayan preservice teachers. It reveals a positive attitude towards the inclusion of digital technologies into teachers' practices and pinpoints the need to aim at inclusive uses of digital technologies (Porta & Motz, 2020). The second study confirms all previous findings about preservice teachers' perception that their previous DC training has been deficient. The study also refers to the fragmentation of teacher education in different organizations (even within the same institutional frame of CFE) and separate from a university context, adding to the explanation of a lack of common criteria in the way DT and teaching are approached (Tomczyk et al., 2019).

Another set of publications was identified with the common trait that they have authors or co-authors from CFE who have studied at or have been associated with University ORT of Uruguay, for the purpose of research. This university has had an important role providing master's degrees in education, publishing a journal about education and facilitating joint research with other foreign Universities such as Universidad de Porto in Portugal, Universidad de Sevilla or Universidad de la Laguna, the two latter in Spain. In some cases, University ORT has provided a context for education professionals to engage in research directly related to institutional changes in CFE, which have already been addressed above. This is, for example, the case of the exploratory study about school preservice teachers' perceptions of their training in pedagogical use of digital technologies (Puglia, 2016).

25.4 Discussion

This discussion intends to contextualize the results of this systematic mapping in the national and institutional processes that preservice teacher education is undergoing, in Uruguay. This means an exercise of interpreting these results, considering what these data might be reflecting about preservice teacher education and digital technology integration into teacher training in this country. It requires pondering the institutional processes in the context of an ongoing debate where a variety of actors are involved. It also implies proposing further questions for future research.

The sudden increase in the number of publications in 2018 raises questions. Does this mean that the topic of preservice teachers' digital competency suddenly became more relevant? Or were there more incentives to carry out research on this and other topics? The answer can only be speculative. But some known facts provide relevant information that could be decisive to understand the sudden rise in the number of publications on the topic. Let us consider them.

The National Research and Innovation Agency of Uruguay (ANII) and Ceibal Foundation, created Fondo Sectorial de Educación: Modalidad Inclusión Digital—Educational Sector Fund for Digital Education—in 2015, with the following objectives: favoring the creation of knowledge and scientific evidence that allows decision making in education, promoting international networks and knowledge transfer, fostering the adoption of new research methods, increasing the visibility of existing research, and transferring results to the classroom (Ceibal Foundation, 2018). According to this report, up to 2018, 65% of the applying institutions were foreign, working in cooperation with national ones. Undoubtedly, this funding possibility provided a valuable stimulus for the development of projects in education and digital technologies, and many of the research projects developed focused on preservice teachers' DC. Having so many foreign universities interested in these possibilities has also provided great opportunities to national researchers and academics who have been able to associate and engage in more long-term, high-budget projects.

A second element to be considered should be the agreement between ANII and CFE, the Uruguayan public institution in charge of teacher training, to implement the Sector Fund in Education called "CFE conducts research," which started its yearly calls in 2016. This funding establishes priority research lines that have covered topics such as: education and digital technologies, teaching practices, preservice teacher education, education and lifelong learning, education, and multimodality (Castaings, 2019) (Agencia Nacional de Investigación e Innovación, 2021). This agreement was part of a series of institutional incentives to support research, including providing the opportunity to apply for sabbatical leave dedicated to research projects, having a few hours a week to dedicate to research or extension, and participating in an institutional call for financed research projects in the context of postgraduate studies, among others.

The facts outlined above could be enough to pose the hypothesis that these stimuli have had a positive effect in the academic community, promoting research. It would have to be further studied considering the other research lines proposed. In this chapter, all that can be said is that these measures altogether, account not only for specific opportunities to conduct research but also for establishing research as a necessary and valuable activity to be part of an academic professional curriculum. DC building among preservice teachers seems to be one of the topics of interest.

Another aspect to consider at the national level is the process associated with the integration of technologies to education, as it has been proposed and developed by the various educational policies and educational authorities in Uruguay. Was DC building among preservice teachers' part of the agenda that accompanied the process? In fact, this research provides initial answers to this question. Chronologically, the first article of the sample analyzed addresses digital competencies indirectly, as part of an MA degree thesis entitled *Teacher training and the introduction of ICT: A comparative analysis of the different training courses that accompany the ICT Introduction Programs in Argentina and neighboring countries* (Viñals, 2012). It states how Plan Ceibal (Educational Connectivity of Basic Informatics for Online Learning) was deployed as a Presidential initiative for a digital inclusion public policy. This meant that ANEP, "Administración Nacional de Educación Pública," in English: National Public Education Administration, which is the national authority in education, *did not have a say in the implementation of the plan.* Viñals quotes a qualified informant and states that ANEP "tried to resignify the project and help the teachers." According to the study, *ANEP did not possess the technical and didactic know-how to assume teacher training in the area.* This, added to the fact that the initiative took place "from outside" of the educational system, made the digital competency development for educational institutions involve a challenging endeavor from the start. Later publications will not only confirm these original traits of digital technology inclusion processes in formal education in Uruguay, but they will also provide valuable input to understand the processes that the educational institutions have followed, to compensate for this lack of initial pedagogical guidance.

As explained above, CFE, the largest institution in charge of teacher training in the country, is undergoing a process of pondering and debating its future. Shall it gain a university status, with the consequences that this entails? Marrero, who published her research on the subject in a book with the evocative title "Teacher training in its labyrinth" (Marrero, 2011), highlights the extremely hectic nature of this ongoing debate, even 10 years ago. The author characterizes the pace of this process as "feverish" due to the number of positions and decisions, in such a short time that they barely allow time for them to become objects of analysis and study. The author highlights the polyphonic nature of the debate, in which a variety of actors such as professional unions, educational institutions, and civil society organizations participate.

Even if this research refers to the specific topic of preservice teachers' development of digital competencies, it taps into areas of knowledge that have been subject to many changes and objects of significant observation and pondering, such as competency vs. disciplinary knowledge as components of teacher training models (Tardif, 2001). This discussion is present, for example, in Campos and Mendez (2019), as they consider opposing views that either favor or criticize the inclusion of competence-oriented teacher education. As noted above, the authors refer to the tensions generated by these opposing views that are part of different "pedagogical discourses." This debate poses questions, such as: Should a competence perspective be integrated into the curriculum? How and when should DC be integrated and how could it be part of a curriculum that was originally conceived before these technologies even existed?

Results reveal that 30 of the 40 papers revised have been authored or co-authored by teacher educators or educational managers who work in CFE. Reviewing these papers has provided access to the narrative developed by its own protagonists in either isolated or joint efforts to systematize and resignify institutional structure and classroom practices, under the light of digital competence development challenges. Another relevant trait of these works is that they have been produced based on isolated projects made possible by specific funding efforts by ANNI, or in the context of a thesis development or sabbatical leave. In reference to their topics, they address the immediate concerns related to institutional management or classroom experiences. As it has already been stated, these pieces construct a narrative that basically "tells a story" of needs identified, and institutional or didactic practices analyzed in an effort to build the knowledge of the profession and its practices. They do not seem to respond to an institutional agenda or research line prioritized by CFE. This reflects the fact that the institution provides isolated incentives to carry out research but lacks a research department with a group of researchers with permanent funding and ongoing lines of inquiry that ensure continuity and allow accumulation.

Reading Tardif's concept of *epistemology of professional practice* (Tardif, 2000), some interesting questions arise, which become particularly relevant as part of this debate: What should be considered the professional knowledge a teacher needs to have? To what extent should the professional knowledge of teachers be considered *working knowledge* associated with a teaching situation? Is the knowledge a teacher needs better produced in the context of a university education? Among the studies analyzed, those produced by teacher educators have addressed issues that are contextualized in their practice, identified as problems to be approached and solved. Such is the case of pedagogical practices and didactic choices in the implementation of DT integration in the classroom. It is also the case of educational administrators designing different training models to be implemented. These topics selected by teacher educators themselves already provide a list of relevant areas of study, which could constitute the beginning of a necessary research agenda. Furthermore, the valuable contribution in terms of research experience and knowledge transfer that national and foreign universities provide would increase the possibilities of implementing long-term research projects.

25.5 Conclusions

Going back to the questions posted in the introduction: Is there research on preservice teachers' DC? Yes, there is. What kind of research-based knowledge is being generated? The kind of knowledge generated involves topics such as the following: DC and the place it should have in the curriculum; teaching practices to be used with preservice teachers in order for them to develop digital competencies: digital narratives, formative assessment based on class video recordings, use of mobile devices in learning processes, disciplinary knowledge and DC development; preservice teachers' perceptions about their own digital competencies; level of preservice teachers' digital competencies; public policies and institutional choices related to how digital competencies will be approached in preservice teaching.

Has preservice teacher DC of Uruguayan teachers-to-be been measured? Yes, it has. The result shows that the level of DC of fourth year preservice teachers in Uruguay is low (Salinas et al., 2017; Silva, Usart, et al., 2019). The level that Uruguayan preservice teachers achieved was 54% of achievement as an average result, with the lowest score, 46% in the dimension *Planning, organization, and management of digital spaces and resources.*

What challenges do studies identify in preservice teachers' DC building? Challenges seem to be present in many areas: from the definition of teacher training strategies to develop DC, to classroom practices. And the greatest challenge of all seems to be related to the fact that teacher training in the country is undergoing greater transformations that might, in turn, imply important institutional changes related to its status as a higher education study center.

What does research say about the way preservice teachers are being educated and trained in DC building? It says that preservice teachers are currently reflecting these ongoing processes, which still show fragmentation and a variety of approaches to DC training, although some important achievements are also evident. Mostly, these achievements are in reference to the presence of an initial group of academics who have decided to focus on the topic from the point of view of a situated practice.

In terms of recommendations, the first and most evident need that arises from this study is the urgency to keep developing the tools and conditions to support research on the topic of DC development of preservice teachers. As shown in the studies, not only is it essential according to students' concerns for their lack of DC competencies but also it is a topic of high interest among preservice teacher trainers. They identify the need and seem to be ready to assume the challenge of carrying out research.

Secondly, although the institutional initiatives taken by CFE and its association with ANII have created new opportunities for research in the area, it does not seem to be enough to provide continuity and allow long-term planning in terms of research lines and their impacts. In order for research to have quality, continuity, and contextual relevance, at least three elements would be necessary: an agenda that translates into research lines, strong methodological training and a budget that makes it all possible. The topics addressed so far by the papers analyzed in this chapter provide the basis for what should become an institutional research agenda. Ideally, it should be agreed upon by the main actors involved: educational authorities, teacher trainers, and preservice teachers, considering contextual societal needs.

Strong methodological training will be more fully achieved in the context of a university academic life that makes it possible for researchers to keep developing. Also, according to the analysis of the addressed articles, a productive and enriching association emerges from the collaborative work of teacher educators, who provide the essential perspective of the situated professional practice, and academics who have the methodological know-how and extensive experience that allow a richness of investigative approaches.

Finally, a budget that supports this endeavor would emerge from profound institutional changes in teacher education. According to evidence referred to in this article, these changes are tied to current political debates. Evidently, addressing this issue seems to be one of the urges that the stakeholders of the educational system of the country would have to prioritize.

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Chapter 26
Digital Competence of Future Teachers as a Topic of Russian Scientific Discourse

Olga Fedotova, Alla Belousova, and Mariya Vyshkvyrkina

Abstract The purpose of the article is to study the state and trends in the development of pedagogical problems, related to the use of approaches and technologies for the formation of information culture of future teachers in higher educational institutions of the Russian Federation. It is shown that the analysis of the formation and the development of the problems of the education informatization in the period from 2000 to the present should be carried out on the basis of the system of introduction of the State Educational Standards of Higher Professional Education of 1995 that has developed in the Russian Federation. Taking into account the sequence of adoption and qualitative originality of the requirements of state and federal educational standards of different generations, as well as the requirements of professional standards that determine the professional functions of teachers of various typological groups, the following will be considered in detail: dissertation research; publications published in special pedagogical periodicals; reports on the implementation of research projects within the programs of academic institutions of the Russian Academy of Education in the framework of fundamental and applied complex research. Based on the criterion "requirements for mastering digital culture by a future teacher", two stages of research development on the problem of forming the information competence of future teachers (2000–2016, and 2017–present) are identified and characterized. Conclusions are drawn about the trends in the development of the theory and practice of the formation of information competence of future teachers, which are currently neglected in the norms and requirements of the UNESCO Recommendations on Information Competence of Teachers and ISTE standards for teachers. The necessity is noted for developing diagnostic tools that allow objective assessment of the level and quality of the formation of digital competencies among future teachers.

O. Fedotova · A. Belousova (✉)
Don State Technical University, Gagarin sq.1, Rostov-on-Don 344003, Russia
e-mail: akbelousova@donstu.ru

M. Vyshkvyrkina
Southern Federal University, 105/42 Bolshaya Sadovaya Str., Rostov-on-Don 344006, Russia

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Keywords Digital competence · Information culture · State educational standard · Professional standard · Future teacher · Educational technologies · Higher education · Dissertation · Research project

26.1 Introduction

The integration processes taking place in the modern world raise the question of the directions and prospects for the development of education under new socio-economic and technological conditions, the ability of pedagogical science to initiate changes in educational practices, thereby creating a need for a person to study all his life. Currently, a new field of pedagogical science is being theoretically formed—the informatization of education, integrating fundamental and applied research. This provides the field of education the methodology, theory, and practice of developing and effectively using information and communication technologies in comfortable conditions that guarantee the preservation of the health of participants in the educational process. Informatization of education as a field of scientific and practical activity is designed to ensure the achievement of such strategic goals as training specialists with a new type of thinking. This meets the requirements of the information society, improving the quality of education, improving all types of educational practice based on the use of information and telecommunications technologies, creating new electronic educational tools, their effective use in the system of information and educational interactions at all levels of education, and in educational institutions of different types.

26.1.1 The Concept of the Study

Factors determining the formation and content of the future teacher's training

With the introduction of digital technologies, social life is changing, and the economy and education are "going digital". Digital technologies have ceased to be just a means, they have been transformed into a modern way of life. Thanks to this, new opportunities have appeared in education: continuous education, the formation of individual educational trajectories, the assimilation of a new role by young people, and the formation of the ability to become a creator of information resources. All these places increased the requirements for future teachers, which involve obtaining new digital competencies, skills, and abilities to work in the digital educational space. In these conditions, the system of pedagogical education should ensure the preparation of a graduate with a high level of digital professional competence. A feature of the design and further implementation of the content of education and the methodological system aimed at the formation of digital competencies is the complete twinning of approaches and measures with the requirements of administrative and regulatory documents regulating the educational process in higher education. After the completion of complex processes which led to the termination of the Soviet Union in 1991, education in Russian universities followed the ethos “Take as much sovereignty as you can”. This gave the right to each educational institution of higher education to develop and implement its own educational programs uncoordinated with other universities within the framework of a single specialty. The period came, interesting from the standpoint of the uniqueness of the content of new educational programs and technologies for their implementation, which completely depended on the intellectual and material capabilities of the students. However, soon a noticeable disadvantage of this approach began to be felt more and more, due to the lack of a single (or coinciding at a certain percentage) curriculum, which made it impossible to implement academic mobility of students and broke the unified educational space of the Russian Federation. In addition, different disciplines mastered by students have created dissonance in determining the qualification framework of future specialists. It has also led to dissatisfaction among employers who have stopped focusing on the content of subject training of specialists who have mastered educational programs in different higher educational institutions.

Attempts to solve this problem were made in 1995 by introducing a regulatory document at a federal level—the State Educational Standard of Higher Professional Education, published under the auspices of the State Committee of the Russian Federation for Higher Education.

This document for the first time gave a general description of the specialty and established requirements for the level of training of persons who have successfully completed training in a particular specialty program.

In the future, according to the adopted state regulations, new state educational standards (later called federal state educational standards) were to be adopted every five years in order to make the required changes.

This setting is still maintained at the present time, but it is observed with varying degrees of frequency. With regard to the system of teacher training in the enlarged group of specialties “Education and Pedagogical Sciences”, the terms of introduction of new federal educational standards relate to 1995, 2000, 2005, 2010, 2015–2016.

A further step in changing the system of training specialists was the development and implementation of a new type of regulatory document—professional standards. In relation to the system of pedagogical education, the following professional standards are currently in force, adopted in different years:

1. 01.001. Teacher (pedagogical activity in the field of preschool, primary general, basic general, secondary general education) (educator, teacher) (2013);
2. 01.002. Teacher-psychologist (psychologist in the field of education) (2015);
3. 01.003. Teacher of additional education for children and adults (2018);
4. 01.005. Specialist in the field of education (2017);
5. 01.006. Master of industrial training in driving vehicles (2018);
6. 01.007. Specialist involved in the organization of the activities of the children’s collective (2019);
7. 01.008. Head of a scientific organization (2021);
8. 01.009. Scientific director of a scientific organization (2021);

9. 01.010. Head of an educational organization of higher education (2021).

Currently, the scientific and pedagogical community is discussing and preparing for the adoption of the professional standard “Teacher of higher and additional professional education”.

This professional standard should replace the previously adopted, but subsequently invalidated 01.004 Teacher of vocational training, vocational education, and additional vocational education (expired from 13.06.2020).

The adoption of professional standards is a significant step toward the development of the system of professional activity in teaching. However, the peculiarity and complexity of the situation lies in the fact that educational and professional standards were developed by separate ministries. Educational standards were developed by the Ministry of Education and Science of the Russian Federation. Professional standards, meanwhile, were set out by the Ministry of Labor and Social Protection of the Russian Federation.

The standards have fundamentally different conceptual foundations, different structures, and solve different tasks. They do not march in step at various crucial points.

The adoption of professional standards, which define the requirements for the labor functions of a specialist, for his labor actions, knowledge and skills, requirements for practical work experience, led to the need to finalize and significantly change the content of educational standards. These were then modified and received the name of Federal State Educational Standards of Higher Education, taking into account professional standards (FSES 3++).

Currently, the adoption and introduction of the FSES 3++ in various specialties is being completed, but these standards have already been adopted and are in effect for the enlarged group of specialties “Education and Pedagogical Sciences” (with the exception of the postgraduate level).

Thus, the system of training future teachers is directly related to the requirements of federal state educational standards. Based on these standards, educational organizations develop and implement their own educational programs for teacher training. They include the problem of forming and measuring the level of formation of digital competencies.

The following terms were used during the study:

- the digital culture of the future teacher, which was understood as a complex systemic quality of the individual, is characterized by a worldview focused on the values of information interaction in the digital environment and the experience of information activities necessary for the organization of subject training and education;
- the information (digital) competence of the future teacher as a system of knowledge, skills of searching and selecting the necessary information, experience of its transformation, transmission, and preservation. This has developed at a certain level, ensuring future professional activity. The scope and content of this concept includes the presence of a complex of technical, informational, legal, ethical, and social skills (Tomczyk, 2019).

These terms, as well as their semantic analogues, are also used to form a search query in information, analytical, abstract, and bibliographic systems.

26.2 Research Methodology

The purpose of the chapter is to reveal the state of scientific research and development trends in the formation of digital literacy of future teachers in Russia in the period from 2000 to the present.

The object of the research is the texts of scientific works of various genres that reveal the results of research on various aspects of the problem of forming the digital literacy of a future teacher. These are presented in public discourse in the form of scientific articles, reports, and dissertations.

The hypothesis of the study. We proceed from the hypothetical idea that the determination of the qualitative originality of research on the problem of formation and diagnosis of the level of formation of digital competence of a future teacher should be carried out on the basis of the requirements of federal state educational and professional standards, in force at the time of the appearance of studies of different levels and directions.

This will allow us to identify the stages of research within the period under review, the directions of fundamental and applied research in the field of information training of future teachers, and the trends in the development of professional training of future teachers of various typological groups.

Research methods—analysis, synthesis, generalization, abstraction, comparative analysis, content analysis, cluster analysis, interpretation.

The sources of the research are materials presented in scientific-analytical and bibliographic databases (the Russian State Library, the Russian Science Citation Index), information resources of the Center for Information Technologies and Systems of Executive Authorities (CITS), and the portal of Federal State Educational Standards of Higher Education (http://fgosvo.ru/archivegosvpo/157/155/5/625).

When selecting scientific texts, the presence in the system of professional training of teachers of various typological groups was taken into account (by levels and profiles)—teachers, educators, coaches, tutors, industrial training instructors, home teachers, etc.

Sources containing references to “humanities students”, “students”, “IT specialists”, “coordinators of informatization of education”, “informatization personnel”, etc., as well as sources analyzing the peculiarities of the practice of working teachers, including those improving their qualifications, were not considered.

26.3 Results and Discussion

26.3.1 The First Stage of the Study

The task of the first stage of the study was to determine the qualitative originality of the content of dissertation research reflecting a given topic, dissertation research being considered one of the most significant forms of presenting new scientific knowledge.

The dissertation is a complete scientific project characterized by thoroughness, integrity, stage-by-stage implementation, conceptual unity, and the presence of a clearly expressed new idea.

A doctoral dissertation is a study in which theoretical provisions have been developed, the totality of which can qualify as a major new scientific achievement.

When conducting the research, we believe it expedient to use the content analysis procedure as a multipurpose research method. This has been developed specifically to investigate a broad spectrum of problems in which the content of communication serves as a basis of inference» (Cohen et al., 2007).

In accordance with the logic of content-analytical research (Cohen et al., 2007), at the first stage, we identified the key question that content analysis is aimed at: namely, as the topic of a dissertation research on the formation of ICT competencies of teachers—with the dynamics of requirements for this type of competence—provided for in the SES?

This question involved obtaining information that would allow establishing a general tendency in the adherence of dissertation candidates to the study of specific aspects of the stated problematics.

The second step of the content analysis was devoted to the definition of a set of dissertation research texts reflecting the topic of formation of the ICT competence of teachers and future teachers.

When determining the empirical array of research, it was taken into account that writing and defending master's theses in the Russian Federation is the implementation of final qualifying work.

Master's theses are not described as a storage unit in resource bases; the texts of this genre are not available to the general reader. For this reason, they do not systematically affect the quality of specialist training.

Accordingly, Master's theses are not considered in this study.

In the third step ("Define the sample to be included", p. 477), we consider it advisable to include in the content analysis only dissertation research officially recognized by the Higher Attestation Commission under the Ministry of Science and Higher Education of Russian Federation and contained in the catalogue of the Russian State Library in the "Catalogue dissertations".

The fourth step, addressing the context of the generation of the document, requires and allows setting the level of the dissertation.

In Russia, there are two levels of dissertation research—PhD (candidate's dissertation), the results of research which do not imply a scientific result at the level of the discovery of a new scientific direction. There is a doctoral dissertation, being a dissertation of the next, higher level, which has no analogue in European countries. Within the framework of this chapter, we do not distinguish between the levels of dissertation research, since their topics reflect the new problems of training future teachers that arose during the transition of Russia to a new technological method. Master's theses are not considered in this study.

The fifth step of content analysis—"Define the units of analyses"—(p. 477) is aimed at choosing semantic categories of research, which has become the key concept of "digital competence", its synonyms and derivatives, which have a discerning power, in the context of the concept of "pedagogy".

The fifth step ("Defining units of analysis") and the seventh step ("Creating categories for analysis") are combined. The category "dissertation" was used as a counting unit, information about which was available on the official website of the Russian State Library.

The sixth step made it possible to carry out the coding, which became the concept of "professional typological group". At the eighth step of the study, this position was categorized into actors ("teacher", "future teacher", and "student"). In accordance with this coding, the data were thus entered into the table of the EXCEL program.

The ninth step of content analysis is devoted to the construction and visualization of data using visualization tools from the EXCEL program.

Based on thematic search queries in the catalogue of the Russian State Library, the repository of all Russian dissertation research (http://aleph.rsl.ru/F/?func=file&file_name=find-b&local_base=xdis), it was found that 35 dissertations on the problems of digital-competency formation among teachers were defended during the period 2000–2021.

The cluster analysis allowed us to identify four thematic groupings reflecting the following positions: information competencies of (1) future teachers; (2) students who are not mastering pedagogical programs; (3) teachers; and (4) general basics of the informatization of education.

Figure 26.1 shows the results of content analysis in accordance with the periods of the validity of state educational standards in higher professional education, and federal state educational standards of higher education among different generations (marked in different colors).

A qualitative analysis of dissertation research (the tenth step of content analysis) made it possible to identify the originality of the authors' approaches to the problem of the formation of ICT competencies, in different periods of the federal state standards.

As shown in the histogram, during the first of the considered periods of the Federal State Educational Standard, the greatest attention was paid to the development of the theoretical foundations for informatization of the education of pedagogical personnel.

It should be noted that during this period there was a revision of the requirements for the knowledge and skills of a graduate who is mastering teacher education programs. Already in the State Educational Standard of Higher Professional Education of 1995, in the section "Requirements for knowledge and skills in disciplines", it is determined that the graduate "has knowledge about information processes in nature and society, about computer technologies, and the possibilities of electronic technologies in the field of culture and education" (State educational standard of

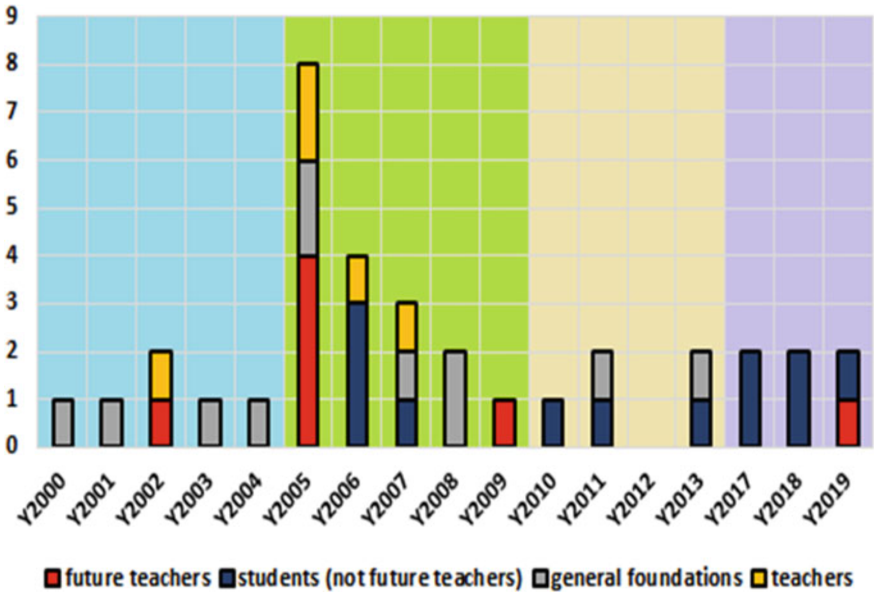

Fig. 26.1 Distribution of dissertation research on the problems of the formation of ICT competencies performed during the periods of the state educational standards of different generations

higher professional education, p. 4). The Standard introduces the concept of the “information culture of the individual”.

The State Educational Standard of Higher Professional Education, which was put into effect in 2000 (hereinafter—the SES HPE-2000), defines that the activity of a future bachelor teacher is aimed at mastering the sources of general cultural and professional information.

It should be guided by the requirements of the principles of information security, using information and communication technologies.

In line with the requirements of the standard, Shkutina’s (2002) dissertation research proves the need to integrate pedagogical and information technologies of education into professional training. In the dissertation, an algorithm for the use of automated training systems, an educational system of computer-aided design was developed and put into practice, to improve the preparation of a teacher of professional training (ibid.).

The SES HPE in the direction of 540,600 Pedagogy, which entered into force in 2005 (hereinafter—the SES HPE-2005), established: (a) a list of professional and educational profiles of teacher training, and (b) significantly fixed the theoretical positions that determine the need for the formation of the specific knowledge, skills, and abilities related to the information competence of the future teacher.

The standard for the first time established the profile 540,619 “Computer Science in primary education”, and also introduced a mandatory academic discipline of the cycle “General mathematical and natural Science disciplines”, called “Information and communication technologies in education", in the amount of 100 classroom hours.

The course of practical pedagogy includes the topic "Information and technological support of the educational process", which is implemented in such mandatory disciplines as "Theoretical foundations of Computer Science", "Practical computer problem solving", "Pedagogical creativity in the information environment", and "Modern approaches to the organization of the school information space".

The position "use of information and communication technologies" has been introduced into the content of all academic disciplines provided by the State Educational Standard HPE-2005 (http://fgosvo.ru/archivegosvpo/157/155/5/625).

It is used in the description of the content of education in relation to school subjects (Russian language, literature, mathematics, natural science, etc.), to special-needs specifics (children with hearing disorders, people with developmental problems, etc.), and to the levels of education (primary, preschool education).

The shift of emphasis to actualizing the problems of the informatization of education in the SES HPE-2005 was reflected in the subject of dissertation research.

Of the four works related to this period of the SES HPE-2005, one study is devoted to the development of the content of computer science education in a pedagogical university, while the other three are devoted to the problem of forming a pedagogical culture enabling a future teacher to carry out professional activities in an information rich environment.

The research of Fridland (2005) is addressed to the problem of the development of the content of teaching computer science, based on the integration of a syntactic and semantic approach to information processes, systems, and technologies.

The novelty of the author's approach to the problem lies in the substantiation of the model of interrelated processes involved in the formation of personality. This consistently includes two blocks: a) information process, communication process, educational process, pedagogical process, educational process, didactic process b) "student—information resource—teacher—information environment—information environment". This model differs from the previously adopted model of one block "student—textbook—teacher".

This approach, according to Fridland, will allow us to design systems that are adequate for these processes. The author has identified such information and intellectual resource as the desire for action and justified measures for its development.

Experimentally (consisting of 864 participants of the experiment), the expediency of using the methodological complex "Portfolio of a computer science teacher" for the formation of the ICT competence of a future teacher was proved.

It is also proposed to use the interactive system "Sprint-Inform" in the form of a website. It is an element of the portal of the virtual pedagogical university. The author proposed an original author's computer science course, including an automated tool system "AIS-Test".

The results of the study, according to the author, will increase the level of teaching ideological and systemic aspects of computer science, thereby increasing the level of information culture among future teachers and schoolchildren, ensuring the continuity of the content of teaching computer science in secondary and higher schools.

Three dissertations, completed during the period of the SES HPE-2005, are devoted to the technologies of forming the information and communicative culture of future teachers.

In Suvorova's study (2005), various aspects of the formation of the communicative and discursive culture of future teachers are considered. The author introduces the concepts of "information macroenvironment" and "information microenvironment" into scientific circulation and conducts research based on experimental work involving 524 students, 102 teachers, and 19 heads of educational organizations.

The author proves that the creation of an information and educational environment contributes to the formation of a communicative and discursive culture of future teachers for several reasons.

The first factor is the presence of the information macroenvironment, which ensures the stability and controllability of the process under study, due to a system of means and conditions of the external "information" field.

The second factor is the presence of components of the information microenvironment, which ensure the functioning of the process of forming the communicative and discursive culture of future teachers at all stages of the formation of digital competencies: motivational-value, cultural-creative, intentional, evaluative-corrective.

From a different position, information and communication culture is considered in the dissertation of Danilchuk (2005).

On the basis of theoretical modeling, the author has developed a communicative component of the information culture of the future teacher. It includes the competence of the said teacher in the flexible and constructive conduct of dialogue such as "man–man" (information problems); "man–computer" (effective management of a computer system); and "man–computer–man" (experience of joint activities in the information environment), as well as the reflection of the future teacher on all his information contacts.

Information activity is presented at several levels—the level of computer literacy ("I am a performer"), methodological ("I am a tactician"), and the level of self-development ("I am a strategist").

In contrast to the previously considered works, Danilchuk developed a system for monitoring the formation of the information culture. It includes collecting information about the qualitative growth and progress of the formation of the information culture of the future teacher; establishing the level of formation of the information culture of the future teacher; determining the contradictions that arise in this process, identifying problem areas; determining trends and didactic conditions for the effectiveness of the formation of the information culture of the future teacher; correction of the formation process during monitoring.

Terminological increments in the form of the concepts "information pedagogy" as an educational strategy and "information and project culture of the future teacher" on the example of training a teacher of technology and entrepreneurship were proposed by Petrova (2005).

The dissertation describes and develops methodological support for an information-integrated education module, that ensures the development of the information-projective culture of a student's personality.

It implies the formation of projective qualities and the ability to innovate. 100 teachers and 500 students took part in the experimental substantiation of the author's concept of information-projective culture, to evaluate the proposed module.

A sufficient sample allowed the author to prove the expediency of using a system of pedagogical monitoring, which allows one to determine the formation of the information-projective culture of future teachers at the content-procedural, evaluative-creative, value-motivational, and moral-social levels.

The research of Ovchinnikova (2009) also belongs to the dissertation research of the period of the SES HPE-2005, analyzing the problem of the formation of information culture.

This paper does not contain any qualitative differences from the concept of Petrova (2005). It proves the previously established positions on the importance of information culture, which is associated with the development of personality. A new position is the introduction of the term "information-reflexive approach", which is not properly disclosed, as well as the stated evaluation and criteria tools of pedagogical monitoring. Information about the number of participants in the experiment is not provided.

Thus, the period of validity of the SES HPE-2005 was quite intensive when studying the problem of forming the information competence of future teachers. This cannot be attributed to the state of thematic pedagogical research during the period of validity of the Federal State Educational Standard of Higher Professional Education in the direction of training 050,100 Pedagogical education (http://bsk.vsu.ru/docs/sveden/eduStandarts17.2011__46.pdf).

During this period, not a single dissertation was defended. Interest in this issue of dissertation discourse was observed in 2019, falling within the system of requirements of the most recent educational standard adopted in 2018 (http://fgosvo.ru/uploadfiles/FGOS%20VO%203++/Bak/440301_B_3_15062021.pdf).

In the dissertation of Gnatyshina (2019), the emphasis is placed on the formation of value-semantic guidelines that, according to the author, determine the digital culture of the teacher. The technology for the formation of digital competencies includes blocks of pedagogical tasks, organization of activities, control and correction, and conditions for the formation of digital culture. The experimental part of the study contains the names of academic groups of students, but it does not indicate their numbers.

The eleventh step of the content analysis made it possible to draw preliminary conclusions. It reflected the specifics of the answer to the key research question of the correlation of the topic of dissertation research with the problems of the formation of teachers' ICT competencies; the dynamics of requirements for this type of competence were provided for in the State Federal Educational Standards.

Thus, dissertation research on the problem of the formation of digital competencies of future teachers reflects, to varying degrees, the requirements for training a future teacher in terms of digital competence. During the validity of the SES HPE-2000, the dissertation research (Shkutina, 2002) fully reflected the requirement of preparation for the use of modern information and communication technologies.

The SES HPE-2005 is replete with references to the concept of "culture", which, in different variants of semantic representation, occurs 27 times. However, the term "information culture" is not used. The document suggests only the need to use the information and information-activity models in training (a block of general professional disciplines). The preparation of five dissertations on the formation of various aspects of the information culture of future teachers can be considered a product of advanced developments in the topic.

The requirements of the professional standard 01.001. "Teacher" (2013) and the requirements of the Federal State Educational Standard HPE-2010, for the first time were built on a competence basis and were focused on the development of information competencies and did not arouse any interest among young scientific researchers.

Attention to professional standards is not reflected in any dissertation, completed in 2019 (Gnatyshina, 2019), i.e., after the adoption of a whole range of professional standards, which emphasize the need for effective use of digital competencies in teaching activities. At the same time, it cannot be argued that the dissertation discourse is the only one from a wide range of research practices.

26.3.2 The Second Stage of the Study

The principles and pace of work in a digital society require a change in the very paradigm of education, the result of which is a developing personality ready to function in the most complex information and knowledge digital systems.

Documents regulating the development of the digital environment have entered into force in the Russian Federation:

- the concept of long-term socio-economic development of the Russian Federation for the period up to 2020 (https://varnamuz.chel.muzkult.ru/media/2018/09/20/1219968882/Koncepciya_modernizacii_Rossijskogo_obrazovaniya_do_2020_goda.pdf),
- the "Strategy for the development of the Information Society of the Russian Federation for 2017–2030" (http://www.kremlin.ru/acts/bank/41919),
- the National Project "Education" "(in relation to the problem under consideration—in the part" Digital educational environment") (https://edu.gov.ru/national-project/projects/cos/), the Federal project "Teacher of the Future" (https://new.avo.ru/documents/33446/1306658/Учитель+будущего.pdf/19fa3c31-eb98-87ad-089d-de00fc799f6d).

They, as well as the previous strategic directions for the development of education, gathered a wide range of like-minded people from special scientific and methodological journals, in which topics related to the informatization of education are discussed in detail.

Therefore, the task of the second stage of the study was to determine the qualitative originality of the activity of representatives from the scientific community, in the professional discussion of the problems of the formation of digital literacy of the future teacher in the non-dissertation discourse.

In modern literature, information literacy is understood as a person's need for information, as well as his knowledge about finding and using the information to solve various problems (Novković et al., 2018). Currently, there are various definitions concerning the types of information literacy: media literacy, which is defined as the ability to critically evaluate and verify sources); computer literacy, which assumes the ability to apply new technologies; digital literacy, which includes competencies in the digital environment. According to Belshaw (2011), there is a transition from media literacy to digital literacy.

There is no doubt that for the development of digital literacy of future teachers, the educational practice of using gadgets, computers, the possibilities of social networks, and the potential for interaction with the digital environment are necessary.

In modern Russia, different definitions of digital literacy are used.

Many researchers rely on the definition of Jenkins, who believes that digital literacy includes the ability to work with a computer, understanding the specifics of the dissemination of digital information, and network communities http://henryjenkins.org/blog/2006/10/confronting_the_challenges_of_2.html). Teachers also support the position of Belshaw, who attributes the following components to digital literacy: understanding the cultural context of the Internet environment, the ability to communicate in online communities, the ability to create and distribute content, and the skills of using digital technologies for self-development (https://clalliance.org/wp-content/uploads/files/doug-belshaw-edd-thesis-final.pdf).

In the near future, Russia plans to adopt the "Digital School" standard, according to which a teacher should be able to use services to work with digital educational content and master advanced training programs online; they will conduct classes using digital educational content, interactive electronic educational materials, virtual laboratories, simulators, and so on. Since digital technologies and content are very dynamic, constantly changing and improving, the teacher is required to develop digital competencies and the formation of digital competence for effective pedagogical activity.

According to the concept of Soldatova et al. (2013), digital competence is considered as a component of social competence. Digital competence includes four components (knowledge, skills, motivation, responsibility) that have applications in four areas of activity on the Internet (content, communication, consumption and the technosphere). The authors identified four types of digital competence:

(1) information and media competence—processes related to the adoption, critical rethinking, organization of digital information, formation of information objects;
(2) communicative competence—the ability to communicate using digital means;
(3) technical competence—the ability to use information tools;

(4) consumer competence—the competence of consumers in solving everyday tasks using digital technologies.

According to Tsarapkina et al. (2020) and Chorosova et al. (2020), the most important task in the training of teaching staff in the context of the development of digitalization is the formation of digital competence and the formation of ways to assess it. Boronenko and Fedotova (2021), and Dyakova and Sechkareva (2019) emphasize that digital competence is an essential characteristic of a modern teacher, being the basis for the formation of digital literacy in schoolchildren, with a teacher's digital competence considered within the framework of the concept (2013). Digital competence is understood as the ability of a teacher to "confidently, effectively, critically, and safely choose and apply… digital technologies" in four areas: (content, communication, consumption, and technosphere). The authors also included the teacher's readiness to work in these areas in this competence. From the authors' point of view, the digital competencies of a teacher include three classes: general use, general pedagogical, and subject pedagogical, represented by a set of digital competencies that are implemented at three levels: basic, digital use, digital transformation. These characterize its cognitive, functional, and creative aspects.

Grebenyuk (2020) believes that it is necessary to consider the issue of digital literacy, bearing in mind a specific subject of education, that is, students—future teachers. The author considers the spheres of students' psyche: intellectual, motivational, emotional, volitional, subject-practical, existential, and the sphere of self-regulation, the components of which act as digital competencies.

Yachina and Fernandez (2018) consider the digital competence of a teacher as understanding the potential of digital technologies for innovation; a basic understanding of the reliability and reliability of the information received, and the ability of a person to critically, confidently, safely, and effectively apply and choose information and communication technologies in various spheres of life. Meanwhile, Petrova and Shcherbik (2018) believe that the digital competence of a teacher is the effective use of new technologies.

In the period from 2001 to 2010, there were practically no works directly aimed at studying the peculiarities of the formation and development of digital competencies among students studying in pedagogical specialties. The published works describe the features of the formation of the information culture of students, in general, and information competence in particular.

Masyaykina (2006) studied the information competence of future teachers, proving that the information and educational environment of the university is one of the factors determining its development. As part of her research, the author identified and implemented several pedagogical conditions that contribute to the development of students ' information culture—the development and implementation of the training course "Fundamentals of Information Culture". The modules included in this course not only facilitate the acquaintance of students with the specifics and possibilities of the information and educational environment of the university, but also show the possibilities and trajectories of personal development among students mastering this course, and identify the personal significance of some components of information culture (ibid.).

The research of Gorneva (2007) is also devoted to the study of the information culture of future teachers. The author has developed a model for the formation of an information culture among students–teachers, which includes the goals and objectives of training: the main methods, means, forms, and results of training. As a result of the implementation of this model, Gorneva revealed that in order to increase the efficiency of the process of complex formation of information culture among future teachers, it is necessary to comply with the following requirements:

1. to match the goals and objectives of information training to the information basis of their future professional activity and to form the readiness of future teachers to use information and communication technologies for the organization of the educational process;
2. to use a variety of activities using information and communication technologies in the process of teaching students;
3. to create an educational environment that will activate the process of forming an information culture of students;
4. to prepare students in the process of development of the special course "Information culture of the teacher" (Gorneva, 2007).

Thus, from Russia's accession to the Bologna Process, to the end of the reform of the national education system in accordance with the provisions of the Bologna Declaration, there were a limited number of papers devoted to the measurement of the extent of the formation of digital competencies, and those mainly aimed at the study of information competence.

In the period from 2010 to 2017, the scientific interest of Russian researchers in the study of digital competencies of future teachers increased due to the intensive digitalization of the educational process at all levels of education. Scientific works of this period are mainly devoted to the specifics of the formation, as well as to the assessment of the degree of formation of IT competence among students studying in pedagogical specialties (Belousova & Vyshkvyrkina, 2015), mastering specific technical means of teaching. Zalilov, Lebedeva, Denesenko, Kosolapov, Sergeev, Sukhanova, Boldin, Tarasov, Sekulich, and others write about the features of the formation of IT competencies of future teachers, in the process of mastering special disciplines and methods of assessing the formation of competence.

Zalilov and Lebedeva (2010) developed the author's teaching methodology aimed at the formation of an educational multipolar environment. The specificity of this method consists of a minimum amount of lecture material, and a combination of lectures and practical classes. Within the framework of two disciplines, future teachers acquired skills in working in the Windows operating environment, together with skills in using various packages and applications. These included: MS Office, VirtualDub, Windows Movie Maker, GIMP, developing online courses in the Moodle environment, and also formed the ability to use personal digital devices; knowledge of the main information and educational opportunities of global Internet networks; the ability to use multimedia technologies in the educational process. In the process of implementing the disciplines, the teacher regularly collects the students' opinions on the solution of the tasks set and the originality of the action program, and checks whether certain actions are being carried out correctly. A similar model, according to Zalilov and Lebedeva, allows you to track the psycho-emotional state of students in the process of forming IT competencies, provides information about the assimilation of the material and the quality of the skills being formed, and allows you to make the necessary adjustments to the discipline program at any stage (ibid.).

Desnenko (2015) writes about the development of a special discipline for future teachers; by mastering this, students form a system of knowledge about technical and audiovisual means, technologies, and the possibilities of their application in the professional activity of a teacher. The author suggests evaluating the degree of competence formation after mastering the course in two directions: theoretical knowledge—based on automated control, including computer testing with test tasks of various types, and practical skills—through the implementation of practice-oriented projects (ibid.).

Analyzing the stages of the process of pedagogical training of future teachers, Sergeev (2015) comes to the conclusion that the formation of IT competence also goes through a number of stages:

1. the stage of formation of general user ICT competence. At this stage, students get acquainted with various digital devices, the capabilities of the Internet, databases, methods and means of information exchange in the process of remote interaction, the rules of information security, etc.;
2. the stage of formation of general pedagogical competence. At this stage, the formation and development of a future teacher's basic competence takes place in the process of solving real professional tasks using various technical means, software shells, etc.;
3. the stage of formation of subject-pedagogical ICT competence. At this stage, the existing knowledge and skills are expanded and deepened, taking into account the specifics of the subject and the scientific areas of the future professional activity of students (ibid.).

Sekulich (2017) distinguishes three stages in the formation of ICT competencies: 1 stage—the formation of computer literacy; 2 stage—the formation of ICT competencies, and 3 stage—the formation of ICT competencies based on other scientific material.

At the same time, the author emphasizes that the content of ICT competencies is changing in accordance with the development of digital technologies. At the beginning of the twenty-first century, the content of digital competencies included the ability to use the Internet, search for information in databases, and work skills in MS Office. Meanwhile, today this content includes a variety of visualization tools, software for creating a multimedia product, platforms for recording online lessons, and so on. Unfortunately, the author does not provide criteria for determining the stage of formation in the work (ibid.).

In our opinion, it should be noted that in the works from 2001 to 2017, the authors, speaking about the formation and development of information or IT competencies, represent this as a process of mastering a particular special discipline, the degree of competence formation being assessed by the results of boundary control in the discipline.

Starting from 2018, the federal project “Digital Educational Environment” has been approved and is being implemented in Russia. The main goal of this project is to create a safe digital educational environment that meets modern requirements by 2024 and to train personnel to be able to use modern digital technologies in their professional activities. The rapid development of digital devices and new technologies has led to the need not only to develop digital and information and communication competencies among students, but also to realize the importance of evaluating students’ digital competencies. This issue became particularly acute in 2020 in connection with the announcement of a pandemic and the transition of the entire education system of the Russian Federation to remote forms of work, which affected the number and content of studies.

In Russian psychological and pedagogical research, a group of works has been presented that describe the criteria and levels of formation of digital competencies which allow the assessment of the skills of future teachers, when using various digital technologies in real activity to solve professional problems. This is because the traditional characteristics and criteria for mastering disciplines in general, and individual competencies in particular, have lost their relevance (Tkachenko, Saukova, Soboleva, Perevozchikov, Tagaeva, Bakulina, Bakaeva, Kasko, Fedorova, Khrisanova, Tenyukova et al.).

Tkachenko (2019), moving away from the traditional criteria that characterize the degree of formation of the skill, considers it necessary to identify a graduate’s areas of activity and describes the criteria for the formation of digital competencies within these areas. In accordance with this, the author highlights the basic, educational, and professional skills of using digital technologies. Basic skills are the skills of working with various platforms to interact with government and commercial structures and solve the everyday tasks of a citizen. Educational digital skills allow you to interact effectively in an educational environment. Finally, professional digital competencies are the skills of using modern digital technologies to solve the actual professional tasks of a teacher. Within each level, specific technologies are prescribed that must be mastered; for example, at the basic level, the skill of using various electronic services; at the educational level, the skill of working in a variety of electronic educational resources, the skill of creating multimedia materials, and so on; at the professional level, the skill of working with specialized software, digital platforms, professional resources, and so on. (Tkachenko, 2019).

Fedorova et al. (2020) basing their research on the developed criteria for assessing the degree of formation of digital competencies of future technology teachers identified three levels:

1. a high level implies the skills of an advanced user of the electronic information and educational environment, information and communication technologies as a means of organizing the educational and extracurricular activities of students

in the conditions of contact and distance work. This was as a means of organizing communication and interaction with schoolchildren; such a person is an advanced user of professional digital equipment and software;

2. intermediate level—the future teacher has sufficient knowledge of the electronic information and educational environment and information and communication technologies, and can use them to organize the educational process and independent work of schoolchildren. He also knows and can use applications and programs to organize the interaction with schoolchildren, etc., but in practice may not use all the equipment or software in full;
3. low level—the future teacher uses equipment, electronic resources, and software at an elementary level, partially using some applications and the network to organize the training of schoolchildren.

The level of formation of digital competence of future technology teachers was determined through diagnostic sections, which included tests to determine the level of knowledge in the field of digital technologies, and test tasks aimed at identifying the ability to use the electronic information and educational environment, etc., effectively. (ibid.).

Tagaeva and co-authors (2020) identified the levels of formation of digital competencies. They are equivalent in content to those described above, but are named as threshold, basic, and advanced. Furthermore, they distinguished the fourth level-below the threshold, indicating that competence has not been reached. Each level corresponds to a quantitative assessment: below the threshold—0 points, threshold—1–2 points, basic—3–4 points, advanced—5 points. The authors show that with the assessment of the level of formation of ICT competence, the quality of educational tasks, independence, and the ability to analyze information and create new information are evaluated (ibid.).

Several different criteria for the formation of digital competencies are proposed by Soboleva and Perevozchikov (2019). The authors identify five skills, on the basis of which they evaluate: the ability to analyze information of various types, the ability to structure material, the ability to solve a problem, the ability to form a holistic image of a product, and the ability to generate ideas and critical thinking.

Soboleva and Perevozchikov conducted a diagnosis of the degree of formation of digital competencies of future teachers and found that only a tenth of the respondents have the above-mentioned skills formed at a high level. Having formed the control and experimental groups, the authors changed the approach to learning in the latter, retaining the traditional forms in the control group. In the experimental group of the study, classes in the discipline "Digital Technologies in Education" included the design and development of mobile applications with educational content for schoolchildren. The primary diagnostics showed that the high level of digital competence formation in the control and experimental groups was 12.0% and 13.0%, respectively. After mastering the discipline in the control group of the study, a high level of formation was revealed in 30.4% of students, while in the experimental group, it was 72.0%. According to the authors, repeated diagnostics demonstrated the high efficiency of the new approach to training (ibid.)

Various models of the formation of digital competencies of students studying in pedagogical specialties are also presented in the works of recent years. One of the models of the digital culture of the future teacher, reflecting the technological component, is presented in the work of Nosova et al. (2019). The authors, based on the three-component structure of ICT competence, identified sections in each component (general user, general pedagogical, and subject pedagogical) (digital competence, electronic information and educational environment of the organization, digital educational resource in the subject), each of which contains certain categories, for example, device synchronization, multimedia content, online learning, organization of students' activities using digital technologies, development of a digital educational resource on the subject. In accordance with the selected categories, students' digital skills are formed. Within the framework of their model, the authors distinguish four levels of digital competence formation: initial, basic, high, and expert. The first three levels should be formed during the period of study in the bachelor's degree, and the expert level—the level of Master's training. (ibid.).

Koroleva (2020) has developed a model for preparing undergraduates of pedagogical education to work in the conditions of digitalization of education. When developing the model, the author worked on the assumption that a Master's student should demonstrate skills in various digital technologies in all professional activities: pedagogical, research, project, methodological, managerial, cultural, and educational. Graduates should also be prepared to apply digital competence in solving practical and applied problems in all of the above types of professional activities of a teacher. Based on this, Koroleva believes that the main goal of teachers in the process of teaching undergraduates is to choose educational tasks that will be similar to the professional tasks of a teacher. The author identifies three levels of digital competence formation for undergraduates: key, basic, and special, also indicating that the first two levels should be formed for students during their undergraduate studies (Fig. 26.2).

Koroleva writes that in the process of mastering the courses included in the model, on the basis of contextual activity training, including such active methods as solving case tasks, specially selected tasks, preparing an electronic portfolio, defending mini-projects, students' interest in studying disciplines and the effectiveness of mastering the content of the Master's program is noted (ibid.).

Thus, we can say that from 2001 up to the present, the formation and development of digital competencies has been carried out through the development of special disciplines in the curricula of pedagogical directions. Many authors indicate a rather low development of the skill of working with digital devices and special software necessary for the implementation of professional activities in the future; in many of the country's universities, there is thus a replacement of traditional forms of education with innovative, practice-oriented approaches. Criteria for assessing the degree of formation of digital competencies have been developed, and the levels of its formation have been identified, but the question of measuring these remains open. In the vast majority of works, one method of measurement is presented—the quality of practical tasks that reflect the professional tasks of the teacher.

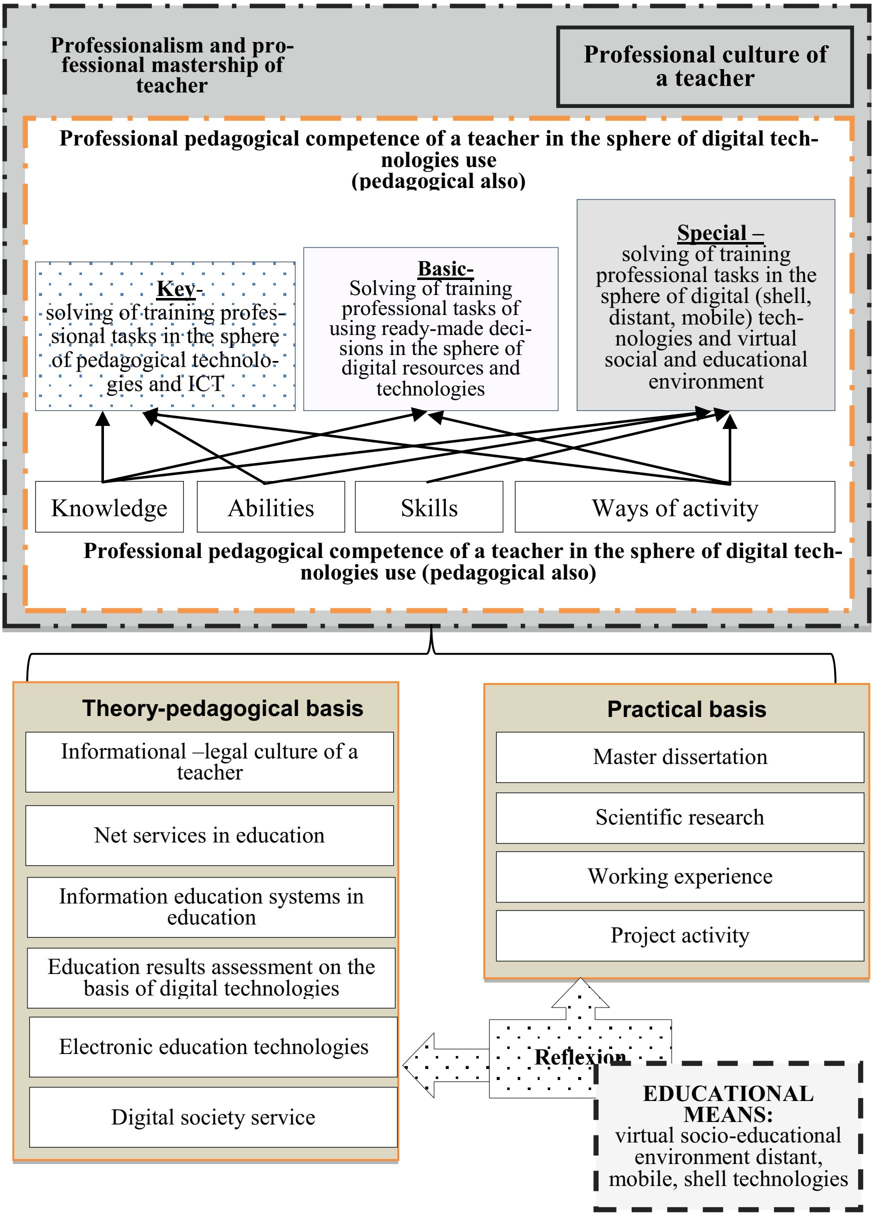

Fig. 26.2 Model of formation of professional readiness of a teacher to work in a virtual socio-educational environment (cited by Koroleva, 2020)

As noted earlier, content analysis is a research procedure that allows one to obtain objective data on the intensity of the appeal of representatives of the scientific community to the problems of forming the ICT competence of a future teacher.

The key question that determines our concept of studying the features of the approach of the scientific community, and practitioners at the first stage of content analytical research is as follows: are there stably repeating connections/patterns between the intensity of distribution of thematic publications unrelated to dissertations, and requirements to the qualifications of teachers as defined by federal state educational standards of different generations?

The second step of content analytical research is aimed at identifying the textual groups that will answer this question.

The history of Russian pedagogical education shows that at the dawn of the emergence of informatization, several special journals were published, reflecting this topical issue.

The journals "Informatics and Education", "Informatization of Education", and "Mathematics and Informatics: science and Education" have become the leading thematic publications in this field.

However, these sources belong to different types of pedagogical publications.

The publication "Mathematics and Informatics: Science and Education" was an almanac published as an inter-university collection of scientific papers. "Informatics and Education", being a periodical, is not presented in a volume sufficiently complete for analysis in the available electronic bibliographic databases and indices. The same partially applies to the journal "Informatization of Education". However, the periodicity of publications, as opposed to collections of scientific works, prompts us to choose journals as an empirical group.

The third step of the content analysis method is aimed at determining the periodical, the analysis of which will allow you to form the most complete impression of its content.

We shall focus on the analysis of the content of the journal "Informatization of Education", which has been published from 1997 to the present. In its first years, this magazine was published irregularly, which does not allow us to form a complete impression of the development of the stated issues.

However, due to the editorial policy of open access, this journal is available and popular with interested readers.

At the fourth step of the content analysis—"Define the context of the generation of the document" (p. 477), it was established that the journal "Informatization of Education" was originally established exclusively to cover the problems of education.

However, in the future, the problems of digitalization of the economy and medicine fell into the scope of thematic coverage. The expansion of the scope of multi-subject research has led to a clarification of the name. Since 2017, the magazine has been published under the title "Digital Transformation".

When determining the unit of analysis at the fifth step of content analytical research, we proceeded from the need to maintain thematic congruence with the designation of the units of analysis used when considering dissertation research.

The semantic unit of analysis is the concept of "digital competence", its synonyms and derivatives, possessing a discriminatory power, in the logic and scope of the term "pedagogy".

The unit of account is the article published in the journal. The previously applied general approach is preserved, according to which the fifth and seventh steps ("Construct the categories for analyses") are conditionally combined.

At the sixth step ("Decide the codes to be used in the analyses") and the eighth step ("Construct the coding and categorizing of the data"), the content analysis was encoded and categorized.

The thematic range of articles is quite wide, but we have identified three areas covering the problems of preparing a future teacher.

They fix the problems of teaching network practices ("Network"), discussing the problems of pedagogical creativity by means of information technology ("Creativity"), and teaching information security ("Security").

At the same time, the typological groups of future teachers were not taken into account.

The ninth step of content analysis was devoted to the construction and visualization of data previously entered into the EXCEL coding tables.

Based on the content analysis (the semantic category of the study is the digital competence of future teachers, the unit of account is the article), we have studied the frequency of reflection on the issues related to the problems of digital literacy formation among future teachers from 2005 to the present. This period is chosen as a time period within which the magazine was published regularly and in full. The results are shown in Fig. 26.3.

The tenth step of content analysis is devoted to the meaningful interpretation of the data.

As follows from the results of the content analysis, the low representation of dissertation research in certain periods of the introduction of educational standards was fully compensated for by the publication of scientific and methodological materials in a special (profile) periodical.

This fully applies to the periods of validity of the Federal State Educational Standard HPE-2010 and the Federal State Educational Standard HE-2015 (Federal State Educational Standard HE 3++). Attention is drawn to the fact that research activity falls in the second year, after the introduction of the SES HPE or the Federal State Educational Standard (2006, 2011, 2016), and there is also a great intensity of discussion of the system of training future teachers on the problems of forming their digital competencies after 2015 to the present. This chronologically coincides with the periods of the introduction of professional standards for education.

Since 2002, a new stage of research on the problems of informatization of education has begun, conducted within the framework of fundamental research of the Institution of the Russian Academy of Education "Institute of Informatization of Education" under the scientific supervision of Academician Robert I.V.

Reports on the implementation of the comprehensive program "Information and communication technologies in general, professional and additional education" (2002–2007) allow us to conclude that the team has developed methodological

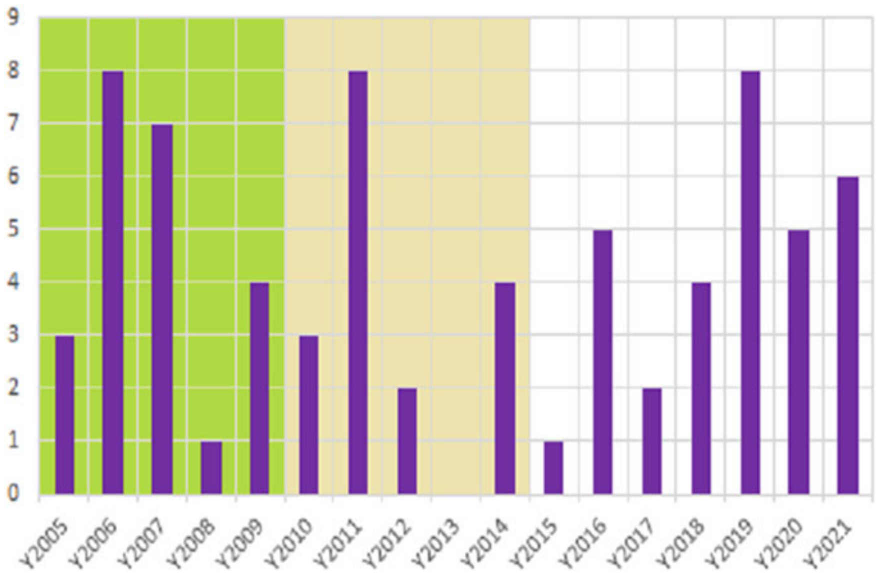

Fig. 26.3 Distribution of publications in the journal "Informatization of Education" on the problems of the formation of IR competencies performed during the periods of the state educational standards of different generations

approaches to training future computer science teachers in the higher education system to use wireless technologies in the educational process. This also includes the training of future English teachers within the framework of the profile course "Development of author's applications in a foreign language based on ICT tools" (http://robert-school.ru/iio/pages/NIR/nir/plans_KP/).

In the texts of the reports on fundamental research for 2008–2014 under the research program "Methodology for the development of the domestic informatization system in health-saving conditions" (http://robert-school.ru/iio/pages/NIR/fi/fi_2008_2012/), the positions reflecting the leading directions of the development of research activities are named.

These include "the definition of the structure and content of the training of a mathematics teacher in the field of the use of ICT and in professional activities and the development of the content of the training of a subject teacher for pedagogical creativity by means of information technologies". The experimental part of the research was carried out at the experimental sites of the cities of Moscow, Veliky Novgorod, Cheboksary, and Kazan (http://robert-school.ru/iio/pages/NIR/nir2/exp_fi/exp_fi_2014/).

So, as the analytical review shows, in the period from 2000 to the present, in the field of digital training of future teachers, there are complex processes associated with determining the structure and content of scientific and pedagogical support for information activities, carried out in the information and communication subject environment.

With a certain degree of conditionality, according to the criterion “requirements for mastering digital culture by a future teacher”, two stages of the development of the pedagogical situation, theoretical achievements of the problem under study, and the practice of solving it can be distinguished.

The first period (2000–2015) is characterized by increased attention to the problems of determining the prospects for the development of pedagogical projections of informatization, for the formation of the information culture of a future teacher. This is reflected in the expansion of the pedagogical thesaurus, including the introduction into scientific circulation of the concepts of information pedagogy, information didactics, network didactics, e-learning, electronic integrated course, the formation of competence in the field of information and communication technologies (Petrova, 2005; Zamolodskaya, 2008). The efforts of researchers and practitioners were focused on the problem of the intensive development of the Russian theory of the formation of information culture and information security.

The second period (2016–present) is characterized by efforts to transform the phenomenon of “information culture” and concepts that reveal the scope and content of this concept into an understanding of the phenomenon of “digital culture” and the concept of the same name. This is facilitated by the development of digitalization as a leading socio-cultural prerequisite, which is reflected in the government program “Digital Economy of the Russian Federation” (2017) (http://static.government.ru/media/files/9gFM4FHj4PsB79I5v7yLVuPgu4bvR7M.pdf).

The socio-psychological attitudes of young people preparing to get an education are changing: they are already “digital natives”, for the most part, “immersed” in the Internet. In the system of professional training, to quote Nestik and Soldatova, there is a gradual “domestication” of digital technologies” (2016, p. 113).

This is reflected, first of all, in the expansion of the educational space through the use of an immersive approach and immersive technologies (Kornilov, 2019; Meskhi et al., 2021; Robert, 2020), the use of virtual web quests, network practices, open educational resources of virtual universities. These trends are developing despite the formal consolidation of the category (group) of general professional competencies “Information and communication technologies for professional activity” in the FSES VO-2018 (http://fgosvo.ru/uploadfiles/FGOS%20VO%203++/Bak/440301_B_3_15062021.pdf).

26.4 Conclusion

The analysis of research practice on the problem of the formation of digital competencies of future teachers has shown that this problem is relevant for Russian scientists, as well as teaching staff implementing their professional training. Research on this problem has several levels and scientific discourses—dissertation, scientific-journalistic, and methodological. When developing the problem of digital competence formation, there is a certain thematic advance, aimed at the advanced development of the theory and practices of the digital approach to the organization of professional training of the future teacher.

In the Russian scientific and methodological discourse, the emphasis on the construction or description of information culture of various types prevails, while the problem of measuring the level of formation of information competencies is not consistent with the degree of pedagogical problems of this orientation. In the stated positions related to their assessment with the help of diagnostic procedures, tools, meters, the possibility of their assessment are used, and the leading method is called reflection and self-assessment of creative products. Preliminary results of the analysis allow us to say that there is a plurality in the understanding of the main terms used by the authors; the theoretical and methodological basis of the research is not sufficiently expressed; there are problems in the development of diagnostic tools aimed at assessing the formation of digital competencies of future teachers; the research is local in nature, there is often no representative sample and valid research methods.

As the analysis shows, Russian researchers and practitioners, when organizing the system of training future teachers, do not fully focus on the structure of the ICT competence of teachers recommended by UNESCO (http://ru.unesco.kz/unesco-ict-competency-framework-for-teachers-version-3), as well as on the ISTE Standards for Teachers (https://www.iste.org/ru/standards/iste-standards-for-teachers). The study of these approaches may constitute an impetus for improving the system of training future Russian teachers for the effective use of digital competencies in their work and one of the resources for professional growth.

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