

Chapter 9

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



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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,

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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 (Liyaganawardena, 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 published, 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, & Hernández, 2015), which considers the frequency of use and pedagogical integration of technological resources in their activities	Not specified	Perception 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

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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

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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

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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	Measurement 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 judgement, 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

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Table 9.4 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement 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

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Table 9.4 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement 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

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Table 9.4 (continued)

Reference	Size and context of participants	Purpose and instruments used	Theoretical reference	Measurement 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 (Bastías & 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 Hinojosa (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 Hinojosa (2014)	46 universities that train teachers in Chile. Participants: 495; deans: 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 and didactic 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 acknowledged, 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 & Hinostriza, 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 (Cerdeira 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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