




Competence of an ICT Teacher Concerning Didactic and Methodological Support in Teaching ICT at Primary School

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Abstract. The widely accepted rhetoric is that our industrial society has been changing to an information society that manages huge amounts of information, which can be disclosed and processed with the help of information and communication technology (ICT). This fact has been reflected in the revised school curricula, and subsequently in the growing role and importance of both, ICT implementation into non-informatics subjects, and the computer science teachers in schools of all levels. These teachers should master the new competencies related to the changes brought by the Educational Policy 2030 + in the Czech Republic, which clearly defines the implementation of computer science in non-informatics subjects. Our research aimed to find out, through a field survey, the real situation in the field of professional readiness of ICT teachers in selected primary schools - with special regard to the perception of the situation by professional teachers. The results of our survey showed that especially computer science teachers in primary schools are not sufficiently professionally or technically prepared for the implementation of ICT in the teaching of non-informatics subjects. They also encounter several problems that prevent them from successfully applying the new educational strategy. Our findings are important in terms of current developments when the COVID-19 pandemic completely paralyzed full-time teaching and underlined the importance of the educational environment to be prepared for such exceptional situations while accelerating the implementation of computer science in non-informatics subjects.

Keywords: Information and communication technology (ICT) · Implementation of ICT · Non-informatics subjects · ICT competences · Professional readiness

1 Introduction

Schools across the globe have already closed in the wake of the coronavirus pandemic. As a result, teachers are suddenly faced with the challenge of how to continue their students' education. While this might seem a daunting task, there are several ways teachers can utilise the technology and resources already available to support online learning and ensure students still receive a quality education. In light of the coronavirus,

companies such as Microsoft and Google have opened up the availability of their remote learning tools to schools and are offering support to teachers and students to help them use their resources. One of the biggest concerns for teachers is to be prepared to provide technology-supported learning opportunities for their students. Being prepared to use technology and knowing how that technology can support student learning have become integral skills in every teacher's professional repertoire. Teachers need to be prepared to empower students with the advantages technology can bring. Schools and classrooms, both real and virtual, must have teachers who are equipped with technology resources and skills and who can effectively teach the necessary subject matter content while incorporating technology concepts and skills. Interactive computer simulations, digital and open educational resources, and sophisticated data-gathering and analysis tools are only a few of the resources that enable teachers to provide previously unimaginable opportunities for conceptual understanding.

However, the Czech School Inspectorate found out that only 9.5 per cent of large primary schools meet digital education standards. Within small primary schools, it is only less than 5 per cent. The research aims to find out, through a field survey, the real situation in the field of professional readiness in the teaching of ICT subjects in primary schools - with special regard to the perception of the situation by professional teachers.

2 Theoretical Basis

The skills acquired in the educational area of Information and Communication Technologies allow pupils to apply computer technology using a wide range of educational software and information sources in all areas of their basic education. This application level goes beyond the content of the educational area of Information and Communication Technologies and becomes part of all educational areas of basic education.

The involvement and use of modern technologies in teaching modifies the teaching style, the approach of teachers and pupils to the instruction. It subsequently changes the image of the school, climates at school, processes in teaching, and cooperation of teachers.

2.1 ICT Competency

“Successful integration of ICT into teaching and learning requires rethinking the role of teachers in planning and applying ICT to enhance and transform learning. Education systems need to regularly update and reform teacher preparation and professional development according, ensuring that all teachers can harness technology for education [1]. The UNESCO ICT Competency Standards for Teachers focus on teachers in primary and secondary schools. However, these approaches apply to all levels of education.

New technologies require new teacher roles, new pedagogies, and new approaches to teacher [2]. Teacher professional development is a crucial component of the educational improvement and thus the framework can be used to localize or tailor a teacher competency program as illustrated in Fig. 1.

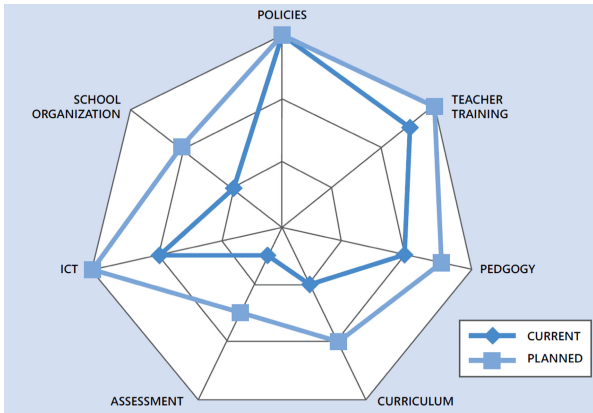


Fig. 1. Example of a teacher competency program.

2.2 Teacher's Professional Readiness in Teaching ICT Subjects

There is a shortage of computer science (ICT) teachers at all levels of schools in the Czech Republic, especially the first stage of primary school (elementary school), as there is no such field at pedagogical faculties. The study is only for the second stage of primary or secondary school (secondary school). In any case, ICT teachers at primary schools in the Hradec Kralove region are ready to develop digital literacy of pupils from the didactic and methodological point of view. As part of the new education policy, they are placed in a new role: to train teachers of other subjects to use ICT technologies in teaching. At present, several subject didactics talk about the information and communication concept of their field, which emphasizes the growing importance of informatics as a science, as a subject and as a necessary basis for the effective use of digital technologies at school and in practical life [3].

Many research studies with a particular focus on ICT (e.g. Hennessy et al., 2005; John, 2005; Watson, 2001) have indicated an apparent conflict concerning whether to use ICT in order to facilitate subject learning, or whether the emphasis should be on demonstrating ways in which ICT can be used and on teaching technical skills [4]. Research findings also emphasize the crucial importance of teachers' awareness about the type of support that ICT can provide, with the purpose of implementing digital resources to enhance pedagogy and pupils' capacity to learn within and across subject domains [5, 6].

Examples from primary classrooms demonstrate that using ICT without a clear method does not bring about progresses and that digital resources need to be matched to the pedagogic intention of the teacher [7]. These outcomes have underlined the necessity to further investigate teachers' integration of ICT in a primary school practice. This need is currently further supported by the situation brought about by the COVID-19 pandemic and the consequent reduction in full-time teaching in schools.

Digital technology is nowadays one of the tools that provides possibilities and limitations in teaching and learning in schools. Teachers should have an available range of methodologies and forms from which they can choose ones that suit their

personality, characteristics and professional orientation. A quality teacher then acquires several selected methods and forms of teaching and then chooses them for the teaching according to the situation, the specific composition of pupils in the classroom and other criteria [8].

2.3 Strategy of Digital Education

Concerning the new role of ICT teachers, which is to train teachers of other subjects to use ICT technologies in the instruction, it is also important to mention the situation in terms of the new Digital Education Strategy. According to the criteria of the Union of School Teachers of Informatics in the Czech Republic, the schools will only be able to teach with ICT, if they have an updated ICT strategy, ICT administrator, make a computer or other device available to more than 50% of teachers, renew computers for pupils after 7 years at the latest, and have sufficient coverage (at least 60% of classrooms) by the internal network for connecting computers.

According to the latest data published by the Ministry of Education, only 14.3% of primary schools meet the minimum criteria for quality teaching and use of ICT in schools. In 33.5% of primary schools do less than half of teachers have a computer, and 9% of primary schools are equipped with the new computers (under five years old) in the classrooms. In a questionnaire survey conducted by the Czech School Inspectorate in 2019 in 5 316 primary schools, teachers mentioned the following reasons that prevent them from implementing ICT in teaching: insufficient equipment 45,8%); lack of time (29,7%); little knowledge of computer operation (28,5%); problems in the organization of the instruction (26,3%); ICT concerns and lack of self-confidence (20,5%); difficulties in linking ICT and learning (14,1%), negative attitude towards ICT in teaching (12,2%), and previous bad experiences (7,7%), see Fig. 2 [9].

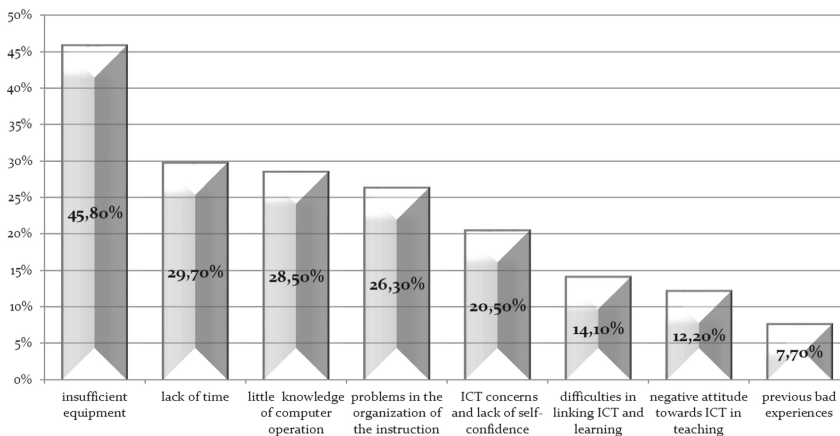


Fig. 2. Reasons that prevent teachers from implementing ICT in teaching.

2.4 The National ICT Curriculum

In connection with the above-mentioned facts, the significant innovation of the national curriculum is needed, namely - to take into account the development of new technologies, its impact on developments in disciplines and related requirements for equipping primary and secondary school graduates with new competencies. The whole general curriculum in the framework of educational programs should be revised and the changes could be divided into three areas:

1. Inclusion of ICT topics in the binding general curriculum. The aim is not to educate IT professionals, it is to develop computational thinking and provide basic insight into the issues of data, information and their processing with the expectation that a certain part of such educated students will be interested in the field of informatics and will continue their studies.
2. The innovation of other educational fields according to how the development of digital technologies has influenced the development in their parent fields and various areas of human activities in general.
3. The condition for the sustainable development of pupils' digital competences means the use of digital technologies by pupils in everyday school work. The new concept is therefore based on the innovations in educational fields, and the expected level of digital competencies is determined by the field problems that the student should be able to solve with the help of technology.

Experience shows that incorporating digital technologies into traditional teaching strategies and working with them using traditional methods does not lead to more effective teaching with better results for pupils [10]. Often the opposite is true. For schools and teachers to prepare pupils for life and work in the world to come, they must work in a different way than usual.

The integration of digital technologies into education and school life is changing established practices. It is a controlled process of transformation that has the same rules and characteristics as introducing any other innovation. Most teachers and schools perceive the need and benefits of using digital technologies and are interested in integrating them into the instruction.

2.5 Subject Didactics as a Starting Point for a Methodical ICT Cabinet

The field or subject didactics can be considered as an exceptionally important area influencing the quality of education. The subject didactics have developed relatively independently as scientific disciplines, over the years they have further developed, specified the subject of their research, developed the relevant methodology, etc. Previously they focused mainly on teachers and teaching, over time the focus is on the pupil and learning in a broader context.

Although subject didactics in the Czech Republic is a relatively young discipline, there are efforts to develop this area. One of the main challenges of subject didactics was the curricular reform, which has been taking place since 2005 and a revision of the framework of the educational programs is currently planned. Subject didactics thus have the opportunity to react and form a new philosophy of subjects and to comment

on the transformation of the curriculum itself [11]. For this reason, it is appropriate to coordinate activities of methodical ICT cabinets with subject didactics and reflect their suggestions to the level of individual subjects, or wider educational areas, as is typical for the concept of transdisciplinary didactics, see the suggested concept of the development of digital and IT competences of pupils, Fig. 3.

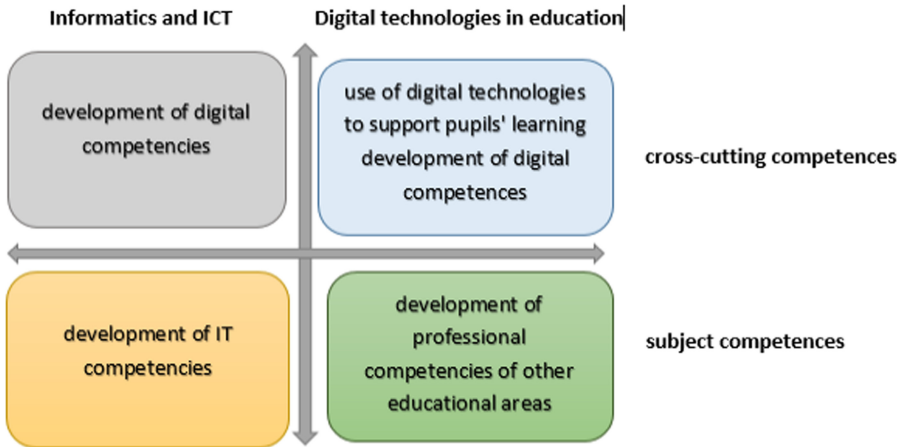


Fig. 3. Concept the development of digital and IT competences of pupils.

In the presented paper, we were focusing on the situation in the field of professional readiness in teaching ICT subjects at primary schools. The emphasis was placed on the perception of the situation by the professional teachers. We detected didactic resources and the overall readiness of ICT teachers for the planned introduction of computer science into non-ICT subjects. The research question was: *How do teachers of ICT subjects at primary schools perceive the specifics of the new role and its management?*¹

3 Methodology

Applied pedagogical research was carried out at primary schools in the Hradec Kralove region, focused on the detection of didactic aids and the overall readiness of computer science teachers for the planned introduction of computer science into non-ICT subjects. Research and data collection was realized directly in the field. The research method we applied was a structured questionnaire. The questionnaire contained two research parts, the first part was focused on exploring a new role (new competencies, subjective satisfaction), and the second part was aimed at the reflection on experience

¹ Note: The basis of the new role is the transmission of competencies of the use of ICT in the education of teachers of other subjects.

(behavioral questions focused on empiricism in transmission, examples of good practice, problem formulation and solutions).

The research group consisted of ICT teachers from the Hradec Kralove region. Inclusive criteria for inclusion in the research group were as follows: ICT teacher with at least 2 years of experience; the teacher was either a member of the Regional Methodological Cabinet of Informatics and ICT (N = 150) or an ICT teacher in selected regional primary school (N = 150, standard research mortality was calculated). Research data were obtained from N = 300 respondents.

Group 1, for details see Table 1, represented ICT teachers with at least 2 years teaching practice, members of the Regional Methodological Cabinet of Informatics and ICT. The Methodological Cabinet of Informatics and ICT (MCI) is designed as a structured professional community of ICT teachers, whose task is, in the context of the mentioned significant changes in the curriculum, to provide support to two groups of teachers:

- Teachers without pedagogical experience (or with minimal pedagogical experience), i.e. those who are just starting in the role of a teacher, typically graduates of teaching studies, or experts from the practice - recent graduates of supplementary pedagogical studies.
- Teachers with pedagogical experience, i.e. practicing teachers who will become acquainted with significantly new educational content and related new teaching methods, forms and strategies.

150 members of this Cabinet took part in our research, three from each district of the Hradec Kralove Region, while each district has its own specifics, such as a large number of so-called small classes, or a lot of pupils from socially excluded localities.

Table 1. Basic input data of the research Group 1.

Gender	N	Age range			ICT proficiency		Teaching experience (years)		Previous degree		
		30s	40s	50s	Qualified	Non-qualified	2	3/more	Bc.	MA/Msc	Ph.D.
F	53	17	23	13	53	0	15	38		50	3
M	97	32	48	17	97	0	29	68		92	5
Σ	150	49	71	30	150	0	44	106		142	8

Group 2, see Table 2, was composed of ICT teachers who have at least two years of teaching experience. From each district (the Hradec Kralove region includes 5 districts), 150 teachers from primary schools, recommended by the Czech School Inspectorate, were selected. Criteria of the Czech School Inspectorate assessed the quality of teaching and the corresponding technical equipment at selected primary schools in the region.

Table 2. Basic input data of the research Group 2.

Gender	Age range				ICT proficiency		Teaching experience (years)		Previous degree		
	N	30s	40s	50s	Qualified	Non-qualified	2	3/more	Bc.	MA/Msc	Ph.D.
F	61	21	34	6	54	7	18	43	7	53	1
M	89	29	46	14	78	11	26	63	11	76	2
Σ	150	50	80	20	132	18	44	106	18	129	3

The obtained data were processed by quantitative analysis procedures: tests to verify the psychometric properties of the questionnaire, descriptive statistics (non-parametric test to compare two or more files - comparison of files concerning monitored variables: length of practice, overall evaluation of experience, etc.). Behavioral questions in the form of open items were administered through procedures of qualitative analysis (categorical analysis) and computational linguistic analysis (keyword detection, frequency analysis).

4 Research Results

4.1 Research in the Field of a New Role of ICT Teachers

In the first part of our research we focused on the exploration of a new role of ICT teachers as mediators in the triad teacher – pupil – ICT in a non-IT subject. When creating the structured questionnaire, we took an example from the ICT competence framework of UNESCO and focused on five competencies concerning the new role of ICT teacher at school (mediator in the implementation of ICT in non-IT subjects): 1) Communication 2) Digital Competency 3) Connecting theory and practice 4) Adaptation to the use of a new role 5) Motivation. The structured questionnaire contained a total of 12 questions, which included the key concepts: professional readiness, the available offer of methods and forms of teaching, support from school management, opportunities for further education, linking digital technologies and curricula, technical readiness of the school, fear of losing authority over colleagues, technical school readiness.

The non-parametric U-test of Mann and Whitney was used to evaluate given answers. The Likert scale, where 1 meant “definitely no” and 5 meant “definitely yes” was applied. Based on the determination of the p-value from the test, the null hypothesis (for every question) was accepted or rejected. The null hypothesis was set as follows: the answer of Group 1 is identical or similar to the answer of Group 2. Therefore, if a statistically significant difference was detected, the p-value was printed in bold, see Table 3. If there was no statistically significant difference between the answers of the groups (the null hypothesis was not rejected), the p-value in Table 3 was indicated in a basic font.

Table 3. Comparison of responses of Group 1 and Group 2.

Question	p-value
Question 1	0,279
Question 2	0,006
Question 3	0,0002
Question 4	0,810
Question 5	0,023
Question 6	0,003
Question 7	0,253
Question 8	0,0002
Question 9	0,023
Question 10	0,006
Question 11	0,003
Question 12	0,003

The results of the first part of the research clearly showed that ICT teachers who are members of the Methodological Cabinet (Group 1) are in all respects much better prepared for the planned changes in the position of ICT teachers at schools. Only in the first and fourth questions of the questionnaire survey there was a statistical agreement. It was a question of professional qualification (Are you professionally prepared for teaching ICT?) and support from school management (Do you have the support of the school management to get prepared for the new role?).

4.2 Qualitative Analysis (Categorical Analysis) and Computational Linguistic Analysis (Keyword Detection, Frequency Analysis)

In the second part of our research we aimed at behavioral questions (empiricism in transmission, examples of good practice, problem formulation and solutions). Figure 4 and Fig. 5 show the key words which appeared in Group 1 (Fig. 4) and Group 2 (Fig. 5) in the open answers most frequently.

During the interview with ICT teachers in Group I (members of the Regional Methodological Cabinet of Informatics) and Group 2 (ICT teachers at selected primary schools), we monitored the occurrence of keywords and their frequency as teachers answered the submitted behavioral questions. The procedures of qualitative (categorical) and computational linguistic analysis (keyword detection, frequency analysis of lemmas) were used.

The results of the survey showed that most often in both groups there are concerns about the insufficient quality of technical equipment of schools (group 1–92%, and Group 2–90%) and also about the implementation of modern ICT technologies in the teaching process (Group 1–82%, Group 2–80%). On the other hand, there has been a fundamental difference in the approach to communication skills (Group 1–30%, Group 2–80%), where ICT teachers from Group 2 were concerned that the lack of qualified communication competencies would prevent them from cooperating smoothly with

teachers of other subjects. This can consequently, in the opinion of the respondents, cause a decline in professional prestige among colleagues. This output is consistent with the results of similar research in the world, e.g. K. Hakkarainen from Finland, who pointed to the existing discrepancy between ICT teachers’ pedagogical principles that commonly emphasized active construction of knowledge, and their self-reported pedagogical practices [12].

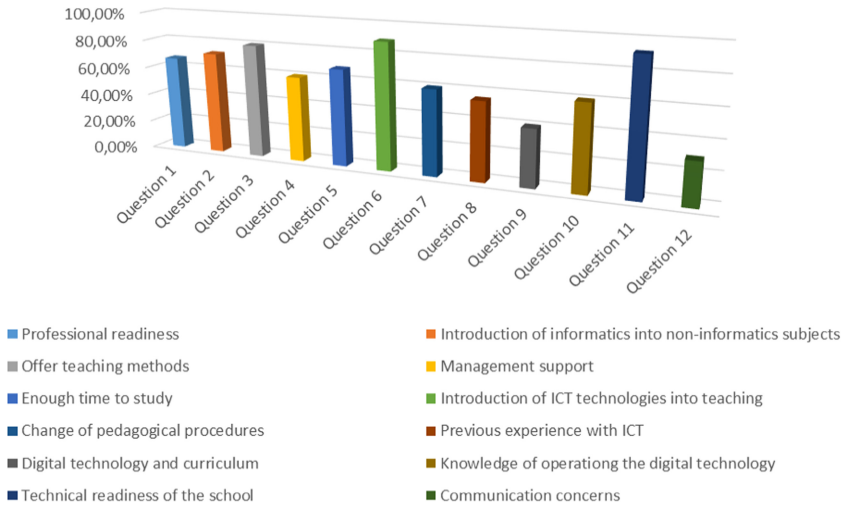


Fig. 4. Frequency of keywords in Group 1 (members of the Regional Methodological Cabinet).

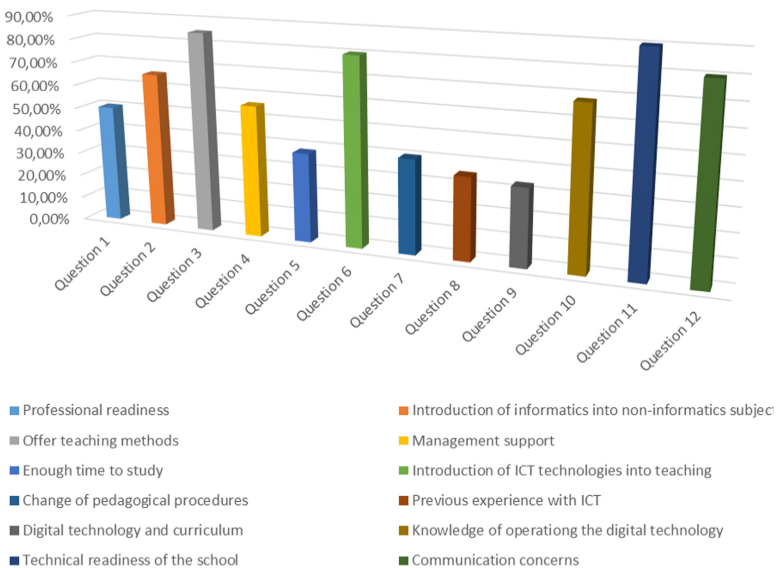


Fig. 5. Frequency of keyword in Group 2 (ICT teachers at selected primary schools).

5 Implications and Conclusions

The implementation of ICT in non-IT subjects is becoming an inevitable step towards the smooth provision of teaching, as we could see at the time of the coronavirus pandemic and the subsequent closure of schools. The failure of full-time instruction and the transition to teaching in the cyber environment has proven the growing importance of the role of the computer science teacher as a methodologist and a mentor in the implementation of ICT to other subjects. The question remains whether ICT teachers are professionally prepared for their new role. It is clear that at least in the Czech Republic, the preparation of teachers for the implementation of ICT in subjects is not yet fully ensured. Although this issue is partially included in the teaching of subject didactics and methodology, it is still not taken as a separate subject.

Our field research pointed to several other problems that schools of all levels gradually encountered, whether it was insufficient technical equipment of schools, absence of quality ICT methodology, fear of teachers in the application of ICT in teaching, legislative unpreparedness for distance learning, lack of quality educational materials in the field of support for distance education and subject didactics, etc. As the research of the Faculty of Education in the Hradec Kralove region (conducted in spring 2020) showed, 30–40% of children did not participate in online education during the COVID-19 pandemic in the Czech Republic. These children skipped lessons not only because of the absence of a computer or good internet connection but simply because this method of teaching does not suit them and their parents did not motivate them to work in an online environment. This issue, however, was not the subject of our research, although it is certainly interesting and would merit a more detailed study.

The results of our research confirmed that most teachers are still not methodically and didactically sufficiently prepared for the new role of ICT teacher, which carries the elements of a mentor. Unfortunately, there are currently not enough quality training programs to help existing ICT teachers complement their communication and mentoring training. Teachers working in Methodological Cabinets have a better starting position, because they are informed well in advance about the steps of the Ministry of Education and they also have sufficient training in communication due to their position. One of their main activities is mapping the situation in the ICT teaching and networking of teachers interested in closer cooperation. Future teachers at pedagogical faculties do not yet have a specific subject that would allow them to prepare for the role assigned to them by the 2030+Educational Strategy in the Czech Republic. Should the situation, urged by the COVID-19 pandemic, changed and the pedagogical programs for future teachers would incorporate the communication competency and mentoring aimed at knowledge sharing skills, the authors believe that the ICT implementation into non-informatics subjects will improve. It is important as ICT have become the transversal axis of all teaching activities in which they almost always have three functions: they are an instrument in learning processes, a tool for information processing and implicit learning content.

Acknowledgement. This paper is supported by Specific research 2020 at the Faculty of Education University of Hradec Kralove. Special thanks go to the dean's office of the Faculty of Education for support, students Jana Novotna and Andrea Cernikova, for assistance in data collection in the field.

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