Perception of Digital Competences of Future Teachers at the Faculty of Science of Palacký University in Olomouc

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Abstract

The paper deals with the importance of the development of digital competencies during the pedagogical training of future science teachers at the Faculty of Science of Palacký University in Olomouc. It emphasizes the issue of information thinking, which is increasingly required by professions. One of the questions for IT students related to algorithms and programming was included in the questionnaire survey. This is due to the fact that these are the two main pillars of IT concepts in the context of changes in education in the Czech Republic. The results of the survey led to a clear conclusion regarding the use of educational robotics. This tool is a suitable tool for personality development, logical thinking, creativity and teamwork. The use of mathematical software in science subjects generally allows the students (future teachers) to better understand the context, cultivate their sense of imagination and teach them this way of thinking.

Key words: Digital competence, computer thinking, pedagogical training, robotics.

Vnímání digitálních kompetencí budoucích učitelů na Přírodovědecké fakultě Univerzity Palackého v Olomouci

Abstrakt

Příspěvek se zabývá významem rozvoje digitálních kompetencí během pedagogické přípravy budoucích učitelů přírodovědných předmětů na Přírodovědecké fakultě Univerzity Palackého v Olomouci. Zdůrazňuje problematiku informačního myšlení, které je vyžadováno stále více profesemi. Do dotazníkového šetření byla zařazena jedna z otázek pro studenty informatiky týkající se algoritmizace a programování. Důvodem je skutečnost, že se jedná o dva hlavní pilíře pojetí IT v kontextu změn ve vzdělávání v České republice. Z výsledků šetření vyplynul jednoznačný závěr týkající se využití výukové robotiky. Ta je vhodným nástrojem pro rozvoj osobnosti, logického myšlení, kreativity a týmové spolupráce. Využití matematického softwaru v přírodovědných předmětech obecně umožňuje žákům (budoucím učitelům) lépe pochopit souvislosti, rozvíjet jejich smysl pro představivost a naučit je tomuto způsobu myšlení.

Klíčová slova: Digitální kompetence, počítačové myšlení, pedagogické praxe, robotika.

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Introduction

Changes in society, influenced by the development of digital technologies and their use in various areas of human activity, require a continuous adjustment of the strategy for education. The reality of today's education is increasingly focused on a constructivist approach to teaching aimed at individualizing the teaching process in order to put forward transmissive methods that suppress the development of the student's personality and are focused on the verbal monological concept of teaching. The development of computer thinking among students is not important due to only the shortage of IT specialists in the labor market, but mostly due to the fact that computer thinking is required by more and more professions. Informatics thinking can also be used to solve everyday situations. At the same time, it helps with the acquisition of skills, problem solving, creativity or the ability to structure (MŠMT, 2014).

1 Digital competence in relation to digital literacy

The work points out the importance of the development of digital competencies in the educational training of future science teachers. The current concept of digital competences is based on their understanding as the ability to use relevant knowledge and skills in a creative way. The basic framework of digital literacy, which includes not only technical skills, but also relevant knowledge and attitudes, contains a total of seven sub-competence areas (Ala-Mutka, 2011):

- Information management – identify, locate, retrieve, store and organize information
- Collaboration – connect with others in online networks and communities, communicate constructively
- Communication and sharing – communicate through online tools with security and privacy considerations in mind
- Creation of content and knowledge – integrate and rework previous knowledge and content, build new knowledge
- Ethics and responsibility – to behave ethically and responsibly, to be aware of legal frameworks
- Assessment of problem solving – identify digital needs, solve problems using digital means
- Technical activities – use technology and media

According to the European Commission Joint Research Center (DigCompEdu, 2013), the most important digital competences include:

- Working with information – the search for digital content and its processing is becoming more important. It also includes information evaluation, critical assessment, analysis, organization and storage.
- Communication and collaboration – digital media are means of communication. Communication and collaboration requires purposeful interactions and the ability to share through digital technologies. At the same time, it enables participation in civic activities. For these activities carried out in the digital environment, it is necessary to know and respect information ethics and be able to take care of your digital identities. Be able to acquire, assess, manage and share data, information and content using digital technologies.
- Creating digital content – the third area of digital skills is called digital content creation. This includes not only the creation of new, but also the reworking or remixing of existing digital content. To get everything right, you need to understand copyright and licenses. In order for the student to be able to solve some problems or perform some tasks, he should orientate himself in the basics of algorithmization and programming.

- Security – security includes multiple sub-areas, from the protection of computer equipment to the protection of personal data and privacy to the protection of health, maintaining the quality of life and protecting the environment.
- Problem solving – solving technical problems arising when working with digital devices, as well as selecting and using adequate digital tools and appropriate technological solutions. Creative use of technology, innovation of traditional practices and collaboration with others in the field are seen as increasingly important. It is important to improve your digital competences due to the dynamically developing digital technologies following Industry 4.0.

Digital competence is an essential 21st century skill for teachers and students. Research (NCES – National Center for Education Statistics, 2013) shows that 40 % of the EU population does not have sufficient digital competence and 22 % of citizens do not use the Internet.

It emphasizes the need for pedagogical training in undergraduate preparation and the perception of digital competences by students – future teachers.

2 Pedagogical training from the point of view of different authors

Buchberger and Busch (1983) define pedagogical training as acquiring skills directly related to the teaching process to encourage the ability and willingness to actively apply theory in practice. It is a part of the study, influenced by experienced teachers in the school responsible for practical training.

Clift et al. (1990) view teaching training as an area in which the student can develop their own teaching as a form of research and experimentation, with many forms of guidance from an experienced teacher.

Vonk (1985) defines pedagogical training as an opportunity for learning to learn, as learning situations for future teachers in teacher education, which are systematically confronted with possible practice, concrete teaching activities and classroom management in school, led by special lecturers and practicing teachers.

Šimoník (2005) understands pedagogical training as an inseparable part of undergraduate teacher preparation, which is only a stage in the practical training of a teacher, as it is not possible to practice everything that we expect from a teacher. It points to the necessity of connecting pedagogical training with theory. Šimoník (2005) claims that pedagogical training should be a discipline integrating the theoretical and practical components of teacher training.

Průcha, Walterová and Mareš (2001) characterize pedagogical training as part of the practical preparation of teachers and educators at the faculties preparing teachers. The

main goals of the training are: combining the theory and practice of all components of university preparation, introducing the future teacher to the conditions of a real school environment and training him in the activities of the teaching profession.

According to Nezvalová (2007), it follows from the indicated definitions that pedagogical training is understood as an opportunity for students to use their theoretical knowledge, to verify their didactic skills and, based on observing the activities of experienced teachers and reflecting on their own activities, to create individual concept of teaching from all these elements.

2.1 Approach to creating professional skills of future teachers at the Faculty of Science of the Palacký University in Olomouc

The Section of Pedagogical Training of the Faculty of Science of the Palacký University in Olomouc provides pedagogical training for future science and mathematics teachers. As part of their study programs, future teachers complete the first and second continuous teaching training. These trainings give an opportunity to recognize the educational activities of the school as a whole. Students acquire skills that are directly related to the teaching process. During these trainings, they develop subsequent skills, which we consider to be key during the first teaching training. These include the following (Nezvalová, 2007):

1. Planning and preparation for the lesson
2. Realization of the lesson
3. Management of the lesson
4. Classroom climate
5. Evaluation of student results
6. Reflection of own activity and evaluation

Planning and preparation have a clear purpose and goal, where the educational content and methods correspond to the educational needs and abilities of the pupils and the desired outcomes. The lesson must be structured in such a way that it always follows on from previously learned concepts in an appropriate way and creates prerequisites for the clarification and understanding of subsequent and related concepts. In the implementation phase of the lesson, the future teacher in the role of facilitator of the student's learning presents the planned content using appropriate organizational forms and teaching methods that will lead to the achievement of the planned teaching goals. The future teacher develops skills leading to the successful achievement of set goals. A student of teaching can already effectively monitor the results of his activities, correct his procedures, monitor the activities of pupils and provide feedback.

A practicing future teacher creates a positive classroom climate with his attitudes and behavior and corrects any inappropriate behavior of some students. As part of the

reflection, he should be able to recognize those aspects of himself that require further improvement and associated development.

Future teachers learn to apply all these skills in a specific situation at school in the presence of experienced teachers.

2.2 Organization of the first continuous teaching training at the Faculty of Science of the Palacký University in Olomouc

Continuous pedagogical training is implemented in the first year of the follow-up master's study, in the summer semester lasting 3 weeks. A student who intends to carry out continuous training submits an application. All documentation (date of training, list of students registered for training, placement of students at individual schools, information for students on the course of training, forms) is located on the website of the Section of Pedagogical Training (http://cpp.upol.cz/). The staff of this Section will provide students with the necessary recommendations at the information meeting. The student does not secure the training independently, but on the basis of his application, Section staff carry out the necessary administrative activities (communication with the school management, list of students doing continuous pedagogical training at the school, information about the course of continuous teaching practice, requirements for the course of continuous teaching training, Agreement for the head teacher). The student's teaching activity at the respective school is evaluated by the head teacher of the school on the appropriate form.

During the pedagogical preparation of future teachers, the future teacher becomes familiar with basic theoretical pedagogical and didactic knowledge and skills, which he applies in his activities in a real school environment, thus creating his initial individual professional skills and attitudes under the guidance of experienced school teachers. As part of pedagogical training, emphasis is placed on the development of the teacher's personality. As Dytrtová and Krhutová (2009) state, pedagogical training and theory prove that any ideal content of education is an indifferent phenomenon by itself, and the driving force is the personality of the teacher and the methods of education that the teacher uses.

2.3 Formulation of the problem

How do future science teachers who have undergone only theoretical training in their undergraduate training perceive their readiness in the field of digital literacy and computer thinking? Do students whose field of study includes IT have sufficient know-how as to how to teach algorithmization and programming? (Klement & Dragon,2020).

3 Research Methodology

In our research we applied the methods of theoretical analysis and synthesis, analysis and comparative analysis of theoretical sources. A questionnaire was applied as a basic empirical method for the purposes of the survey. It was an online graphic interactive questionnaire. Selected items of the questionnaire were conceived as graphic objects that the respondent could manipulate. This is because the use of graphic objects ensures a faster response. Emphasis was also placed on motivational elements.

A total of 50 first-year follow-up students in science teaching took part in the questionnaire survey, of which 44 % were women and 56 % were men. Empirical methods focused on proportional stratified selection – Chráska (2003) – were chosen for our own research (Chráska, 2003). A questionnaire was presented to students (immediately after the end of the first continuous pedagogical training), which aimed to find out how future teachers perceive their readiness for the first continuous pedagogical training in the field of digital literacy and computer thinking. We understand digital competences as cross-cutting key competencies, without which it is not possible to develop other full-fledged key competencies in children and pupils. Their basic characteristic is the application in various activities and solving various problems. This results in their variability over time, depending on how the way and use of digital technologies in society and in human life changes.

The questionnaire contained a total of 10 complex questions. One of the first questions concerned the ability to develop the use of new technologies in different processes and in different situations (Table 1). None of the respondents answered the question "How are you able to develop the use of digital technologies in different situations?" in a clearly negative way (*definitely no*), the answers *rather yes* and *rather no* were almost balanced. Among women, there were also answers of *definitely not*.

Table 1
How are you able to develop the use of digital technologies in different situations?

	Men		Women	
	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency
Definitely yes	21 %	6	0 %	0
Rather yes	46 %	13	43 %	9
Rather no	33 %	9	57 %	13
Definitely no	0 %	0	0 %	0

Another question (Table 2) was about digital content creation, i.e., whether students are able to express themselves through digital media and technology. This question was also meant to determine the extent to which students were able to include various web applications in their teaching, such as Kahoot, wordwall.net, flippity.net and Google Slides. The students stated that, for example, within wordwall.com it was possible to verify in an entertaining way the basic knowledge that is needed for further work. In addition, 30 % of students said that Google Slides and flippity.net could be used to create popular escape games that are styled based on popular themes.

Table 2

Are you able to include various web applications in your teaching?

	Men		Women	
	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency
Definitely yes	0 %	0	0 %	0
Rather yes	78 %	22	71 %	16
Rather no	22 %	6	29 %	6
Definitely no	0 %	0	0 %	0

What is interesting is the fact that none of the interviewed students answered *definitely yes*, and none of them gave the answer *definitely no*. Students – future teachers are aware of the need to include various web applications in their teaching. They are aware of the fact that every teacher should be able to effectively identify those resources that suit the educational objectives, the group of pupils and the teaching method. They realize that technology is capable of improving the quality of teaching in many ways. Furthermore, they realize that the teacher should have the ability to plan and implement the use of digital technologies at different stages of the learning process.

The third question concerned the extent to which future teachers can assess information applicable to schoolwork. Positive responses appeared in both men's and women's responses. Both investigated groups clearly answered *rather yes*. None of the respondents answered *definitely yes*. The reason for their answers is the fact that the students have minimal experience of teaching in primary or secondary school.

The fourth question concerned the issue of assessing the credibility of information from the Internet and its use. Finding and obtaining information, security, copyright and ethics showed complete agreement in the answers of both groups (men, women). It can be said that respondents identified it as key for the development of digital competences.

The fifth question related to information on whether future teachers had the opportunity to use digital tools to communicate with pupils. Most of them stated that due to the possibility of implementing continuous pedagogical training in face-to-face form, most of them did not use this possibility.

Another question (Table 3) concerned the ability to search for electronic information on a given topic. Both investigated groups chose the unequivocal answer to a greater extent, namely yes. It is worth noting the fact that none of the students gave the answer *rather no*, *definitely not*.

Table 3

Can you figure out where to find electronic information on a given topic?

	Men		Women	
	Relative frequency	Absolute frequency	Relative frequency	Absolute frequency
Definitely yes	54 %	15	29 %	6
Rather yes	46 %	13	71 %	16
Rather no	0 %	0	0 %	0
Definitely no	0 %	0	0 %	0

As part of the survey, we included two open-ended questions regarding the importance of certain topics in the teaching of informatics. These questions were asked only to IT students.

It became clear that future IT teachers considered the computer science topics they know best to be important. They usually consider topics that are not so much their own to be unimportant. For the majority of respondents, it turned out that algorithmization and programming appear to be very important topics. It is worth mentioning here that all students clearly agreed on its importance. Informatics thinking "develops the ability to analyze and synthesize, generalize, find appropriate problem-solving strategies, and validate them in practice. It leads to the accurate expression of ideas and procedures and their recording in formal records, which serve as a general means of communication" (MŠMT, 2014).

According to the research of Klement and Dragon (2020), the lack of teaching materials for pupils and methodical materials for teachers seems to be a big problem at the moment.

3.1 Discussion

The results of the questionnaire survey brought a number of interesting suggestions for improving the educational preparation of future teachers. Future teachers are aware of the need to develop digital competences. They realize the importance of their development in connection with the development of creative and critical thinking. They are aware of necessity of connecting IT thinking and creativity to the content and process of education at all types and levels of schools. This integration has been emphasized in strategic documents (UNESCO, 2005).

Most of the students answered the questions positively. It should be emphasized that future teachers are able to use digital technologies at least partially in their teaching. They mostly focused their attention on the creation and implementation of educational presentations. All students are able to search for relevant information on the Internet. They would also be able to use selected web applications in teaching. They realize the importance of creating their own electronic portfolios and personal learning environments. Future teachers are also aware of the risks associated with cyber security and health protection.

In their responses, IT students also mentioned the importance of using robots in teaching. The use of robots makes it possible to materialize the abstract behavior of algorithms and programs. Robotics provides hands-on experience with real-world problems and can reduce fear of unfamiliar concepts. Robotics generally develops fine motor skills in students. It supports creativity in finding alternative solutions.

The questionnaire survey also produced a number of stimulating suggestions for improving the concept of pedagogical trainings:

- inclusion of listening and assistant training during bachelor's studies,
- enabling tandem teaching within training,
- extension of continuous training,
- mutual communication training between teacher and pupil,
- practical training of various forms and methods of teaching within the framework of branch didactics,
- use of digital technologies in different stages of the learning process
- available methodology explaining the use of educational web applications.

It can be unequivocally stated that the first continuous teaching experience fulfilled the students' expectations. Although some students encountered unexpected problems, they always managed to deal with them properly. The training was also beneficial in that some students clarified whether or not they wanted to devote themselves to teaching work only during it. Respondents evaluated their own professional erudition very positively. On the methodological side, however, they themselves perceived significant shortcomings. In their answers, future IT teachers also mentioned the lack of methodological materials for teachers. They also pointed out the lack of teaching

materials for pupils. In their statements, IT students said that Informatics generally supports the development of IT thinking and understanding of the basic principles of digital technologies. Informatics leads students to experience that teamwork together with technology can lead to better results than individual work. Informatics, according to the opinions of IT students, leads to communication using formal languages that can be understood even by machines and many other competencies. Informatics thinking, according to the IT students, develops persistence when working with difficult problems and thus the ability to solve open problems.

Conclusion

In the field of digital competences, it is necessary to focus on the transfer of knowledge in the field of information and communication technologies into the process of teaching science subjects. The use of various software for validation of results, possible procedure of solving examples and also visualization of a specific issue should be the standard of a modern teacher.

The use of mathematical software in science subjects allows the student (future teacher) to better understand the context. Mathematical software develops the imagination and teaches the computer way of thinking.

Future IT teachers often do not have enough experience with learning programming or lack the methodological background for teaching it. A possible solution is educational robotics, one of the most promising tools for the development of computer science and programming. Its advantage is that it attracts students and adds to the motivation in teaching. Robotics enables the visualization of the taught material (Dytrtová & Krhutová,2009).

In the Czech Republic, there has not been a big shift in the attitudes of current IT teachers over the last ten years. Czech education is currently undergoing modernization. The Strategy 2030+ has become a key document for the development of the Czech Republic's educational system in the decade 2020–2030. This document is aimed at the modernization of framework educational programs. Adjustments to the framework educational programs are intended to support two strategic goals. The first one is to focus education more on acquiring the competencies needed for civic, professional and personal life. The second one is to reduce inequalities in access to quality education and enable the maximum development of the potential of children, pupils and students. Key competences and literacy will support and strengthen the continuity of individual levels of education. Digital competence was included as a new one. Digital competence is based on the concept of cross-sectional development of pupils' digital literacy. Emphasis is placed especially on the use of digital technologies in teaching and learning (NÚV, 2022).

The trend of robotics, coding and gamification in education is constantly growing worldwide. Robotics as support for the teaching of (not only) technical fields in schools is a connection that cannot be doubted at all. In addition to educational value, it develops fine motor skills, logical thinking, students' creativity in searching for alternative solutions, their creative abilities, imagination and fantasy (Hyksová, 2021).

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