Research Article https://doi.org/10.12973/eu-jer.11.3.1729

European Journal of Educational Research
Volume 11, Issue 3, 1729 - 1745.
ISSN: 2165-8714
http://www.eu-jer.com/

Analysis of Requirements for the Digital Competence of a Future Teacher

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Received: January 23, 2022 ▪ Revised: March 11, 2022 ▪ Accepted: June 7, 2022

Abstract: The article discusses the topical issue of a model of digital competencies for a future teacher. The analysis of the composition and structure of the most relevant models of digital competencies of a citizen and a modern teacher is carried out. In addition, the article reveals approaches to the formation of the content of digital competence, and provides the results of an empirical study, which consists in analyzing the results of a survey of practicing teachers and teacher-training students in order to identify the most demanded digital competencies of a future teacher. The article substantiates the authors' content of the competence of a future teacher, a university student. The purpose of this article is to develop a theoretical model of digital competence of a future teacher, taking into account the dynamic technologisation of the modern world and the peculiarities of Russian education, based on an analysis of approaches to determining the content of its digital competencies. According to the analysis of studies, the issue of teachers' digital competence is not sufficiently disclosed. Numerous studies on digital competencies of a person, teacher, etc. do not fully solve the problem of assessing the digital competence of future teachers.

Keywords: *Assessment of digital competence, content of digital competencies, digital competence, digital competence of a future teacher, education structure.*

To cite this article: Galimullina, E. Z., Ljubimova, E. M., Mukhametshina, D. R., & Sozontova, E. A. (2022). Analysis of requirements for the digital competence of a future teacher. *European Journal of Educational Research*, *11*(3), 1729-1745. https://doi.org/10.12973/eu-jer.11.3.1729

Introduction

Relevance of the Problem

Digitalization is the main modern trend in the development of the economy and society, based on the transition to a digital format for presenting information, which is aimed at increasing the efficiency of the economy and improving the quality of life (Zubarev, 2020). The digitalization of the economy is primarily focused on increasing its efficiency and competitiveness. It is obvious that the transition to the digital economy is currently one of the key priority areas in many countries. The leaders of the "digital race" were the United States of America, China, and the countries of the European Union (Anisimova et al., 2020; Aznar-Díaz et al., 2019). Ala-Mutka (2011) notes that "there are different perspectives on what these new skills and competencies should include, though they typically agree that digital competence is an integral part of them" (p. 39). Employers need more flexible competencies (Claro et al., 2012; Öztürk, 2020; Panova et al., 2020), interpersonal and related to information and communication technologies (ICT) (Erbilgin & Şahin, 2021; Van de Oudeweetering & Voogt, 2018).

Researchers suggest that digital competence is acquired at school and university (Hoe et al., 2021; Ilomaki et al., 2016; Kalimullina et al., 2021), which generates great interest in this issue in international education research. Brox (2017) notes that "in the last decade, much effort has been put into defining the specific demands on new teachers' digital skills and to how they should be strengthened in their training". Most scholars point out that a teacher is a key figure in the development of the modern education system. Ala-Mutka (2011), Aesaert et al. (2013), Hoffmann (2017), Ilomaki et al. (2016), and others think that modern society requires the emergence of a "new type" of the teacher who will possess a system of certain competencies, including digital ones.

The works by Marais (2021), Movchan and Yakovleva (2019); Tsakeni (2021), Volkova and Petrova (2019), Van den Beemt and Diepstraten (2015), and others are dedicated to studying the issue of teachers' digital competence. An integrated approach to the content in the field of digital technologies is reflected in the United Nations Educational,

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Scientific and Cultural Organization (UNESCO) recommendations. The works by Carretero et al. (2017), Erstad (2010) are dedicated to the assessment of digital competence. The assessment systems iSkills, ICT, DigCom, etc. are noteworthy.

According to scientists, many traditional functions of a teacher are losing their significance in the digital educational process (Balganova, 2021; Blinov et al., 2020; Tarman & Kilinc, 2022; Volkova et al., 2020). A bearer of the new functions should be a teacher-training student. A future teacher must possess a system of certain competencies, including digital ones, since this specialist will prepare the younger generation for life in new, dynamically changing living conditions, characterised by ever-increasing technology (Garcia, 2021; Otts et al., 2021; Saenko et al., 2019). Consequently, the identification of new professional competencies of a future teacher that are in demand in transforming education and their assessment is the most important task.

Purpose and Objectives of the Study

The purpose of the study is to develop a theoretical construction of a model of digital competence of a future teacher, taking into account the dynamic technologisation of the modern world and the peculiarities of Russian education, based on an analysis of approaches to determining the content of its digital competencies.

Research objectives are as follows:

- to analyse the composition and structure of digital competence of a modern person;

- to analyse the requirements for the digital competence of a modern teacher, approaches to the formation of its content;

- to conduct an empirical study, which consists in analyzing the results of a survey of practicing teachers and teacher-training students, in order to identify the most demanded digital competencies of a future teacher;

- to substantiate the composition and block structure of the digital competence of the future teacher;

- to form a theoretical construction of a model of digital competence for a future teacher.

Literature Review

Conceptual Field of Digital Competence

An important human competence is the ability to work digitally, as digital technologies are rapidly developing in the modern world, which leads to an expansion of the terminology that describes digital competence. This has led to a "complex landscape of definitions and concepts" (Ala-Mutka, 2011). Referring to such multiple concepts as "a tangled ball of concepts" (Aesaert et al., 2013), and other researchers question the lack of a paradoxical understanding of the concepts associated with the implementation of digital competence in the educational sphere (Evans-Amalu & Claravall, 2021; Korableva et al., 2019; Medvedeva & Mitina, 2021; Pettersson, 2018). In a literature review, to examine the use of the term "digital competence" in the period 2005–2013; Ilomaki et al. (2016) found that the term "digital competence" was a relatively new term in the reviewed scientific articles, with significantly more frequent use of the term "digital literacy".

In Scandinavia, the concept of "competence" is given a different meaning and is often used instead of "literacy", "because the latter term is not translated into the languages of these countries" (Erstad, 2010). In their works, Janssen et al. (2013) indicate a number of reasons for replacing the concept of digital competence with the concept of digital literacy. They argue that digital literacy is more often used in European principles and approaches to the organization of e-learning, and the concept of digital competence is used in pedagogical communities. Aesaert et al. (2013) speak of digital competence as "the complex and functional use of digital knowledge, skills, and attitudes". Ilomaki et al. (2016) argue that the concept of digital competence is associated with an activity approach, which means "there is a transition from a content (and knowledge-based) approach to assessment to a competency-based approach with an emphasis on "new skills for new jobs" (Ilomaki et al., 2016).

The report of the European Commission traces the idea that digital competence includes digital literacy and is its foundation (European Parliament and the Council., 2006). Similarly, Pettersson (2018) notes that "generally speaking, digital competence often refers to the skills and literacy required by the average citizen to be able to learn and navigate the digital knowledge society". Thus, we can conclude that many authors do not see a significant difference between the concepts of "literacy" and "competence". For example, in the understanding of some authors, the concept of digital literacy is collective and consists of descriptors corresponding to knowledge and skills (Abulhanova et al., 2019; Arki et al., 2015; Greene et al., 2014; Ng, 2012), which corresponds to the concept of digital competence described above. In this study, the authors adhere to the concept of "digital competence". However, the authors also use the concept of "digital literacy" where its interpretation will require a deeper meaning. In addition, the question of what requirements are imposed on digital competence remains open.

Analysis of Digital Competency Models

In order to form the content of digital competence, it is necessary to analyse the available approaches to determining the structure and content of digital competencies. The following are the results of an analysis of various sources containing a description of models of digital competence of various categories of persons – a modern citizen, a practicing teacher, a university student in general, and a teacher-training student.

Digital Competence of a Citizen

Below are the most complete and relevant models of citizens' digital competencies.

1. Analysis of "Model of Competencies of the Digital Transformation Team in the Public Administration System" by Shklyaruk and Garkusha. The structure and content of competencies developed by the authors (Shklyaruk & Garkusha, 2020) do not have a pronounced specificity and can be used to build similar competence models (see Table 1).

Table 1. Model of Competencies of the Digital Transformation Team in the Public Administration System

Blocks of competencies	**Block composition**
Basic digital competencies	Digital consumption Digital competencies Digital security
Personal competencies	Focus on results Customer centricity Communication Emotional intelligence Creativity Critical thinking
Professional competencies	Digital development management Organisational culture development Management tools Data management and use Application of digital technologies IT infrastructure development
Digital culture	Digital competence of government civil servants Customer focus of state digital services/products/services Focus on data, not on opinions and interpretations Digital collaboration Flexibility and risk acceptance

This model shows that, in comparison with the already adopted approaches to the formation of the content of competence models, the personal qualities of a person take priority positions. This emphasises the importance of the shift from professional and subject competencies to personal qualities of any person, such as the ability to work with people, the self-regulating and goal-setting abilities, a focus on results, and the ability to take into account people's interests in order to achieve common goals. In this regard, the opinion of many researchers coincides with that of the authors: personal qualities will always take a priority position, since all education is aimed at a person, at the personality formation, therefore, when building this model, the authors will rely on this idea.

Analysis of "Target Model of Competencies 2025 of Sberbank Corporate University"

Sber (formerly Sberbank) is one of the leaders in the IT services market in Russia and is developing approaches to the formation of relevant competencies for the future, including digital ones. They highlight the concept of meta-competency (Katkalo et al., 2018). According to the company's specialists, the category of meta-competencies includes inalienable personality traits: the ability of an individual to realise his/her own strengths and weaknesses of intellectual aspects, the way he/she acts in various circumstances when solving problems, the use of skills and knowledge and the ways to compensate for missing competencies (see Table 2).

Table 2. Target Model of Competencies 2025 of Sberbank Corporate University

Blocks of competencies	Block composition
Cognitive skills	Self-development Achieving results Time management skills Solving non-routine tasks Managerial skills
Socio-behavioral skills	Communication Interpersonal skills Intercultural interaction
Digital skills	System implementation: Information management:

Firstly, it should be emphasised that the items describing cognitive skills in this model differ from the classical ones, which usually include sensation, perception, thinking, memory, attention, and imagination. Secondly, the developers paid attention to the social and behavioral sphere, where communication comes first, from the culture of appearance to the culture of speech and communication. Interpersonal skills are considered important in this model: teamwork, ethics, empathy, customer focus, stress management, and adequate perception of criticism, i.e., those skills that are necessary for every person to function successfully in society. Digital skills are taken to the next level. Nowadays, a person is not only required to process and analyse information but also to manage it. In addition, in the future, the main positions will be occupied by the design and creation of production systems, and programming.

Analysis of the "Talent Development Capability Model"

The well-known American Association for Talent Development presented a model (Association for Talent Development, 2018), which structurally consists of three components (see Table 3).

Table 3. Talent Development Capability Model

Building Personal Capability	Developing Professional Capability	Impacting Organisation Capability
Communication	Learning Sciences	Business Insight
Emotional Intelligence and Decision-Making	Instructional Design	Consulting and Business Partnering
Collaboration and Leadership	Training Delivery and Facilitation	Organisation Development and Culture
Cultural Awareness and Inclusion	Technology Application	Talent Strategy and Management
Project Management	Knowledge Management	Performance Improvement
Compliance and Ethical Behavior	Career and Leadership Development	Change Management
Lifelong Learning	Coaching	Data and Analytics
	Evaluating Impact	Future Readiness

The emergence of such commercial projects emphasises the relevance of the issue under study in the formation of a model of digital competencies, their assessment, and the development of online resources for practical application. In the practice-oriented model, the personal qualities of a successful person in a dynamically changing digital world are especially manifested. This is indicated by such positions as emotional intelligence, cultural awareness, "compliance" and ethical behavior, etc. The model meets the requirements of leading companies around the world; therefore, the ideas of its structure can be used to build such models. The authors of this article have taken into consideration the components called "personal" and "technological".

Analysis of the "Digital Competence Framework for Citizens"

The European Digital Competence Framework for Citizens, also known as DigComp, offers a model (Carretero et al., 2017) consisting of five competence areas (see Table 4).

Table 4. The Digital Competence Framework for Citizens

Competence areas	Competence
Information literacy	Browsing, searching for and filtering data, information, and digital content Data, information, and digital content assessment Data, information, and digital content management
Communication and collaboration	Digital interaction Digital exchange Civic digital participation Digital collaboration Online etiquette Digital identity management
Digital content creation	Digital content creation and development Digital content integration and processing Copyright and licenses Programming
Safety	Device protection Personal data protection and confidentiality Health and well-being protection Environmental protection
Problem solution	Solving technical problems Identifying needs and technology solutions Creative application of digital technologies Identifying digital competence gaps

In the DigComp Model for Citizens, as well as in the previous digital competence models analysed by the authors of this article, there is a Digital Literacy Block. It includes basic digital competencies – the minimum required level of knowledge and skills for their successful application in practice. It is assumed that digital literacy is formed on the basis of reflection skills for self-development in a digital environment. This is especially important for the construction of the Competency Model of a future teacher since a teacher needs intensive professional development to a greater extent than his/her senior colleagues. In order to identify the most suitable positions of this model for the formation of a matrix of digital competence of a future teacher, the authors of the article have identified actions that will presumably become the basis for the formulation of descriptors: to contact, cooperate, solve, create, and provide.

Digital Competence of a Teacher

Analysis of "UNESCO ICT Competency Framework for Teachers"

The ICT Competency Framework for Teachers (ICT CFT) Version 3 is a tool to guide pre-service and in-service teacher training on the use of ICTs across the education system (UNESCO ICT Competency Framework for Teachers, 2018). According to the UNESCO ICT Competency Standards (ICT-CST), modern teachers must work in electronic information and educational environment. The main idea is that teachers with sufficient competencies to use ICT in their professional practice will be able to provide high-quality education and, ultimately, will be able to effectively contribute to the development of students' ICT competencies. This model consists of six aspects (see Table 5).

Table 5. UNESCO ICT Competency Framework for Teachers

Blocks of competencies	Block composition
Aspect 1. Understanding the role of ICT in the education policy	Understanding the policy Policy enforcement Policy innovation
Aspect 2. Curriculum and assessment	Basic knowledge Knowledge application Skills needed in a knowledge society
Aspect 3. Teaching practices	The use of ICT in education Complex problem solving Self-organisation
Aspect 4. Digital skills	Application Integration Transformation
Aspect 5. Educational process organisation and management	Traditional forms of educational work Cooperation groups Learning organisations
Aspect 6. Professional development of teachers	Digital literacy Networking Teacher as an innovator

The analysed model is strictly focused on the pedagogical activity of a school teacher and differs significantly in the structure and content from those studied earlier in this article. The analysis of this source showed that a three-level approach to the formation of a digital competence model was the most appropriate and could be used by the authors to design a digital competency model for teacher-training students. It is also necessary to pay attention to the presence in this model of such components inherent in previously analysed models as digital skills (technological part), professional development (personal abilities), and pedagogical activity (professionalism).

Analysis of the "Digital Competence Framework for Educators (Digcompedu)"

In 2018, the NAFI Analytical Center, on behalf of the Russian Federation, joined the work of the European Commission's expert group on the development of the structure of digital competencies for educators. The result of the joint expert work was the European Digital Competence Framework 2.0 for Educators: DigCompEdu (Redecker, 2017) (see Table 6).

Table 6. Digital Competence Framework for Educators (DigCompEdu)

Blocks of competencies	**Block composition**
1. Professional interaction	Communication with colleagues and students Professional collaboration Reflexive practice Continuous professional development using digital technologies
2. Digital resources	Selection of digital resources Creation and modification of digital resources Governance, protection, and exchange of digital resources
3. Teaching and learning	Teaching Educational guidance Cooperative learning Self-regulatory learning
4. Student assessment	Assessment strategies Analysis Feedback and planning
5. Extending students' rights, opportunities, and independence in the learning process	Ensuring all students have access to digital devices Differentiation and personalisation Students' active involvement
6. Development of students' digital competence	Information literacy Communication and collaboration in a digital environment Digital content creation Responsible use of digital technologies Problem-solving through digital technologies

Comparing the UNESCO and DigCompEdu digital competence models, attention should be paid to differences in the initial goals. The UNESCO recommendations were developed with the purpose of organizing training for teachers in the use of ICT both during their professional training and in the process of work, and the European Digital Competence Framework for Teachers is focused primarily on the assessment of digital competence by teachers as a result of completing a survey. Both models contain six (6) blocks or aspects (groups) of competencies with common points of contact. The authors of this article carried out a comparative analysis of competencies, which is presented in the figure below (Figure 1).

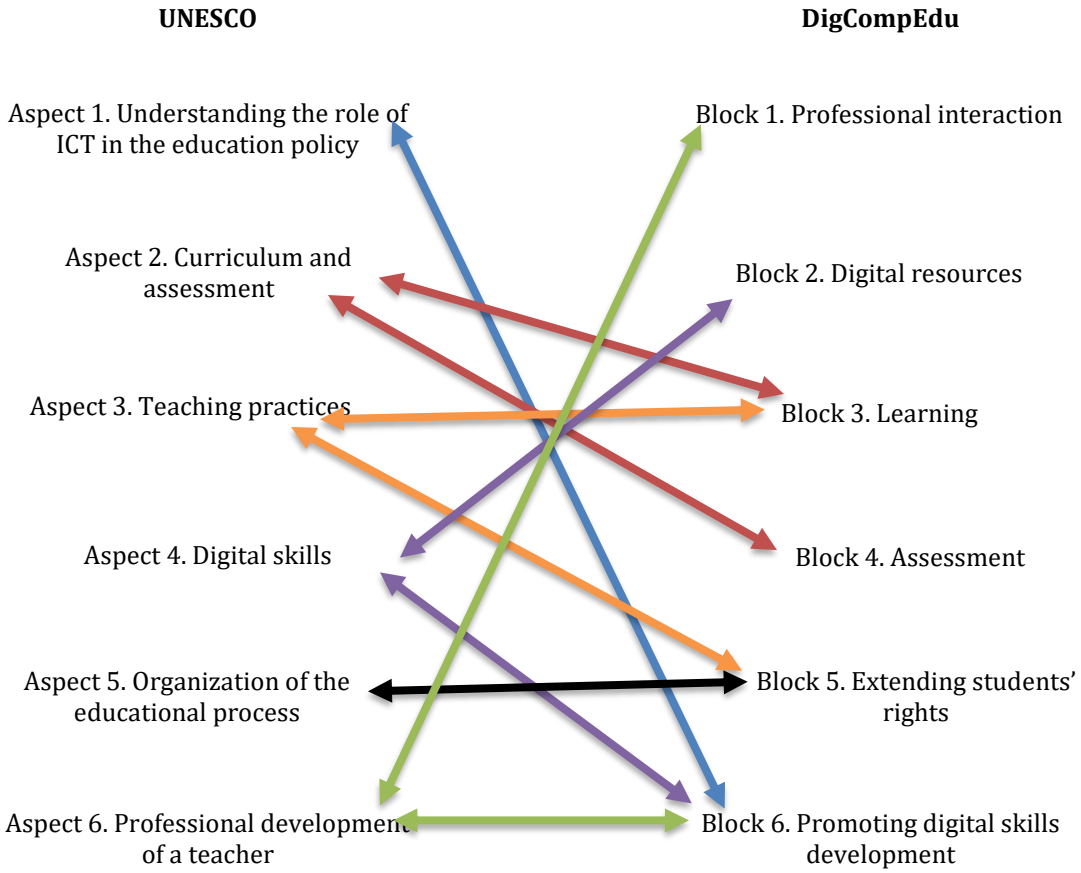


Figure. 1. Comparative Analysis of UNESCO and DigCompEdu Digital Competence Models for Teachers

Based on the fact that the questionnaire is well suited for practicing teachers who can confidently state whether they are currently performing certain actions on the use of ICT, it cannot be applied in assessing the digital competencies of a student who cannot answer such questions, even if he/she undergoes teaching training. In this study, the authors will use the developments of the European model, while moving away from the questionnaire approach to tests, practical tasks, cases, etc.

Digital Competence of a Student

Analysis of the Concept of Development of Students' Digital Competencies of the National Research University Higher School of Economics ("NRU HSE")

NRU HSE specialists are implementing the data culture project, which resulted in the development of a concept of the development of digital competencies, which describes an approach to the formation, development, and measurement of digital competencies in students (National Research University Higher School of Economics, 2020). The developers of the data culture project distinguish five levels of mastering digital competence: initial, basic, advanced, professional, and expert levels. Each next level is the development of the previous one in terms of the volume of skills as the ability to solve a wider range of problems. For each field of study at the undergraduate level, the NRU HSE educational standard defines the minimum required level of mastering digital competence: from elementary to advanced. The professional and expert levels of mastering digital competence are not widespread; therefore, they are not recorded as the minimum necessary and are achieved within the framework of certain specialist fields or individual educational trajectories. These studies confirm the need for a level-by-level approach to building a model of digital competencies and their assessment. Structurally, the authors define three main content components; it is obvious that they are specialised in nature, since NRU HSE is engaged in the training of IT personnel.

Analysis of approaches to the formation of students' digital competencies and recommendations for the development and implementation of competencies in digital literacy at Nizhnevartovsk State University

Researchers of the Nizhnevartovsk State University Volkova and Petrova offer their own approach to the formation of students' digital competencies and general recommendations for the development and implementation of competencies in digital literacy (Volkova & Petrova, 2019). In the authors' opinion, these competencies should be taken into account in building an individual educational trajectory of a future professional.

Researchers have identified three levels of the mentioned digital competencies:

1. Fundamental level: digital literacy, focused attention, counting, reading comprehension, self-efficacy, working memory, writing.

2. Medium level: time management, prioritisation, sequence of actions.

3. Master level: business conduct, protocol and proper job search.

This study confirms the idea of the three-component nature of the digital competence model, the importance of developing the personal qualities of a university student. In the formation of new models of digital competencies of various population groups, it is necessary to focus on cognitive abilities, which include perception, memory, emotional intelligence, thinking, imagination, etc.

Analysis of the Model of Student ICT Competence by Sekulich

Sekulich presented the author's model of ICT competence, which includes three main components: value-motivational, information-technological, and communicative ones (Sekulich, 2017) (see Table 7).

Table 7. Model of Student ICT Competence by Sekulich

Blocks of competencies	**Block composition**
Value-motivational block	Conscious need to master competencies A high need for self-education, self-improvement by means of ICT Awareness of the role of ICT for a modern specialist
Information-technological block	Ability to design one's own software product in various forms Ability to process numerical data using statistics and visualisation tools Formed skills of search selection, selection of relevant information sources
Communicative block	Knowledge of various ways of organizing communication Knowledge of video conferencing tools, webinars, streams Ability to keep business correspondence by e-mail in compliance with netiquette Skills of working with social networks, blogging for education, self-education

According to the authors, the model presented by Sekulich does not take into account the need to focus on the profession, and only the value-motivational component stands out from the personal qualities. This is due to the fact that this model is aimed at junior students who have just started to master the profession. For this target audience, according to the author of the model, communicative components will be more important, this is explained by the need for active interaction of junior students in the information educational environment. Based on this, the authors come to the conclusion that different tools are needed for assessing students' digital competencies, by means of which it will be possible to focus on a certain aspect (component) of digital competence, depending on the level (related to a specific stage of training) of mastering the competence, at which a student currently is.

Digital Competence of a Future Teacher

For several years, researchers have been trying to identify technology competencies to be mastered by future teachers in the transition to the information society (Lee & Lee, 2014; Valtonen et al., 2015; Van den Beemt & Diepstraten, 2015) and in the development of IT tools for building effective trajectories for the training of future teachers (Arki et al., 2015; Isaikina et al., 2021; Tondeur et al., 2016, 2017). According to Marcelo and Yot-Domínguez, in order to integrate technology into the learning process, teachers need to develop training practices based on three interdependent components, including the learning content, the pedagogical model underlying the learning process, and technological resources chosen by a teacher at a certain point in time (Marcelo & Yot-Domínguez, 2015). Yachina and Fernandez (2018) assume that for the successful formation of digital competencies of a future teacher, it is necessary to create conditions for joint work in specialised university laboratories with modern equipment, which will contribute to its effective and creative application in future pedagogical activities.

The study of scientific information sources showed that the matrix of digital competencies of a future teacher has not been developed, in the literature there is only a description of requirements for digital training of a teacher and individual competencies of a future teacher. Therefore, it can be concluded that currently there is a contradiction between the need to assess the digital competence of future teachers and the lack of models that could be taken as a basis when forming a competence matrix and developing an online tool for assessing the level of formation of such competencies in a future teacher.

Methodology

Research Design

The study used both qualitative and quantitative methods. In order to substantiate theoretical conclusions and develop a model of digital competencies of a future teacher, qualitative methods such as the analysis and generalisation of scientific works of educational researchers, psychologists, methodologists, futurologists are used, and a comparative analysis of models of digital competencies among citizens and teachers is carried out. Structurally, the study has three components. The content of the first component is aimed at forming the conceptual field of digital competence of the modern person. The work on this component was carried out according to the following algorithm. The authors consistently carried out the search for publications, screening, assessment, and inclusion in the analysis. As a result, to determine the conceptual field of this study, fifteen (15) main conceptual, most significant sources were selected and analysed, the time interval of which ranges from 2011 to 2018.

The methodological unit of the second component is implemented by searching for and analyzing publications in three directions covering the requirements for digital competencies of a citizen (a successful representative of the digital economy), a teacher, and a student in order to determine the key most relevant competencies of a future teacher, to build a model of his digital competencies. As a result, the authors analyse four (4) models of a digital citizen, two (2) models of a teacher's ICT competencies, and three (3) models of a digital university student. The analysis and theoretical understanding of the material of sources in this component were implemented to determine the availability or lack of relevant practice-oriented models for the formation of digital competencies of a future teacher.

To collect and process the results of an empirical study, the authors used quantitative methods, which are included in the third component of the work. The study consists in conducting a survey of practicing teachers and teacher-training students to identify the most relevant and demanded digital competencies. The results obtained at the second stage are validated through the survey. The tool for organizing the survey was online quick feedback services with automatic processing of results. As a result, graphic visualisation of the data was obtained and statistical analysis was carried out. Based on the results obtained at the first three stages of the study, a theoretical construction of a model of digital competence of a future teacher is formed.

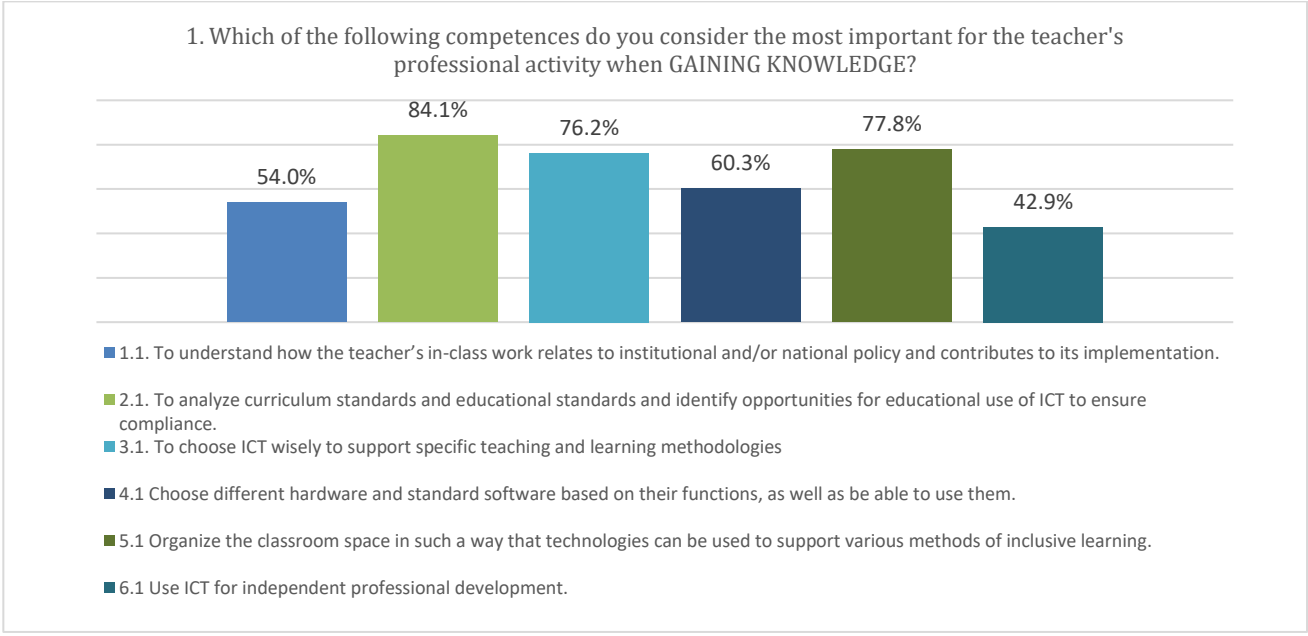
Data Collection

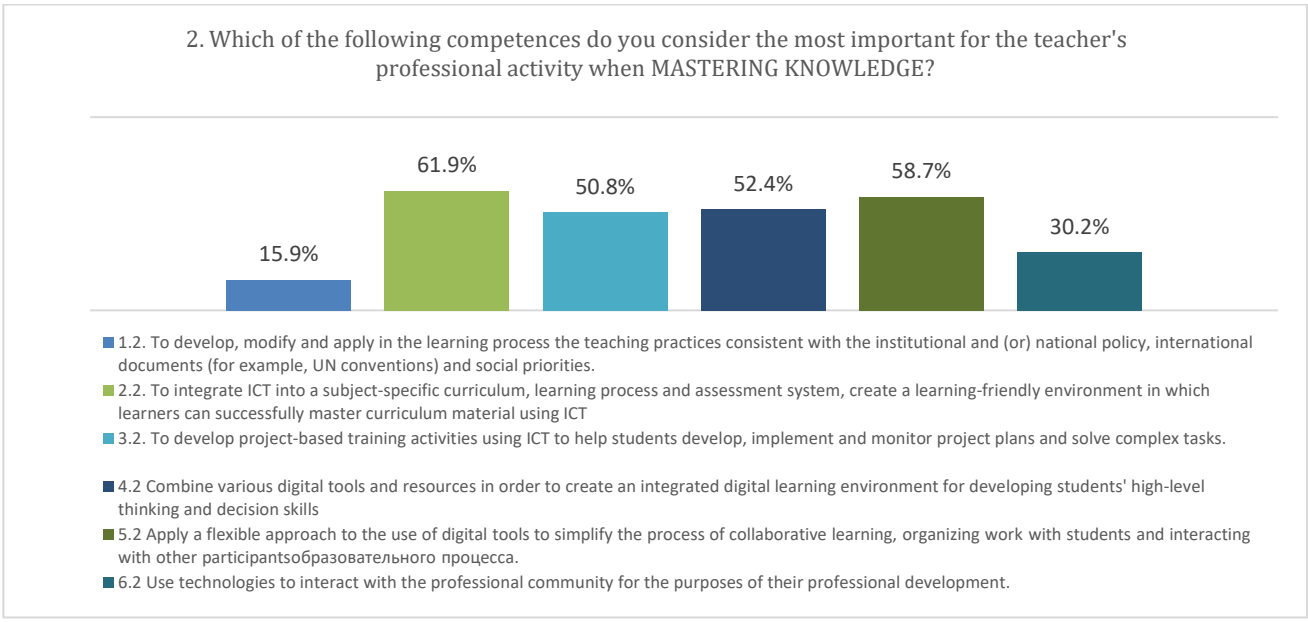
The empirical base of the study was formed by the results of a survey of two groups of respondents in the amount of 1,154 people. The first group (522 people) included teachers from schools of the Republic of Tatarstan, such as Elabuga, Naberezhnye Chelny, Nizhnekamsk, Mendeleevsk, Almetyevsk, Zainsk, Chistopol, Agryz, Mamadysh, and Kukmor. Most of the teachers interviewed were at the age of 46 to 55, which amounted to about 40%. Almost 90% of the respondents were female. Moreover, the ratio of the number of humanities teachers to natural science teachers was 2:3. The second group (632 people) consisted of teacher-training students studying at the Kazan Federal University. The first- and second-year students made up 56% of the respondents. Among the students, 82% were girls. About 52% of respondents were trained in teaching natural science disciplines. The relevance of the survey is also justified by the experience of using digital tools in organizing distance learning acquired by teachers during self-isolation. The questionnaire consists of questions based on the competencies specified in the UNESCO recommendations, as they were developed by experts from more than 20 countries.

Results

Analysis of the Survey of Teachers and Students

Based on the analysis of scientific sources, the authors of the study came to the conclusion that it was necessary to conduct a survey among teachers of the Republic of Tatarstan and students of the Elabuga Institute of Kazan Federal University in order to identify the most demanded digital competencies in practice (Figure 2, Figure 3).





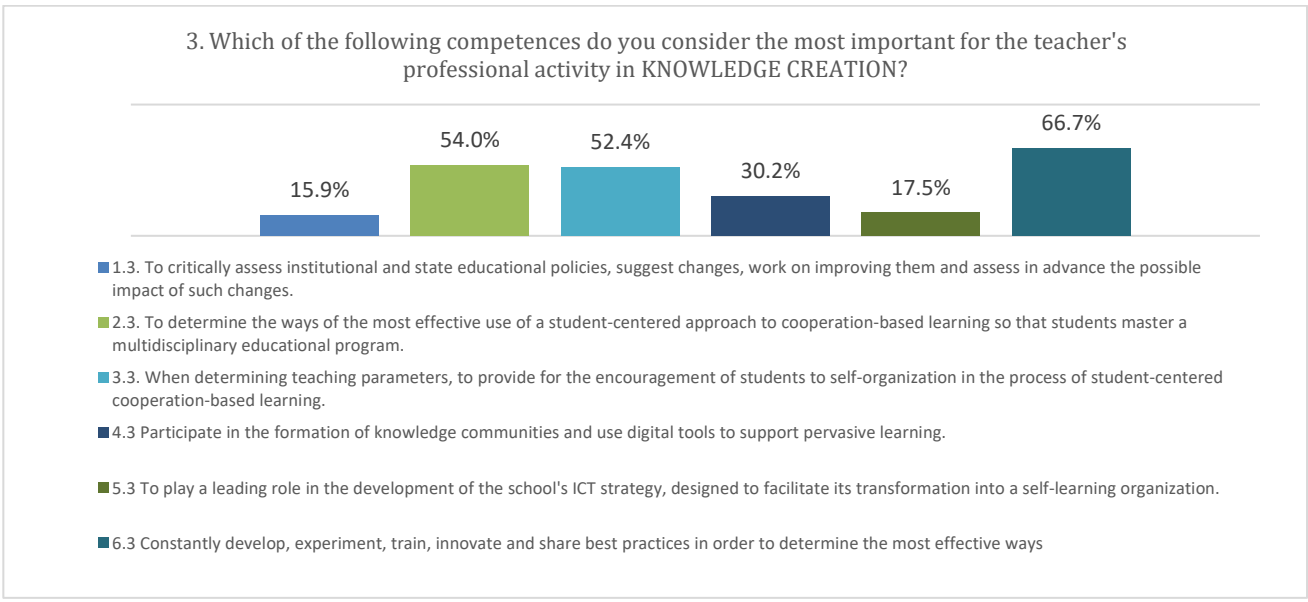
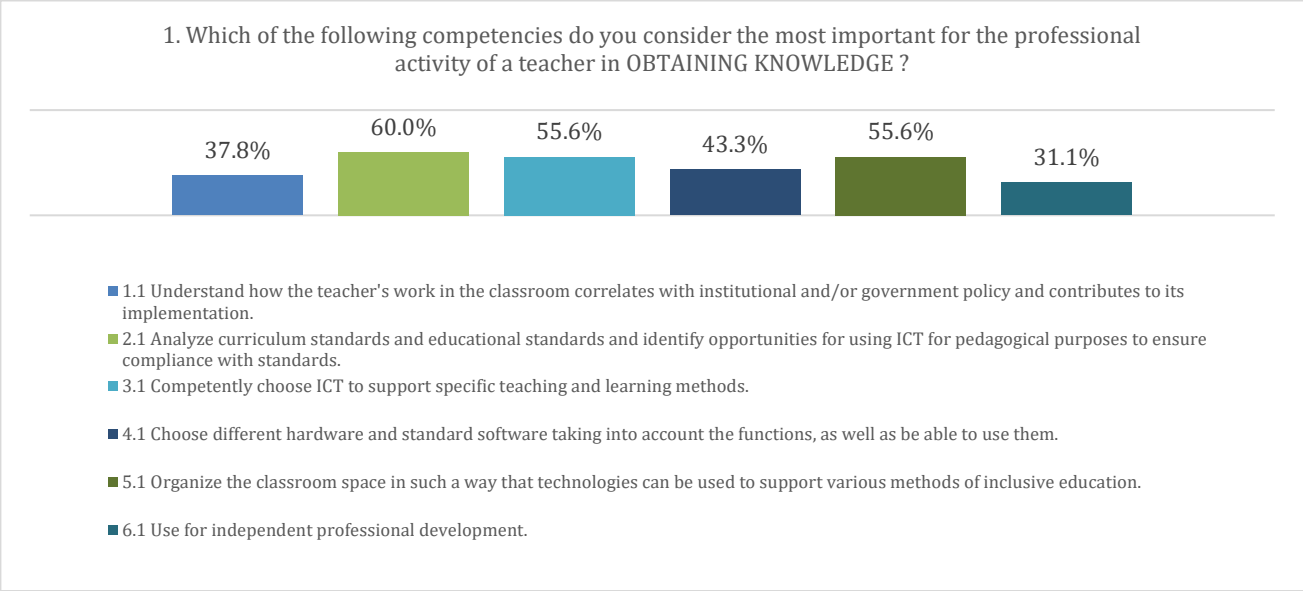
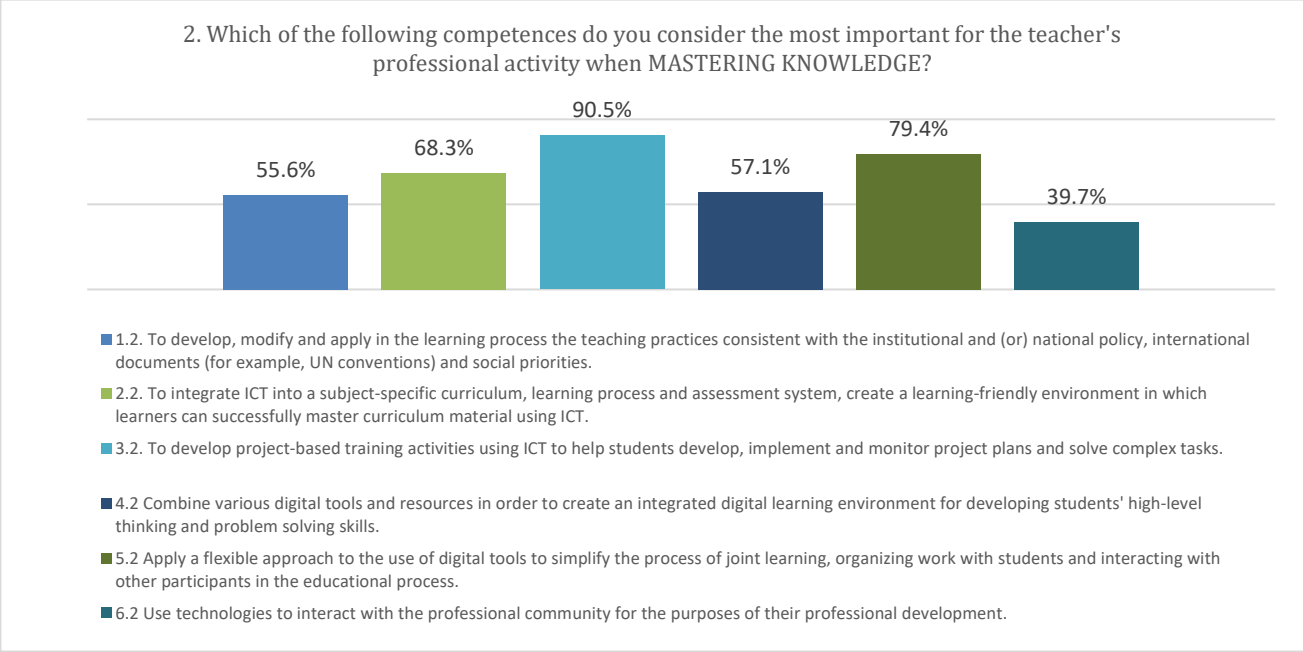


Figure 2. In-Demand Digital Competencies. Survey of Teachers





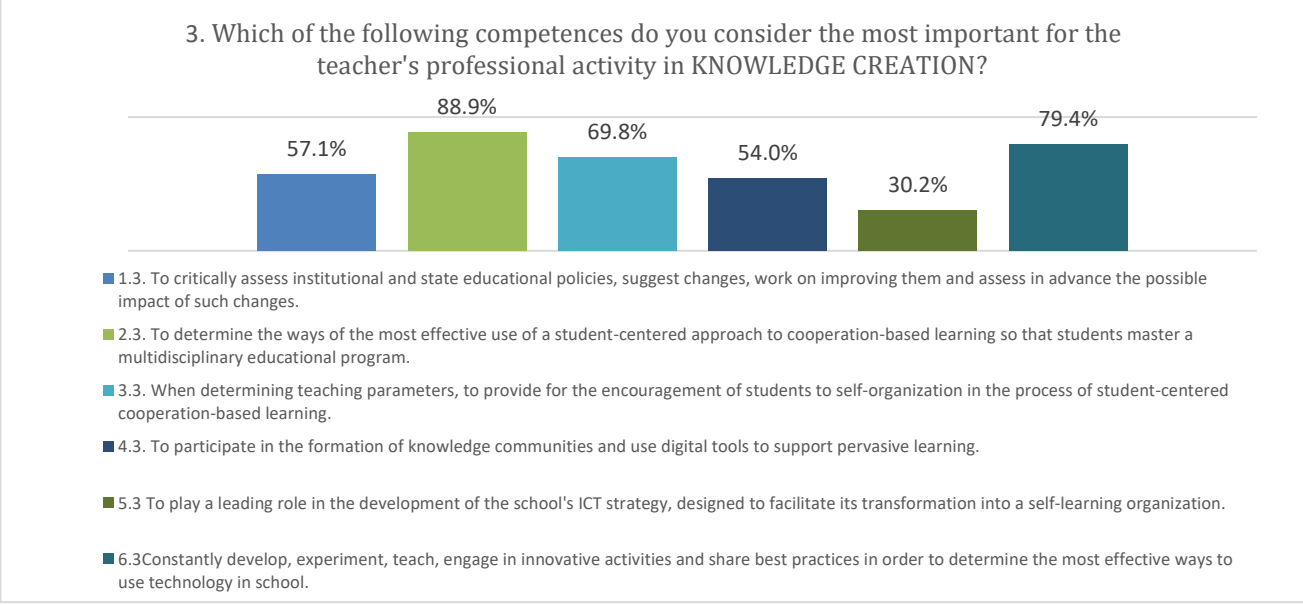


Figure 3. In-Demand Digital Competencies. Survey of Students

The survey shows that over 70% of teachers note that it is important to choose ICT wisely to support specific teaching and learning methods. The lowest percentage was received by positions related to educational policy and standards. Thus, positions related to the choice of digital tools and their practical application turned out to be of priority. In contrast to teachers, students in all survey positions showed more even results. This confirms the authors' assumption that it is wrong to subject students who have no pedagogical experience to the assessment of competencies with a tool similar to that used for practicing teachers. Thus, the priority competencies for students are associated with the design of the educational process (this idea will be further reflected in the formation of the theoretical construction of a model of digital competence of a future teacher).

Building a Model of Digital Competence of a Future Teacher

In order to develop a theoretical construction of a model of digital competence of a future teacher, taking into account the dynamic technologisation of the modern world and the peculiarities of Russian education, a comparative analysis of the results of the study of various digital competence models will be conducted. The analysis of the models of citizens' digital competencies, showed the need to include in the structure of digital competence of any person, and hence a future teacher, a block of personal qualities and abilities. The list of personal competencies indicated in these models is somewhat different; however, there are common positions, from which the authors have highlighted as follows: teamwork, ethics, empathy, stress management, adequate perception of criticism, self-regulating and goal-setting abilities, focus on results, critical thinking, systematic thinking. In this regard, the opinion of many researchers coincides with that of the authors: personal qualities of a person will always take a priority position, since all education is aimed at a person, at the personality formation, therefore, the authors will take this into account when developing their own model.

The analysis of the models of teachers' digital competencies, allowed the authors to identify groups of competencies and determine a level approach to the structure of a future teacher's competence. Thus, the competence model will determine the structure and composition of the required competencies, highlighting the most significant of them and dividing them into certain groups. The UNESCO ICT Competency Framework for Teachers is different in structure and content from the other models discussed in this article. Here are three levels of competence formation, which will be used in the design of the model by the authors of this study. An attempt to analyse the division into groups of competencies in various currently available models of digital competence for teachers led to the need for a detailed comparison of two teacher-oriented approaches (UNESCO and DigCompEdu) (see Table 8). The comparative analysis confirmed the idea that all the mentioned competencies should be divided into the following groups: personal, technological, and professional ones. These groups of competencies are based on basic competence (digital literacy), which should be inherent in any person engaged in intellectual activity.

Table 8. Comparative Analysis of UNESCO Models of Digital Competencies in Citizens and Teachers

Groups (aspects)	**UNESCO**	**DigCompEdu**
Technological	ASPECT 4 Digital skills	BLOCK 2 Digital resources BLOCK 6 Development of students' digital competence
Personal	ASPECT 6 Professional development of teachers	BLOCK 1 Professional interaction BLOCK 6 Development of students' digital competence
Professional	ASPECT 1 Understanding the role of ICT in the education policy ASPECT 2 Curriculum and assessment ASPECT 3 Teaching practices ASPECT 5 Educational process organisation and management	BLOCK 6 Development of students' digital competence BLOCK 3 Teaching and learning BLOCK 4 Student assessment BLOCK 3 Teaching and learning BLOCK 5 Extending students' rights, opportunities, and independence in the learning process BLOCK 3 Teaching and training BLOCK 5 Extending students' rights, opportunities and independence in the learning process

The analysis of the models of students' digital competencies, described above of this article, confirmed the idea of the three-component model of digital competencies of a future teacher. In addition, these models also indicate the dynamic nature of the model, taking into account the student's progress along the trajectory of professional growth. This leads to a level approach both in the design of the model and later in the assessment of digital competencies. Therefore, in order to determine the digital competence of a future teacher, different assessment systems are needed, depending on the stage of training at which a student currently is. Figure 2 and Figure 3 shows the gradual progress of a student by levels of mastering new competencies and deepening existing ones: from technological competencies, based on digital literacy, to professional ones, which a future teacher masters in the fourth and fifth year of study. Thus, the ability to interact in obtaining new knowledge and methods of activity in the information educational environment comes to priority positions for junior students. For senior students, one of the most valuable competencies is the ability and willingness to

manage their activities, organise the work of students, as well as create new digital educational content and design information learning environments. The analysis allowed constructing the following author's model (Figure 4).

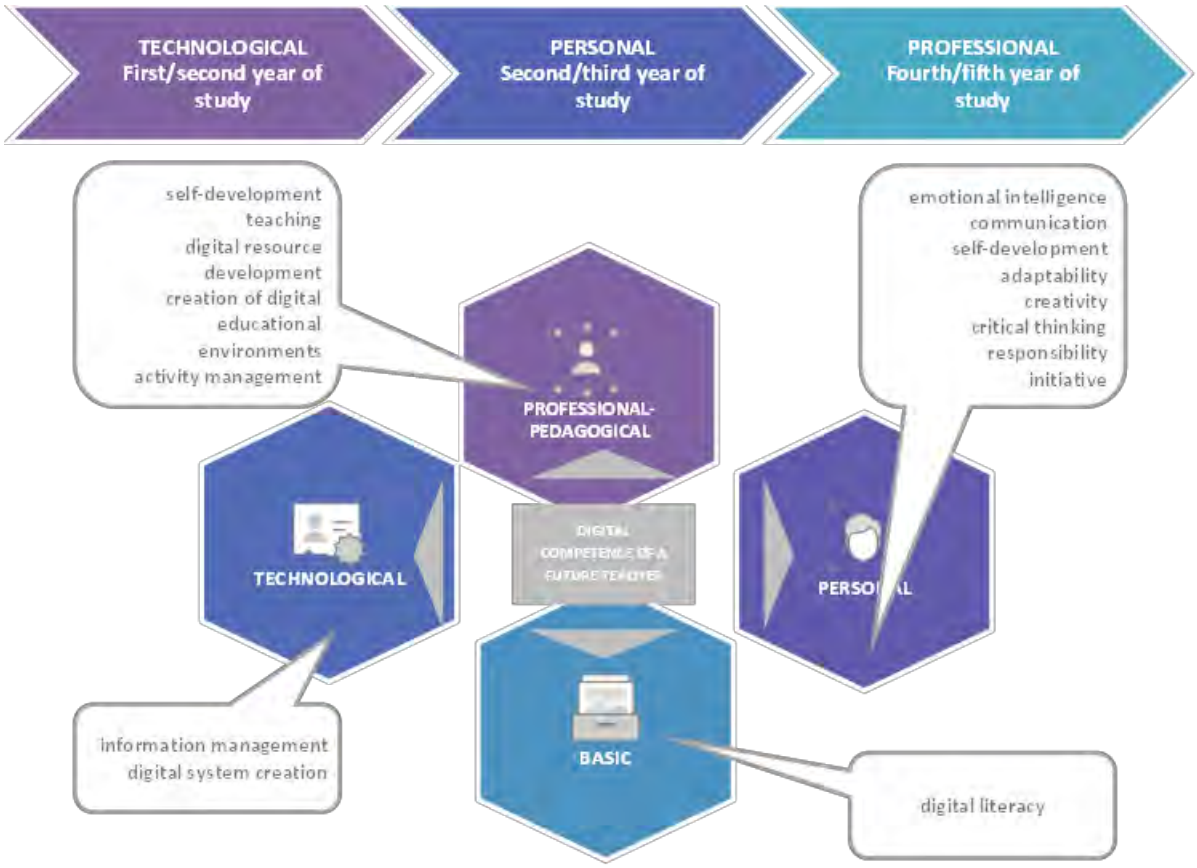


Figure 4. Model of Digital Competencies of a Future Teacher

The specified competency model includes three interconnected blocks: personal competencies (8 competencies are identified); professional and pedagogical competencies (5 competencies are identified); technological competencies (2 positions in total), which are based on basic digital literacy. The model is dynamic and changes over time during the studies.

Personal competencies **–** a group of competencies that reflect individual characteristics of a person, which make it possible to successfully participate in the implementation of a digital transformation strategy and solve professional-pedagogical tasks in a digital educational environment.

Professional-pedagogical competencies – a group of competencies related to the use of methods and tools for building a digital educational environment, managing the educational process, solving professional-pedagogical tasks in a digital environment.

Technological competencies – a group of competencies that provide the minimum required level of knowledge and skills in the use of information and communication technology in professional-pedagogical activities, effective and safe selection and use of information and communication technology in various educational and educational and professional situations.

A detailed description of the model components (groups and competencies) will be based on the models studied in this article. Their content will be determined later in the formation of the matrix for assessing the digital competencies of a future teacher.

Discussion

Below is the comparison of the results obtained in this study with similar ones. In a review of the studies, Uerz et al. (2018) identified four areas of competence that are important in problematizing the digital competence of future teachers: technological competencies, competencies in the use of pedagogical and educational technologies, competencies in the use of information technologies for teaching, competencies in professional development, related to changes in teaching practice and professional development. This list of competencies is similar in many ways to the main components of the author's model and is descriptive; therefore it is difficult to apply for building a competence assessment system (Pogosyan, 2021). The author's model proposed in this article is structured, visualised, and easily transformable into a matrix for assessing the digital competencies of a future teacher.

Nikolay Tsankov notes that the methodological analysis of the competence-based approach in education leads to the search for a cognitive, active, creative, personal, and axiological component in the digital competence of future teachers. The researcher focuses on the *UNESCO ICT Competency Framework for Teachers* without any adaptation to a student-future teacher (Tsankov & Damyanov, 2019). The authors identify six different levels of digital competence of future teachers, for a total of 22 digital competencies. Nikolay Tsankov uses the distribution by types of professional tasks solved by a teacher in organizing the educational process. This approach will not allow building the logic of the formation of the digital competence of a student-teacher, since it is poorly applicable to the system of training a future teacher, based on the consistent acquisition by students of the predominantly general cultural competencies at first and then general pedagogical and professional competencies.

Thus, Garry Falloon schematically presents a valid concept of the digital competence of a teacher. The main components of the model are the competencies within the training programme, personal-ethical and personal-professional competencies (Falloon, 2020). The competencies within the training programme are correlated with the technological competencies identified by the authors. The author also draws attention to the importance of developing the personal qualities of a future teacher. However, the understanding of this component differs significantly from the understanding of the authors of this article. Falloon assumes that personal digital competencies are associated with the ability of a future teacher to create conditions for the formation of digital literacy in students. In the model described in this article, personal competencies imply emotional intelligence, creativity, critical thinking, readiness for communication in teamwork. This is due to an extraordinary approach to identifying the necessary competencies, which is based on the analysis of models of digital competencies not only of a teacher but also of a citizen, as well as of a university student.

The findings of the researchers confirm the conclusions made in this study.

Conclusion

Various methods and techniques corresponding to a particular stage of training are needed to assess the digital competence of a future teacher. Thus, tests, practical tasks are more suitable for testing technological competencies; self-assessment questionnaires should become the main tool to assess personal competencies; vocational pedagogical competencies are better diagnosed through case studies. The analysed various systems for assessing digital competencies that are publicly available on the Internet were divided into three categories. The first category includes testing systems that allow checking the level of proficiency in using tools and the ability to apply them to solve specific tasks. The second category includes questionnaires that allow the respondent to determine the level of competence on a scale from beginner to expert. The third category allows checking the ability to solve specific tasks by means of cases. The central idea behind the digital competence assessment matrix is to integrate all three approaches. This is the matrix basis, which contains the content components of digital competence, the levels of formation of digital competence, and the types of activities that will allow assessing digital competencies of a future teacher. Further work will be related to the clarification of competencies, a detailed study of the matrix for assessing digital competencies of a future teacher, the development of web resources for assessing digital competencies of a future teacher.

Recommendations

The conclusions presented in this article give reason to believe that the construction of a model of digital competencies of a future teacher should continue to be based on the existing experience in building models for other areas of human activity unrelated to the teaching profession. It is possible to join this work with competency models of specialists in digital professions. According to the authors, this study gave an idea of the content and structure and digital competence of future teachers, however, the competency models of teachers of different subjects may differ to some extent. Further research in this area may be related to the development of specific parts of the model for future teachers, taking into account the subject they teach. The authors suggest that the developed model of digital competencies will allow to refine the matrix of digital competencies. Based on the types of tasks indicated in this article, the authors can further develop a system for assessing the digital competencies of a future teacher. The results of this work can become the basis of a dynamic system for assessing the digital competencies of student-future teachers, implemented as a web resource. As a result of the assessment of digital competence, it will be possible to build a trajectory for the development of certain digital competencies of a student.

Limitations

In order to determine the conceptual field of this study, the authors selected and analyzed 15 main conceptual, most significant sources, the time interval of which ranges from 2011 to 2018. To develop a model of digital competence of a future teacher, 9 models of digital competences of a citizen, teacher and student were analyzed. The authors do not exclude the possibility of identifying other components of the model of digital competencies of a student - a future teacher. In other studies, the conceptual field of digital competence can be expanded, new requirements are analyzed, and, consequently, an updated model of the competencies of the future teacher is built. To compare the results of a survey of teachers (522 people) and students - future teachers (632 people) studying at the universities of Tatarstan, 1154 questionnaires were evaluated, which is a sufficient reference sample.

Acknowledgements

The reported study was funded by RFBR, project number № 20-313-90027\20.

Authorship Contribution Statement

Galimullina and Ljubimova: Conceived of the presented idea. Mukhametshina: Developed the theory and performed the computations. Sozontova: Verified the analytical methods. All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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