

ICT Competence of a Teacher in the Context of Digital Transformation of Education *

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Abstract. The transition to digital education is an inevitable trend in modern education. The digital transformation of education is primarily aimed at achieving the required educational results, increasing the availability and quality of education at all its levels. The features of digital education are management of educational results; designing individual educational trajectories; an abundance of educational materials; correct use of new technologies: “mobile learning, virtual and augmented reality; learning in cooperation, involvement in learning based on gamification and storytelling (educational games), etc.”. The teacher needs to understand the possibilities of ICT both for expanding and improving the educational process and for using digital technologies to enhance and introduce innovations in the field of education. In the context of distance learning, in which the whole world found itself as a result of the announced pandemic, it was the teacher’s mastering of the components of ICT competence to solve emerging issues in the professional activity that became a necessary condition for his professional growth, ensuring a high-quality learning process and promoting the skills of the 21st century. Requirements for the teacher’s ICT competence include the presence of an information culture; IT readiness; digital literacy. The article presents the results of a study on mastering the ICT competence of the teaching staff of the Belgorod State National Research University in dynamics, which are based on the requirements for the ICT competence of the teacher and include 3 levels of digital literacy: the basic level, the level of proficiency in working in a digital educational environment and level of proficiency in digital educational technologies

Keywords: Higher education, Digital Pedagogy, Digital Transformation of Education, ICT Competence of a Teacher.

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1 Introduction

Modernity is characterized by dynamic development and active use of information technology. Pedagogy as a science is also dynamically developing by the requirements of society. Therefore, the scientific and pedagogical literature is replenished with a new conceptual apparatus: “digital learning; digital pedagogy; online pedagogy; hybrid pedagogy; critical digital pedagogy; digital humanities "(digital humanities), etc." [7].

It is becoming common to use the terms “digital educator”; Digital student; “Professor-online”, etc. There is a request for new teaching professions: the curator of the online platform (“adapts the requirements of specific disciplines to the online environment”); "Interdisciplinary tutor" ("supervises the student's trajectory"); "Technician of educational gaming environments" (gamifier) (develops, "tests and implements educational online games in augmented and virtual reality") [1]. The dynamic development of education based on the introduction of new digital technologies makes it possible to significantly improve traditionally and form qualitatively new educational results and to develop the creative potential of each student. Numerous studies have shown that the characteristics of students change in the educational process, indicating the need to move to new pedagogical approaches. To improve students' understanding and reduce their misconceptions, researchers propose the use of learning and teaching approaches based on constructivist learning theory [10].

Back in 2015, the Edutainment project published the “Manifesto on the Digital Education Environment” [6]. The main provisions of the document determine the broad possibilities of the digital educational environment: “the presence of interdisciplinary connections; priority of student-centered learning; the possibility of self-control of progress in mastering the discipline; adaptability and much greater independence of the student in the educational process” [6]. Through the use of information technology, information support is provided for the activities of educational organizations [20]. Thus, in the scientific and pedagogical literature, digital pedagogy is understood as "the use of electronic elements in the educational process to enhance and change the educational experience" [15, c. 96].

At the same time, some trends have emerged in modern Russian education, thanks to which the most noticeable changes in the educational process are taking place:

1) "accessibility of knowledge" thanks to mobile, cloud-based learning, online courses that provide an opportunity to study regardless of the location of the students;

2) personalization of education - building an individual educational trajectory for each student as a unique program in which the student's progress in a specific subject is analyzed, what are his weaknesses and what educational materials are better perceived;

3) a paradigm shifts in the relationship between teacher and students, which led to the popularization of such forms of education as collaborative learning (joint activity), interdisciplinary knowledge, collective projects, mutual learning, etc.;

4) Smart Learning - the application of new teaching methods - Blended Learning and Flipped Classroom, merging online distribution of software and content in the form of multimedia.

5) social learning - the use of social networks and various social services for the exchange of knowledge, experience, discussion of joint activities;

6) involvement in learning based on gamification, virtual and augmented reality - as new ways of transmitting and perceiving information, which make learning intriguing, exciting, and easier.

All these changes in the educational process, which are taking place thanks to the new generation of ICT, require an ever wider and more complex set of professional competencies of a teacher than before. The teacher is faced with rapidly changing requirements, he has the opportunity to realize professional competence, including ICT competence, using not only technical skills in working with ICT but skills in working in a digital educational environment, possession of digital educational technologies that contribute to improving the quality of the educational process and introduction of innovations in the field of education.

In this regard, to harness the educational potential of ICTs to expand and improve education, UNESCO is pursuing a policy to develop global ICT guidelines. [25] The developed ICT Competency Framework for Teachers (ICT-CFT) aims to integrate new digital technologies into national education to achieve educational goals by 2030. ICT-CFT represents the complete set of skills that educators need to integrate ICT into their professional work.

In European countries, the European structure of digital competence of teachers (DigCompEdu) is widely used, the basis of which is a systematic approach to support the development of digital competencies of teachers at all levels of education [19]. DigCompEdu offers a digital competency assessment system that can assist educators in self-assessment, setting learning goals, identifying learning opportunities and further professional development for teachers.

In the Russian professional standard of a teacher, ICT competence is interpreted as “the qualified use of ICT tools that are widespread in a specific field of activity in solving professional problems where needed and when needed” [18]. Hence, one of the most important components of the professional ICT competence of a teacher is the competent use of ICT tools in solving professional and pedagogical problems for effective pedagogical support of the educational process, the appropriate choice of ICT to support specific teaching and learning methods; implementation of pedagogical interaction of subjects of the educational process.

2 The Purpose

This study analyzes the dynamics of the ICT competence of the teachers of the National Research University "BelSU" before and after the pandemic. At the same time, in determining the ICT competence of a university teacher, the authors proceeded from the fact that the ICT competence of a teacher characterizes the degree of his readiness to use modern information technologies in professional and pedagogical activities and includes 3 levels of digital literacy: the basic level, the level of proficiency in a digital educational environment and the level of proficiency in educational technologies based on ICT.

The use of the wide possibilities of ICT, methods of transferring and perceiving information allows teachers to more effectively use pedagogical technologies in the educational process, to look for new approaches aimed at increasing the level of sustainable cognitive motivation of students. In this study, the authors set another task: to help teachers choose tools and services to support specific teaching and learning methods, using the innovative nature of digital technologies. In our opinion, this will increase the level of ICT competence.

3 Presentation of the Main Material

The work of foreign and domestic researchers is devoted to the problems of the formation and development of the teacher's ICT competencies [3, 4, 7, 9, 10, 11, 12, 13, 14, 21, 23, 27]. Requirements for a teacher's ICT competence are spelled out in the UNESCO recommendations (ICT Competency Framework for Teachers) [25], in the European system of digital competencies (DigCompEdu) [19], in the teacher's professional standard (Concept and content) [18], the transition to which in Russia was carried out in 2019. To achieve the goal of the study, the following research methods were used: theoretical analysis of scientific literature [2, 3, 8, 15, 17, 19, 20, 22, 26]; interpretive (comprehensive and systematic study of the object of research; generalization of practical experience, etc.), empirical (diagnostics of the teaching staff of NRU "BelGU": a questionnaire and test for teachers to determine the level of their digital competence (Klepikova A.G., Belenko V.B.)).

Digital pedagogy expands, modernizes the means, form, and structure of traditional pedagogy. This enables educators to freely design/design training sessions; use electronic libraries of educational literature, educational services; and for students to independently design an individual educational trajectory. There is a systematic update of the components of the educational process in the digital educational environment (DSP), for example: "required educational results; content of education; organizational forms and methods" [26, p. 102]; evaluation of the results of educational work. This allows you to build an educational process that meets the conditions for successful learning; to form the competencies necessary for life in the information society. Based on the foregoing, we can say with confidence that digital pedagogy transforms the education system to the conditions of an emerging digital civilization, expands the capabilities of every person, regardless of their age qualification, the specifics of their profession, place of residence, to master the open and fair accessibility of information and gender equality in the provision of education supported technology.

The innovative, creative nature of digital technologies makes it possible to solve complex, previously unsolvable tasks (for example, to formulate the competencies of the 21st century in students by evidence, to develop their ability to be independent in various types of activities, to implement the principle of "education throughout life"). The rapid dissemination and renewal of these technologies creates truly unlimited opportunities for teachers and students to access digital tools, materials, and services, to a library of network materials, and allows them to control their own information space.

By the Strategy for the Development of the Information Society in the Russian Federation for 2017-2030. qualitative changes in the content of the teacher's ICT competence are required [24], since the teacher of the modern knowledge society is called upon to instill in students the skills of competent use of digital technologies to obtain additional knowledge from the global Internet, to be able to highlight the main thing from a huge amount of information, to find the necessary material when solving educational -cognitive and research tasks.

Digital pedagogy develops and offers for use in the educational process a huge variety of pedagogical ICT tools: "open educational resources (OER); massive open online courses (MOOCs); learning platforms (Learning Management System / LMS); electronic textbooks (smartbook/e-book); electronic libraries (e-library); mobile learning; global media; cloud educational systems and Internet services (Web 3.0); electronic portfolios and personal electronic accounts; digital video communications" [16]. The main thing for a teacher is to understand how, using ICT tools as a tool, they can generate new knowledge, apply new educational technologies, share new interesting ideas in the professional community.

It is very comfortable for the modern generation of students to communicate on the Internet, and the transmission of educational information by the teacher in the traditional form is perceived by them as uninteresting. Moreover, the Internet currently has a large number of services for the preparation and organization of the educational process by teachers. It:

1. Electronic learning systems (LMS): allow you to remotely give and check assignments (the most popular LMS: Google Classroom, Canvas, Moodle, etc.).
2. Video services (YouTube, SchoolTube, etc.).
3. Websites and platforms with open educational resources, with which you can create interactive lessons, use interesting templates for teaching materials and be inspired by the ideas of other teachers (Yandex & Textbook, OER Commons, TEDEd, SHARE MY LESSON, etc.).
4. Social media (VKontakte, Facebook) allow not only to communicate with students and parents in a less formal atmosphere but also are an effective management toolkit. So, for example, a teacher can create a group for each class: place tasks in it at home, organize "voting" on different occasions (for example, choose a date for an event), as well as work, conduct dialogues with parents (for example, microblogging).
5. Online services in a playful way - many tasks in various academic subjects on websites and online platforms (Learnis, Kahoot, LeaningApps, Wizer, Crossword Factory, Khan Academy, etc.).
6. Documents and presentations (cloud storage - YandexDisk, GoogleDisk, Dropbox, services - Genially, Prezi, Nearpod, Canvas, etc.), which make it possible to write comments, edit various documentation, etc.
7. Tools for digital creativity (Biteable, Powtoon, Utellstory, Learn, etc.) allow you to give students an exciting task, to see the creative result of the activity. A distinctive feature and at the same time the specificity of the above means is that they are not only "discovered" by students and their teachers, but, most importantly, they contribute to interactive interaction, during which both teachers and students are literally "critically investigated" and new knowledge is created.

Educators with ICT competencies can freely use all this variety of pedagogical tools, making an informed choice of digital tools and services to support specific teaching and learning methods, for example: learning in collaboration; project activity; virtual and augmented reality; mobile learning; gamification and storytelling; BYOD technologies, etc.

To provide teachers with the necessary skills and competencies to support learning and improve learning outcomes and digital skills development using ICTs, it is necessary to understand what constituents of ICT competence exist. According to the UNESCO ICT Competency Framework for Teachers, the components of ICT competencies include 6 main aspects of the teacher's work, aimed at understanding the role of ICT in education, curriculum assessment, pedagogical practices based on ICT, the use of digital skills, organization and management of the educational process, professional-personal development [25]. According to ICT-CFT, the main aspects of a teacher's work are related to 3 levels of ICT use in educational practice: 1) acquisition of knowledge; 2) deepening of knowledge; 3) creation of new knowledge. These three levels correspond to the stages of professional development of a teacher, starting from the basic level of ICT proficiency (knowledge of the use of technologies and basic competencies in the field of ICT), then the level of proficiency in working in a digital educational environment (creating a learning environment focused on students, integrating ICT into the educational environment) and, finally, the level of proficiency in educational technologies based on ICT (the ability to model a learning environment based on new digital technologies, which encourages students to create new knowledge necessary for a more harmonious, full-fledged and prosperous society) [25].

It should be noted that the use of ICT in pedagogical practice depends on the state of modern information technologies and those trends that have developed in the global educational space. Therefore, one of the most important components of the professional ICT competence of a teacher/teacher is the degree of his readiness to use modern information technologies in professional and pedagogical activities and the management of educational results in a digital educational environment. And, as a consequence, possession of educational IR technologies is a necessary condition for the formation of information and communication competencies in the process of formal and informal professional development, self-training, and self-improvement of a teacher.

The content of the professional standard of a teacher in the Russian Federation [18]. terms of his ICT competencies include "labor actions" and the necessary skills for the use of information and communication technologies in professional activities, which are referred to the technological level of requirements and methodological. Taken together, these requirements make it possible to implement the interaction of teachers and students in terms of mastering new types of educational resources, their presentation formats, pedagogical practices, methods, and technologies, and also orient the teacher to the use of distance learning resources in educational activities, the professional use of elements of the information educational environment.

4 Results

To determine the ICT competence of teachers, the authors conducted a study of the teaching staff of the Belgorod State National Research University based on a tiered approach: the basic level of digital literacy, the level of proficiency in working in a digital educational environment, and the level of proficiency in educational technologies based on ICT. The dynamics of ICT competence have been monitored since 2020, when the threat of coronavirus infection was announced to the whole world and all educational institutions were transferred to a distance learning format by March 2021. 451 people from among the teaching staff of NRU "BelSU" took part in the survey, including professors (3.7%), associate professors (63.2%), senior teachers (13.8%), assistants (9.4%), directors/deans/heads of departments (9.5%). Age qualification of respondents: from 22 years old to 65 years old and older (Fig. 1).

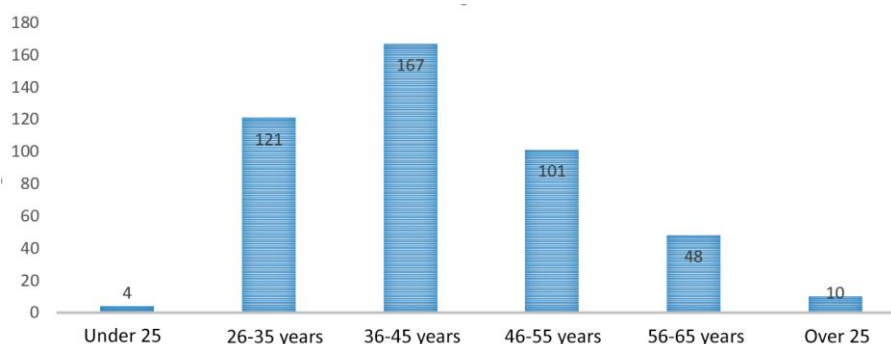


Fig. 1. The number of participants in the study (according to the age qualification).

At the beginning of the study, a survey of university teachers was conducted to determine the level of ICT competence (initial, basic, user, and confident user) in three areas: digital literacy, possession of skills in working in a digital educational environment, knowledge of educational technologies using ICT. The initial level involved the ability to turn on and off the computer, understanding the purpose of the main input devices, information output, knowledge of the basic functions of the operating system (renaming, copying, and moving files, working in a text editor, creating and saving documents), the skill of working with text editors, files, folders, e-mail. The basic level required knowledge of Word and Excel editors, creating PowerPoint presentations, working with e-mail, various Internet browsers (searching and downloading the necessary information), the ability to work with graphic editors, using removable media - disks and flash drives, knowledge of the purpose of archivers and the possibility of their use.

User - knowledge of the purpose and application of various "hot" key combinations, the use of functional buttons on the keyboard, good command of basic MS Office programs (Access, Excel, PowerPoint, Word), the ability to work with all browser settings, finding the necessary information on the Internet via search engines, search for a lost file document or folder in the PC operating system, the use of social networks, including

for educational purposes, the ability to independently install simple programs on a PC. Confident - full knowledge of the PC functionality, the ability to use it, knowledge of text recognition systems, automatic text translation, and image processing; confident knowledge of the MS Office package, specialized programs in a specific professional area; the ability to solve tasks with the help of software, find non-standard solutions, deliver any application through the program installer; the ability to work with different educational online platforms, conduct classes using online courses, use online services, cloud storages, interact with students and colleagues through web technologies.

The data obtained on the basis of teachers' self-assessment at the beginning of the study showed that 2.6% of respondents were at the initial level of digital literacy, 23.1% at the basic level, 40.3% rated themselves at the user level of proficiency, and 34.0% at the level of a confident user. At the level of proficiency in working in the digital educational environment of the National Research University "BelSU", respectively: 4.3% at the initial level, basic - 26.5%, user - 38.7%, the level of confident user - 30.5%. Possession of educational technologies using ICT at the initial level was assessed by 4.5% of the respondents, at the basic level by 30.4%, at the user level by 38.5% among the respondents and 26.6% assessed themselves at the level of confident users (Fig. 2).

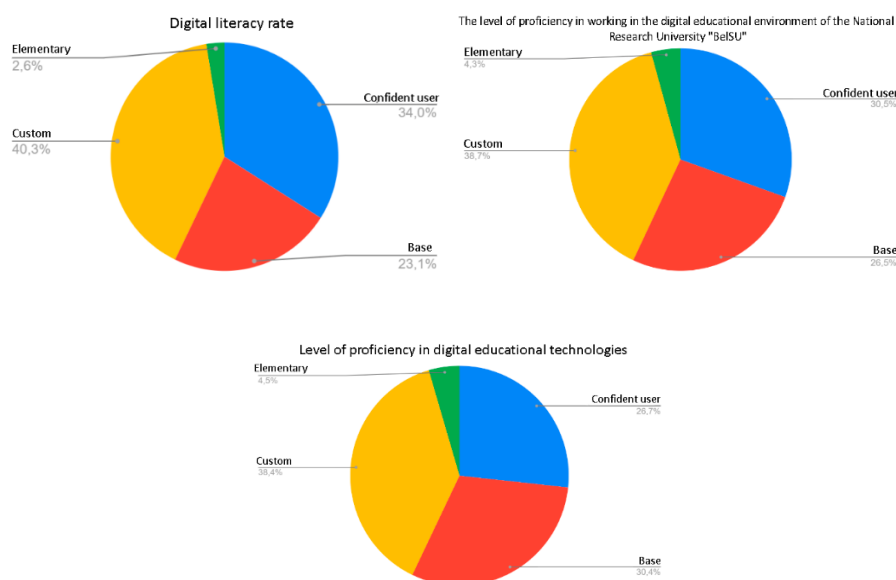


Fig. 2. Distribution of respondents by levels of ICT competence at the beginning of the study (self-assessment).

At the end of the study (March 2021), the distribution of respondents by levels of digital literacy has changed significantly, the self-esteem of teachers has increased, as evidenced by the survey data. The initial level of digital literacy decreased to 1.4%; the difference at the basic level turned out to be significant, the value of which decreased from 23.1% to 7.5%; the level of confident users increased from 34% to 50.8% (Fig.

3). Digital Learning Skills also rose significantly at the Confident User level, from 38.7% to 56.4%, while Basic, Beginner, and User were down 2.9%, 18.6%, and 4.4%, respectively. There were also changes in teachers' proficiency in digital educational technologies - they increased at the user level by almost 3%, at the confident user level by 20%, and decreased at the basic and initial levels by 2.8% and 20.2%, respectively.

These changes in teachers' self-esteem occurred due to the active "forced" use of information and communication technologies in the educational process of the university, without which education became impossible during the period of a mass pandemic and isolation of teachers and students in educational organizations.

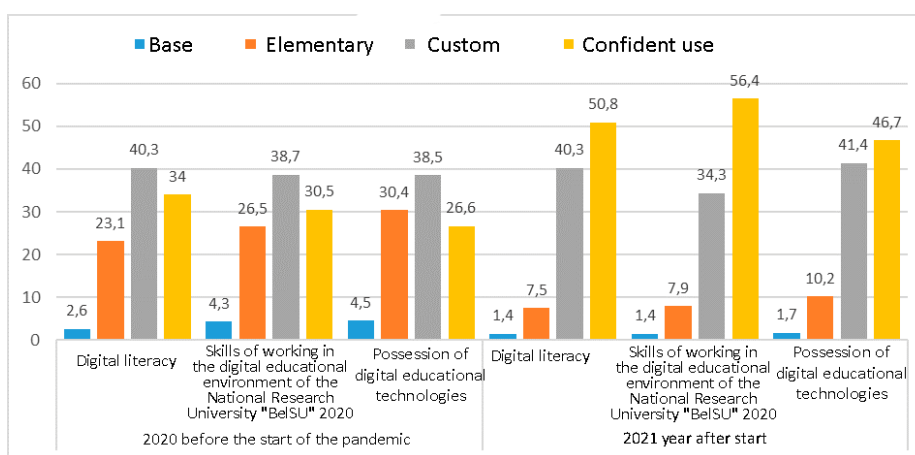


Fig. 3. Dynamics of ICT competencies of teachers by levels of proficiency before the start of the pandemic and at the time of the survey in 2021. (self-esteem%).

By organizing the survey, the task was to find out the opinion of the respondents about their attitude to work in the digital educational environment of the NRU "BelSU", in which they closely interacted with the students during the period of distance learning. In their answers, teachers noted the following: before the pandemic, 16.2% did not use the educational online environment (they communicated with students in person); 55.3% used the information and educational environment to test students; 25.6% of the respondents actively used the resources of the information and educational system of the university in the educational process in all forms of education, 20.9% only for interaction with students enrolled in correspondence courses, 0.2% used another similar e-learning system.

Currently, the attitude of teachers to the information and educational environment has changed, since, for 92.8% of the respondents, the Pegasus e-learning system (SEA) has become the main educational environment for interaction with students, of which: 37.6% wished to modernize their online courses, add more interactive elements; 28.8% learned the purpose and functionality of various elements of the Pegasus system and actively use them in the educational process; 59.3% conduct lectures and seminars online, using video conferencing tools, the BigBlueButton element or a ZOOM meeting

in the Pegasus training course; 41% actively use the point-rating system in SEA Pegasus, and only 5.8% did not change anything with working in a digital environment. This indicates that during the pandemic, almost all teachers and students switched to distance learning and interacted in a digital educational environment (SEA "Pegas" NRU "BelSU"). In it, they were able to "pump" their flexible skills. This is confirmed by the positive dynamics of the level of proficiency of teachers in the skills of working in a digital educational environment (the advanced level increased by almost 26%).

For an objective assessment of the level of proficiency in ICT competencies of the teachers of NRU "BelSU", testing was carried out, the purpose of which is to identify the level of proficiency of teachers in ICT, online services, and digital educational technologies. The test results are shown in Fig. 4. The test included 3 types of tasks for knowledge, skill, and the use of IR technologies in professional and pedagogical activities.

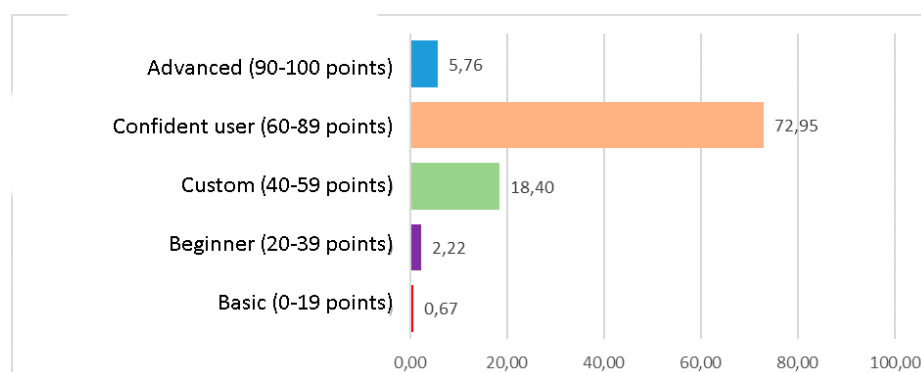


Fig. 4. The level of proficiency in ICT competencies of the teachers of the NRU "BelGU" (test results) (%).

Based on the results of the teachers' testing, a statistical analysis of the main test indicators was carried out. The standard deviation of scores for the test (Standard deviation) is 13.91, which characterizes the suitability of the test for differentiation by the level of assimilation of the material. The score distribution skewness shows negative skewness with a normal distribution of individual scores from a representative sample (-0.8408), i.e. approximately 84% of the average scores are in the center of the distribution, and a negative value indicates the possible difficulty of the test given to the instructors. At the same time, the coefficient of discrimination (Discrimination index) for 3 types of tasks for knowledge, skill, and the use of IR technologies in professional and pedagogical activity varies within 30%, which also indicates that the tasks have sufficient differentiating ability. In the study, we conducted a correlation analysis to determine the level of validity of test items using the Pearson formula. The obtained coefficient of validity is 0.8746, which allows us to conclude that the test can be applied in practice to determine the level of ICT competencies of teachers.

The development of IT education is aimed at eliminating the existing shortage of professional IT staff, due to both the specifics of the system for training IT professionals

in the country and the consequences of the accumulated “demographic hole”. Bridging the imbalance between the demand for IT staff and their supply is a top priority for higher technical education [28-30].

5 Conclusion

Thus, the results of the study revealed the following.

1. The study of ICT competence showed that the basic and initial level of ICT competence among teachers decreased in three directions: digital literacy, possession of skills in working in a digital educational environment, possession of educational technologies using ICT, at the same time, the level of user and confident user in all three areas.

2. During the study period, there were noticeable changes not only in the self-assessment of teachers but also in the real level of ICT competencies: 72.95% of respondents showed results at the level of a confident user, 18.4% at the user level, 2.2 at the initial level and 0.67% baseline. At the same time, the conducted statistical analysis made it possible to conclude that the test is suitable for differentiation by the level of mastering the test material and the possibility of applying it in practice to determine the level of teachers' ICT competencies.

3. Objective data from a survey of teachers showed that 45.3% of respondents changed their attitude to distance learning for the better, as they gained an understanding of the process of distance interaction with students, acquired skills in using distance learning technologies, and increased their ICT competencies. These changes have occurred due to the active use of information and communication technologies in the educational process of the university, without which distance learning became impossible. 37.4% did not change their attitude, in 17.3% the dynamics of the attitude turned out to be negative.

The conclusions made as a result of the study are aimed at improving the digital competence of university teachers and intensifying the exchange of views with representatives of the pedagogical community in the field of ICT education.

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