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DIGITAL INTERACTIVE TECHNOLOGIES IN THE ASPECT OF PRIMARY SCHOOL TEACHER TRAINING

LAS TECNOLOGÍAS INTERACTIVAS DIGITALES EN EL ÁMBITO DE LA FORMACIÓN DEL PROFESORADO DE PRIMARIA

Olena Mamchych [1*]
E-mail: constantaelena@ukr.net
ORCID: https://orcid.org/0000-0003-1770-3311
Lyudmila Kolbina [2]
E-mail: kolbina.ludmila79@gmail.com
ORCID: https://orcid.org/0000-0001-6249-9546
Olena Honcharova [3]
E-mail: urlen@i.ua
ORCID: https://orcid.org/0000-0003-4584-1471
Tetiana Mochan [4]
E-mail: tsybar1975@gmail.com
ORCID: https://orcid.org/0000-0002-7598-1988
Tetiana Zenchenko [5]
E-mail: tatianazenchenko@ukr.net
ORCID: https://orcid.org/0000-0003-3589-4780
Polina Yakymenko [6]
E-mail: serdolik@hotmail.com
ORCID: https://orcid.org/0000-0002-4233-4098
[1] T. H. Shevchenko National University "Chernihiv Colehium". Ukraine.
[2] State institution «South Ukrainian National Pedagogical University named after K. D. Ushynsky». Ukraine.
[3] Odesa Regional Academy of In-Service Education. Ukraine.
[4] Mukachevo State University. Ukraine.
[5] Oleksandr Dovzhenko Hlukhiv National Pedagogical University. Ukraine.
[6] Khmelnytskyi National University. Ukraine.
*Corresponding author

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ABSTRACT

The content and classification of interactive teaching technologies are disclosed, and ways of meeting the requirements when using active and interactive teaching technologies for the formation of professional competencies in future primary school teachers are shown. The planning of the use of digital interactive technologies in higher education is described. The role of auxiliary devices of interactive complexes is shown. The content of new digital interactive tools necessary for the professional training of primary school teachers and the use of digital interactive technologies is disclosed. The advantages of using interactive digital technologies in the professional training of primary school teachers are highlighted. A pedagogical experiment was conducted based on higher education institutions to diagnose the professional readiness of future primary school teachers to use digital interactive technologies. The generalization of empirical data at the ascertaining stage of the study allows us to state that traditional established approaches to professional training of future primary school teachers in higher education do not allow for the formation of the professional readiness of future primary school teachers to use digital interactive technologies at the proper level, and therefore pedagogical conditions were developed and their effectiveness was tested at the formative stage of the experiment. As a result of the implementation of the developed pedagogical conditions, a clear positive dynamics of increasing the level of professional readiness of students was revealed according to all research indicators.

Keywords:

Digital interactive technologies, Primary school teacher training, Professional readiness, Higher education institu-

tions, Interactive complexes.

RESUMEN

Se divulga el contenido y la clasificación de las tecnologías de aprendizaje interactivo; Muestra formas de cumplir con los requisitos al utilizar tecnologías de aprendizaje activas e interactivas para formar competencias profesionales en futuros maestros de escuela primaria. Se describe la planificación del uso de tecnologías interactivas digitales en la educación superior. Se muestra el papel de los dispositivos auxiliares de los complejos interactivos. Se divulga el contenido de las nuevas herramientas interactivas digitales necesarias para la formación profesional del profesorado de educación primaria y el uso de las tecnologías interactivas digitales. Se destacan las ventajas del uso de tecnologías interactivas digitales en el proceso de formación profesional de los docentes de educación primaria. Con el fin de realizar un diagnóstico pedagógico de la preparación profesional de los futuros maestros de escuela primaria para el uso de tecnologías interactivas digitales, se realizó un experimento pedagógico en instituciones de educación superior. La generalización de los datos empíricos en la etapa de determinación del estudio nos permite afirmar que los enfoques tradicionales establecidos para la formación profesional de los futuros maestros de escuela primaria en la educación superior no permiten la formación de la preparación profesional de los futuros maestros de escuela primaria para utilizar tecnologías interactivas digitales en el nivel adecuado y, por lo tanto, se desarrollaron condiciones pedagógicas y se probó su eficacia en la etapa formativa del experimento. Como resultado de la implementación de las condiciones pedagógicas desarrolladas, se reveló una clara dinámica positiva de aumento del nivel de preparación profesional de los estudiantes según todos los indicadores de investigación.

Palabras clave:

Tecnologías interactivas digitales, Formación de docentes de educación primaria, Preparación profesional, Instituciones de educación superior, Complejos interactivos.

INTRODUCTION

In the 21st century, education requires the use of digital interactive technologies in the training of specialists on a large scale, based on the fundamental hermeneutic and epistemological aspects of pedagogy, associated with a high communicative culture and the art of understanding. Today, in pedagogical science, when applying innovative pedagogical technologies, using computer technology, and with high achievements of society, the categories of joint activity of the educational audience and interaction of the teacher remain the least developed (Komar, 2008).

The use of digital interactive learning technologies in the training of primary school teachers makes it possible to increase the motivation and cognitive activity of students, to develop the ability of each individual to be creative, to reject stereotypes, to think critically, which is a prerequisite for interpersonal constructive interaction. The introduction of digital interactive learning technologies into the educational process of higher education contributes to the formation of professional competence of future primary school teachers. (Konovalchuk, 2022).

Therefore, in modern conditions, the educational process of preparing higher education applicants for professional activity without the use of digital interactive technologies is impractical and ineffective. By introducing modern digital interactive technologies in the training of future primary school teachers, the development of professional skills in students is ensured in the best possible way, and motivation for a professional direction is increased. For the successful modernization of the educational process of higher education to European educational standards, there is a need to investigate the ways of using digital interactive technologies in the training of primary school teachers and to establish their essence and specificity.

Literature Review

Scientists are investigating certain aspects of the use of interactive technologies in the training of teachers in the educational process of higher education institutions. Thus, the problem of using interactive modern technologies in the professional training of philologists was updated by Sobchenko, & Fedorenko (2023). Scientists prove that interactive technologies are becoming a necessary component of the work of all higher education teachers in connection with distance learning and the introduction of a blended educational format. The problem is raised, which reveals the features of distance learning and emphasizes the detailed application of various interactives necessary for all participants in the educational process; ways of organizing feedback, features of interactive learning, methods are analyzed; a characteristic of interactive technologies is presented.

The specifics and essence of the concept of interactive technologies in the educational process were determined by Pavlovych (2024). By the conditions of training, the requirements for the choice of interactive technologies were identified. The most effective interactive methods were established; the classifications of interactive learning were considered; in the formation of a professional personality, the conditions for the successful use of interactive methods in the process of training specialists were determined. It was proved that “the use of interactive methods will contribute to the formation of a comprehensive idea of the future profession among applicants – future philologists”.

Komar (2008) reveals the essence of interactive technologies that meet the modern needs of society in preparing future primary school teachers for the use of interactive teaching technologies in primary school. The author addresses historical issues, offers his vision of the problem, explores the conditions and factors of the formation of students' skills, pedagogical experience in the use of interactive teaching technologies in primary school.

Knysh et al. (2024) investigated the patterns of development of pedagogical innovation and technomatics based on the application of innovative technologies by considering the professional training of future teachers and developed a model of updating the professional and pedagogical training of a teacher, which provides the appropriate technology for updating professional training. The leading means of achieving the expected results, according to the researcher, is information-modular technology, "contained in the form of a complex of information and modular teaching technologies".

Kuchai et al. (2022) developed a technology for designing digital innovative pedagogical systems in the educational space. An innovative pedagogical system was chosen as the object of design. In the process of developing a technology for designing innovative pedagogical systems, the researcher "based her understanding of "technology as a set of processes, rules that perform a subordinating (normative) and ordering (algorithmizing) function about the designer's actions aimed at creating a given object – an innovative pedagogical system".

Thus, scientists have studied certain aspects of the use of interactive technologies in the training of teachers in the educational process of higher education institutions. In particular, the ways of organizing feedback, the features of interactive learning have been analyzed, the requirements for the choice of interactive technologies have been identified, the most effective interactive methods have been established, the classifications of interactive learning have been considered, the conditions and factors of the formation of skills in students have been studied, pedagogical experience in the use of interactive learning technologies in primary school has been developed, a technology for designing innovative pedagogical systems in the educational space has been developed, but the use of digital interactive technologies in the training of primary school teachers has not been given enough attention.

RESEARCH PURPOSE: diagnostics of the professional readiness of future primary school teachers to use digital interactive technologies, development, implementation of original pedagogical conditions and verification of their effectiveness.

Materials and methods

To achieve the research goal, the following RESEARCH METHODS were used at different stages of scientific research:

- **theoretical** – analysis and synthesis of sources, Internet resources on the research problem; generalization of the studied practice of higher education institutions; deduction and induction to form the conceptual foundations of the research; comparative analysis to clarify the state of professional training of future teachers to use digital interactive technologies; to determine the essential characteristics, classification and comparison of criteria and levels of readiness of future primary school teachers to use digital interactive technologies;
- **empirical** – diagnostic (observation, interviews, questionnaires, self-assessment, study of activity products) to diagnose the level of readiness of future primary school teachers to use digital interactive technologies; pedagogical experiment with quantitative and qualitative analysis of results to verify the effectiveness of the developed pedagogical conditions;
- **methods of mathematical statistics** for qualitative and quantitative analysis of the results of experimental research, verification of their validity and objectivity.

To conduct a pedagogical diagnosis of the professional readiness of future primary school teachers to use digital interactive technologies, an ascertaining stage of a pedagogical experiment was conducted based on higher education institutions.

Students of pedagogical faculties participated in the experiment.

The ascertaining stage of the experiment was aimed at identifying the level of professional readiness of future primary school teachers to use digital interactive technologies in primary school, and was carried out to identify the components: cognitive and motivational.

The control group consisted of 60 respondents, and the experimental group consisted of 68 respondents, which included students, future primary school teachers.

Using the technical procedure for calculating the selection step and implementing random single-stage selection, the formation of EG and CG was carried out.

The levels of professional readiness of future primary school teachers to use digital interactive technologies were identified: elementary, reproductive, constructive, creative.

For use in the experiment, we selected only those methods that had been tested for validity and reliability, adequacy

and standardization. The selected set of methods and techniques allowed us to effectively diagnose the levels of formation of the components of professional readiness of future primary school teachers to use digital interactive technologies in the participants of the experiment and show qualitative and quantitative manifestations in them.

The generalization of empirical data from the ascertaining stage of the experiment on identifying the professional readiness of future primary school teachers to use digital interactive technologies (cognitive and motivational components) based on the results of diagnostic work allows us to state that traditional established approaches to professional training of future primary school teachers in higher education do not allow for the formation of the professional readiness of future primary school teachers to use digital interactive technologies at the proper level, and therefore it is necessary to develop pedagogical conditions and test their effectiveness at the formative stage of the experiment.

To assess the identified differences in empirical data, their statistical reliability, characterizing cognitive readiness between CG and EG students by levels of professional skills and knowledge of digitalization of education, we applied the Kolmogorov-Smirnov statistical criterion, because this method is most suitable when it is necessary to compare two distributions (one empirical with another or theoretical with empirical) and this method makes it possible to find the point between the two distributions at which the sum of the accumulated differences is the most optimal and to assess the reliability of these differences.

To determine the statistical reliability of the identified differences, we will explain the practical application of the method between EG and CG students by levels of skills and professional knowledge.

The following hypotheses were formulated:

H0: among CG and EG respondents, the differences between the levels of formation of professional readiness of future primary school teachers to use digital interactive technologies are statistically unreliable.

H1: respondents of CG and EG, the differences between the levels of formation of professional readiness of future primary school teachers to use digital interactive technologies are statistically significant.

To test these two hypotheses, the empirical value of the criterion was found and the found value was compared for the significance level with critical values $p < 0.05$ (taking into account the permissible error value + 5%).

For each level of knowledge – the level of gradation of the feature, we first calculate the empirical frequencies for this purpose for the distributions of EG and CG; we calculate the accumulated empirical frequencies for the distribution of CG and EG students. For each level of gradation of knowledge of respondents, the absolute values of the differences between the accumulated frequencies are found – we calculate the differences. According to the results of calculations based on the data, $\lambda emp = 0.809$.

For the significance level $p < 0.05$ $\lambda t = 1.36$ as can be seen from the table of critical values.

Therefore, we reject the alternative and accept the null hypothesis, i.e. statistically insignificant differences in the levels of formation of professional skills and knowledge of a primary school teacher in CG and EG students.

This means that in terms of the level of mastery of knowledge, EG and CG are maximally identical (there are no significant signs of differences between the groups) and gives the right to continue experimental work with them.

Between CG and EG students, the statistical reliability of differences in all components of the professional readiness of future primary school teachers to use digital interactive technologies was similarly assessed.

At the formative stage, as shown by the results of the experimental work, we see a significant increase in the creative level of motivation of future primary school teachers in EG and their desire for high-quality implementation of digital interactive technologies, orientation towards pedagogical cooperation due to the implementation of the developed pedagogical conditions.

Thus, as a result of the implementation of the developed pedagogical conditions for the professional readiness of future primary school teachers to use digital interactive technologies, a clear positive dynamics of increasing the level of professional readiness of students according to all research indicators was revealed.

RESULTS AND DISCUSSION

Content and classification of interactive learning technologies.

Every teacher today is looking for effective new ways to improve the educational process, innovative ways to increase the success of applicants for the educational space, increase students' interest in learning, form their life values, develop curiosity, creativity, and independence. Changes in the innovative approach to higher education are not possible without the use of interactive technologies in classes, which are based on the free exchange of ideas, modeling a choice situation, dialogue, etc. (Siomak & Roiko, 2021).

Interactive technologies of the educational process are subject-subject relations in teacher-student relations,

a new philosophy of providing students with innovative knowledge, which contributes to the development of students' creative potential, their abilities and effective learning, assimilation and reproduction of students' knowledge (Komar, 2008).

Interactive technologies are a form of modern organization, innovative activity of the educational process, which involves active interaction of the learner of the educational space with the team and the teacher during the mastering of new material to acquire new communication skills and success. Interactive technologies encourage a large number of learners to be active in various areas, and not only in classes (Sobchenko, 2020).

The classification of interactive learning technologies corresponds to certain models of learning, where interactive technologies are implemented. And depending on the purpose of the lesson, on the forms of organization of educational activities of higher education students, interactive learning technologies are divided into four groups:

- cooperative learning – "Rotational threes", "Work in pairs", "Two – four – all together", "Work in small groups", "Carousel", "Dialogue", "Joint project", "Synthesis of thoughts", "Circle of ideas", "Search for information", "Aquarium", etc.;
- collective-group learning – "Microphone", "Discussion of the problem in the general circle", "Brainstorming", "Unfinished proposals", "Mosaic", "Learning – I learn", "Analysis of the situation" (case-study), "Decision tree", "Problem solving", etc.;
- situational modeling – "Public Hearing", "Court Hearing", role-playing situations, etc.;
- working out discussion questions (Rudenko & Antipova, 2021).

Ways to comply with the requirements when using active and interactive learning technologies for the formation of professional competencies in future primary school teachers.

To form professional competencies in future primary school teachers, activate educational and cognitive activity, and actualize their motives for mastering the necessary skills and knowledge, it is advisable to use interactive and active learning technologies – discussion, problem lectures, simulation trainings, discussions, heuristic conversations, role-playing and business games, brainstorming, the use of case technologies, modeling pedagogical situations, solving pedagogical professionally-oriented tasks, conducting video conferences, round tables, brainstorming, etc. (Murcia, 2014).

In the process of forming professional competencies of future primary school teachers, the use of interactive technologies is successful, during which the following requirements should be observed:

- understanding the benefits of communication and teamwork;
- positive relationships between group members;
- individual responsibility;
- indirect interaction;
- evaluation of one's own behavior and actions of others;
- mastering the skills of interpersonal interaction, collective activity, etc. (Gómez & García, 2016).

Interactive learning technologies contribute to the independent search for knowledge, activate the cognitive activity of students, contribute to self-improvement, self-organization, self-education, self-development of future specialists (Konovalchuk, 2022).

Planning the use of digital interactive technologies in higher education.

To comply with the requirements when using digital interactive technologies, the teacher must carefully plan his work:

- use digital methods that correspond to the experience of working with interactive technologies and those that correspond to the age capabilities of students;
- select exercises for the lesson that are interactive and would provide higher education applicants with a "key" to mastering the topic;
- during preliminary preparation for the perception of the material, give interactive tasks: reflect, read, perform preparatory independent exercises;
- use a small number of digital interactive technologies in one lesson;
- during the performance of interactive exercises, allocate time for reflection on them so that students do not perform them mechanically, but take them seriously;
- after the performance of each interactive exercise, conduct a leisurely discussion, including updating previously studied material.

Characteristics of the LearningApps service, which is a web 2.0 application to support interactive educational processes in higher education institutions. Let's characterize the LearningApps service, which is a web 2.0 application to support interactive educational processes that we used in higher education institutions (Moorhouse, 2023).

The LearningApps environment has a multilingual interface, which allows it to be used in higher education institutions in different countries.

By performing interactive tasks created in the LearningApps environment, higher education applicants can consolidate and test their knowledge in a playful way, which contributes to the formation of their cognitive interest. Each exercise is created in the LearningApps environment and has a page address for full-screen display of the task and its URL. For interactive tasks to be embedded in blog pages or websites, the service provides the ability to obtain code. Using built-in templates, tasks are created in the LearningApps environment (Prykhodko et al., 2021).

The interactive methodology of using the LearningApps service, which is a web 2.0 application to support interactive educational processes in higher education institutions, ensures the development of the following skills and abilities of students:

- critically analyze information;
- analyze, compare, describe phenomena and processes of social development;
- argue one's own views;
- take responsibility;
- take one's own position and make one's own choice;
- formulate appropriate judgments and give them one's own assessment;
- negotiate;
- influence the decision-making process;
- reach consensus and compromise;
- resolve conflicts tolerantly.

Classes held in higher education institutions using interactive technologies have the following features:

- high activity of students during the class;
- all students in the group are involved;
- the possibility of using various types of mental, cognitive, and educational activity of students to successfully solve problems;
- creating a democratic atmosphere, students make decisions on their own responsibility, act independently;
- achieving high efficiency in learning the material (Siomak & Roiko, 2021).

The effectiveness of the interactive methodology of using the LearningApps service, which is a web 2.0 application for supporting interactive educational processes in higher education institutions, depends on certain conditions that are created when using it. It is necessary to clearly explain to students the main rules of organizing group and pair work first, if students do not have sufficiently developed group interaction skills. It is important to explain the criteria for evaluating collective work and clearly formulate tasks, as well as provide support and constant feedback from the teacher (Nikolaienko, 2021).

Auxiliary devices of interactive complexes.

Interactive complexes should be equipped with the following auxiliary devices: styluses, remote control tablets, markers, etc.

Popular interactive complexes in society are the brands ActivBoard, PanaBoard, StarBoard, Interwrite Board, Smart Board, Mimio, etc., which include the appropriate software, without which interactive complexes and interactive boards will not work (Maher et al., 2012).

It should be noted that software from different companies is practically not compatible with each other, which creates certain inconveniences for the teacher. In the same higher education institution, there may be boards from different companies, and teachers should develop methodological tools for classes for each software; also, difficulties arise when teaching teachers to use interactive technologies in the educational process.

The use of interactive complexes is not limited to the use of interactive computer technologies. Various interactive programs are used for independent work of students, which allows them to learn the material playfully with interest and ease. For independent work at home or in classes, modern textbooks are accompanied by disks with a set of programs.

There are software tools for simulating interactive non-computer methods – role-playing and business games, case technologies. Due to their accessibility and clarity, virtual laboratories, virtual excursions, and virtual tours are successfully used in the educational process of higher education (Hevko, 2018).

The content of new digital interactive tools that are necessary for the professional training of primary school teachers and the use of digital interactive technologies.

Digital interactive technologies require appropriate training of primary school teachers and the availability of the necessary equipment. Therefore, the professional training of teachers requires the right approach, which can significantly improve the learning process and make it more effective and interesting (Kuchai et al., 2017).

The use of new digital interactive tools is necessary for the use of digital interactive technologies:

The modern educational process offers many web resources and virtual digital interactive boards, which, according to the specifics of their use in the educational process, are conditionally divided into four groups:

boards for creating interactive posters, newspapers (Wikiwall; Gloster, etc.);

drawing boards (Flockdraw, Drawonthe.net, CoSketch, Sribblar, etc.);

boards for storing notes (Conceptboard, Srumblr, etc.);

boards with the possibility of joint editing for organizing joint work with various content (Lino it, Educreations, Popplet, Padlet, etc.) (Rudenko & Antipova, 2021).

Interactive whiteboards and tablets: these are the devices that allow teachers and students of higher education to use interactive materials, interact with educational content to promote better learning. The following tools have gained the greatest popularity in our study: Whiteboard, Ziteboard, Twiddla, Classroomscreen, Miro, NoteBookCast (Kovalchuk et al., 2024).

Advantages of using digital interactive technologies in the process of professional training of primary school teachers.

Interactive digital technologies have great potential for the efficiency of education and increasing its quality and are developing dynamically in the modern educational environment.

The main advantages of digital interactive learning technologies are:

- promotion of digital interactive technologies in the optimization and intensification of the educational process of higher education;
- increasing motivation for learning;
- bringing the learning process closer to the practical real activities of primary school teachers;
- promoting the growth of attention, memory, level of knowledge, development of coherent speech, logical thinking, ability to self-analysis and analysis of the opinions of others, independent search for information, ability to make friends and help;
- assistance of digital interactive technologies in the analysis of the information received, in learning to correctly formulate one's own opinion, solve problems, discuss, be independent and confident;
- stimulation of the process of cognition, educational, mental conditions and procedures, to achieve the planned results (Yao et al., 2022);

promoting the development of communicative skills and abilities;

personalization of learning through the use of digital interactive technologies, which allow taking into account the pace of learning of each individual and the individual needs of the student.

the use of digital interactive technologies makes it possible to change the forms of student activity, allows in the educational process to relieve the nervous load of higher education students, to switch their attention to the key issues of the topic of the lessons;

development of digital interactive technologies that will be useful to future learners (Razmjooei et al., 2018).

Methodology of the ascertaining stage of the pedagogical experiment.

To pedagogically diagnose the professional readiness of future primary school teachers to use digital interactive technologies, an ascertaining stage of the pedagogical experiment was conducted based on higher education institutions.

Students of pedagogical faculties participated in the experiment.

The ascertaining stage of the experiment is aimed at identifying the level of professional readiness of future primary school teachers to use digital interactive technologies in primary school, and was carried out accordingly to identify the components: cognitive and motivational.

The control group consisted of 60 respondents, and the experimental group consisted of 68 respondents from the group, which included students, future primary school teachers.

We deliberately selected 3rd year undergraduate students for the ascertaining stage of the experiment and 4th year students for the formative experiment, who are acquiring the profession of a primary school teacher. We explain such a selection by the fact that:

- students have a certain level of formation of professional readiness of future primary school teachers to use digital interactive technologies, the corresponding qualities of their application;
- passed the adaptation stage of training;
- studying professional disciplines, they received professional and pedagogical knowledge and skills.
- Using the technical procedure for calculating the selection step and implementing random one-stage selection, the formation of EG and CG was carried out.
- The levels of professional readiness of future primary school teachers to use digital interactive technologies were identified: elementary, reproductive, constructive, creative.
- For use in the experiment, we selected only those methods that had been tested for validity and reliability, adequacy and standardization. The selected set of methods and techniques allowed us to effectively

diagnose the levels of formation of the components of professional readiness of future primary school teachers to use digital interactive technologies in the participants of the experiment and show qualitative and quantitative manifestations in them.

We will reveal the ways of diagnosing the cognitive professional readiness of future primary school teachers to use digital interactive technologies.

The cognitive component of professional readiness of future primary school teachers to use digital interactive technologies assumes that students have formed a system of professional skills and knowledge of a creative nature, perception and feeling in the system of intellectual properties of the personality, attention, thinking and intelligence, imagination, understanding of interdisciplinary connections at a level that will effectively allow them to carry out professional activities in primary school.

To diagnose the cognitive readiness of future primary school teachers to use digital interactive technologies, the CG and EG were asked to answer the questions of the questionnaire, which concerned the justification of the theoretical and methodological conditions for the use of digital interactive technologies in higher education for their use in primary school.

An incomplete answer by the respondent to the question was estimated at 0.5 points, and for each correct answer – 1 point was awarded.

According to the knowledge levels of the respondents, the obtained points were summarized on the scale:

- 12 – 15 points – creative level;
- 8.5 – 11.5 points – constructive level;
- 4.5 – 8 points – reproductive level;
- 0.5 – 4 points – elementary level.

Analysis of the data of the design stage of the experiment allowed for conclusions.

In the CG and the EG, in general, they do not have proper professional knowledge of using digital interactive technologies, which is important for the implementation of professional readiness of future primary school teachers to use digital interactive technologies in primary school conditions. Let us show a generalization of empirical data on identifying professional readiness of future primary school teachers to use digital interactive technologies (cognitive component) based on the results of diagnostic work:

- 42% of CG students and 49% of EG students showed an elementary level;
- 32% of CG students and 31% of EG students showed a reproductive level;
- 21% of CG students and 16% of EG students showed a constructive level;
- 5% of CG students and 4% of EG students showed a creative level.

Future primary school teachers feel the lack of necessary knowledge and the results indicate that their level of knowledge is insufficient.

The generalization of empirical data on the identification of the professional readiness of future primary school teachers to use digital interactive technologies (cognitive component) based on the results of diagnostic work allows us to state that traditional established approaches to the professional training of future primary school teachers in higher education do not allow for the formation of the professional readiness of future primary school teachers to use digital interactive technologies at the proper level, and therefore it is necessary to develop pedagogical conditions and test their effectiveness at the formative stage of the experiment.

To assess the identified differences in empirical data, their statistical reliability, characterizing cognitive readiness between CG and EG students by levels of professional skills and knowledge of digitalization of education, we applied the Kolmogorov-Smirnov statistical criterion, because this method is most suitable when it is necessary to compare two distributions (one empirical with another or theoretical with empirical) and this method makes it possible to find the point between two distributions at which the sum of the accumulated differences is the most optimal and to assess the reliability of these differences.

To determine the statistical reliability of the identified differences, we will explain the practical application of the method between EG and CG students by levels of skills and professional knowledge.

Let us formulate the hypotheses:

H0: among CG and EG respondents, the differences between the levels of formation of professional readiness of future primary school teachers to use digital interactive technologies are statistically unreliable.

H1: for respondents of CG and EG, the differences between the levels of formation of professional readiness of future primary school teachers to use digital interactive technologies are statistically significant.

To test these two hypotheses, we will find the empirical value of the criterion and compare the found value for the significance level with the critical values $p < 0.05$ (taking into account the permissible error value + 5%).

For each level of knowledge – the level of gradation of the feature, we will first calculate the empirical frequencies

for this purpose for the distributions of EG and CG; we will calculate the accumulated empirical frequencies for the distribution of CG and EG students. For each level of gradation of knowledge of respondents, the absolute values of the differences between the accumulated frequencies are found – we will calculate the differences. According to the results of calculations based on the data, $\lambda emp = 0.809$.

For the significance level $p < 0.05$ $\lambda t = 1.36$ as can be seen from the table of critical values.

Therefore, we reject the alternative and accept the null hypothesis, i.e. statistically insignificant differences in the levels of formation of professional skills and knowledge of a primary school teacher in CG and EG students.

This means that in terms of the level of mastery of knowledge, EG and CG are maximally identical (there are no significant signs of differences between the groups) and gives the right to continue experimental work with them.

Between CG and EG students, the statistical significance of the differences in all components of the professional readiness of future primary school teachers to use digital interactive technologies was similarly assessed, which is presented below.

Let us reveal the ways of identifying the motivational component of the professional readiness of future primary school teachers to use digital interactive technologies.

The presence of professional motives and professional orientation in this field of activity is one of the conditions for the formation of the professional readiness of future primary school teachers to use digital interactive technologies.

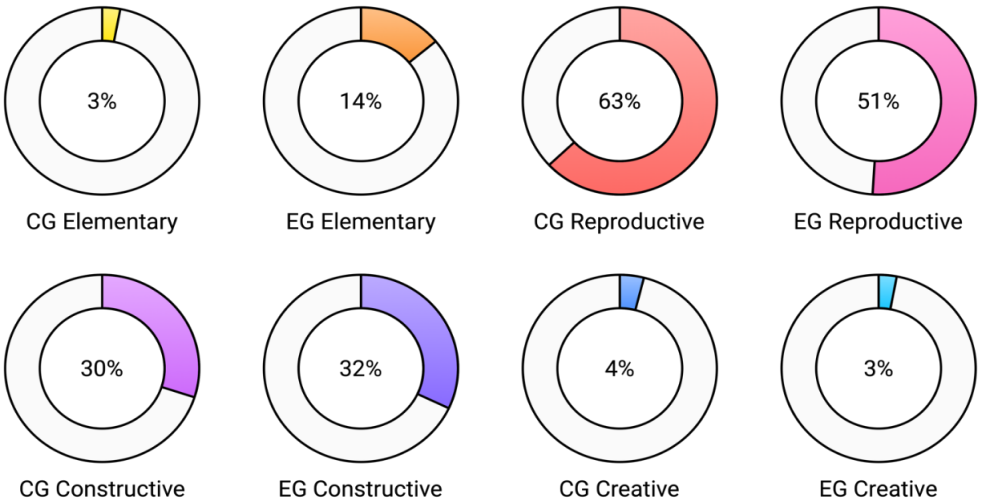
The components of this aspect are: the need for professional self-expression, innovative pedagogical communication, achieving a professional goal, self-knowledge, which determine the significant professional motivation of each student; interest in oneself, in professional knowledge, other people, in the teaching profession; the desire for professional improvement; belief in the need for successful activity of professional interactive knowledge, methods, skills and abilities; self-esteem; value orientations, life goals, etc.

The study of identifying the levels of motivational readiness of future primary school teachers to use digital interactive technologies at the ascertaining stage of work was conducted using an adapted version of the T. Ehlers methodology.

The analysis of the data of the ascertaining experiment shows the following results (Fig. 1):

- 3% of CG students and 14% of EG students showed an elementary level;
- 63% of CG students and 51% of EG students showed a reproductive level;
- 30% of CG students and 32% of EG students showed a constructive level;
- 4% of CG students and 3% of EG students showed a creative level.

Fig 1: Student Performance Levels in Experiment.



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Among the respondents, students with a reproductive and constructive level of motivation to use digital interactive technologies prevail. With such motivation, the student is confident in himself, focused on the necessary types of digital interactive technologies, has formed interests, and is oriented towards digital values.

However, certain differences were found between CG and EG students with an elementary level of motivation. Thus, 3% of such respondents were found to be uninterested in using digital interactive technologies in the CG, and there were significantly more such students in the EG – 14%.

We can state the fact that future primary school teachers demonstrate an optimal level of motivation to use digital interactive technologies, but students experience difficulties due to insufficient preparation for the use of digital interactive technologies in the teacher's workplace. Therefore, making adjustments to the content and procedural component is appropriate in professional training.

Pedagogical conditions for the formation of professional readiness of future primary school teachers to use digital interactive technologies, developed in the process of research.

To make adjustments to the content and procedural component of professional training, we have developed pedagogical conditions for the formation of professional readiness of future primary school teachers to use digital interactive technologies.

Pedagogical conditions for the professional readiness of future primary school teachers to use digital interactive technologies will be implemented through the following measures.

The first condition is the creation of an innovative digital interactive environment for professional training of future primary school teachers in higher education, aimed at ensuring professional training, self-realization of the personality of the future primary school teacher and based on the application and development in the educational process of digital, information and communication, integrative, interactive, intensive, sensitive-verbal, contextual, productive-creative technologies, methods, organizational forms to meet professional and educational needs.

The innovative digital interactive environment for professional training of future primary school teachers designed by us is characterized by the following features: the presence of positive motivation, guidelines for interactive digital activities of the future teacher; implementation of systematic, targeted professional training of students to master knowledge in professional disciplines and the formation of an individual creative digital style of professional activity; the presence of relationships and a favorable climate of co-creation and cooperation.

The second condition is the introduction of a range of organizational forms of teaching in a digital interactive context in a higher education institution: interactive lectures, practical, laboratory classes, research, individual and independent work, distance learning.

In the process of introducing a range of organizational forms to use a digital context in the process of professional training of primary school teachers, we recommend educational programs and applications. Many programs are designed specifically for primary school. And future primary school teachers should master the methodology of their use to apply them in the teacher's workplace. The programs include tasks for training skills, interactive games, educational videos and much more (Khan Academy Kids, DoodleMaths, Minecraft Education Edition, etc.).

Using online learning platforms: MOODLE, Google Classroom, HUMAN, etc. allows you to exchange tasks and materials, organize distance learning, conduct online testing, etc.

Coding and robotics in the process of professional training of primary school teachers is of great importance. In the process of practical application, we have proven that teaching the basics of robotics and programming from an early age helps to develop creativity, logical thinking, and problem-solving skills in a child, as well as in a student. Therefore, it is in primary school that it is necessary to use the following software: Scratch, CodeCombat, Kodable, PictoMir, Code.org, CodeMonkey, Lightbot, CeeBot, etc., which we paid attention to during the professional training of primary school teachers.

The third condition is the development of technological competence of the individual through the use of virtual and augmented reality technologies – the latest tools for learning.

We understand technological competence as the process of digital in-depth familiarization of students with the basics of various innovative digital technologies, the development of special practical skills and abilities to use digital innovative interactive technologies, the formation of digital qualities necessary for work in an interactive educational environment of higher education.

We recommend the use of a virtual digital interactive board in the process of professional training of primary school teachers – (whiteboard project, wall, online board). We used this latest learning tool, a network resource for

editing and creating documents and images, coordinating joint work, and communicating in real time. It was he who made it possible to simultaneously combine images, text, audio and video files on one platform.

Because it is virtual and augmented reality that are the technologies that can create exciting educational experiences for elementary school students that are difficult to implement in real life (visiting another planet, another country, another continent, taking a virtual tour of a museum, etc.). The fourth condition is the creation of material and technical foundations in the process of professional training of elementary school teachers that involve the use of modern interactive digital information and communication technologies: a server for storing audiovisual material, audiovisual tools, electronic media for transmitting and distributing multimedia material among students and teachers, an archive for storing existing materials on electronic media, access to the global Internet.

Analysis of the results of experimental testing of the effectiveness of pedagogical conditions for the formation of professional readiness of future primary school teachers to use digital interactive technologies, developed in the research process: the formative stage of the experiment.

The system of pedagogical innovations and pedagogical conditions developed in the research process, used to solve the goal of the formative experiment, was aimed at ensuring the formation of creative and constructive levels of professional readiness in future primary school teachers to implement the use of digital interactive technologies in primary grades and was used only in the EG.

In the CG, professional training of future primary school teachers was carried out using traditional technologies and teaching methods.

The processing of the results and analysis of the formative experiment in the CG and EG was carried out using unified methods and diagnostic tasks, which were aimed at facilitating the obtaining of reliable experimental data. During the formative stage of the experiment, the level of readiness of respondents to use digital interactive technologies was assessed.

To ensure the reliability of the results of the study, which consisted in the professional training of future elementary school specialists for artistic and educational activities, the specified criteria, indicators and diagnostic methods were used as the starting points.

With the help of the selected methodological tools, according to the program of research and experimental work, the level of formation of students' professional readiness for their use of digital interactive technologies in elementary grades was determined by the components (cognitive, motivational), which ensure the formation of a holistic personality of a future elementary school specialist as a professional.

Let's analyze the formation of the leading components of students' professional readiness for their use of digital interactive technologies in elementary grades at the formative stage of the experimental study.

Let's analyze the indicators of the cognitive component. We have positive changes in the indicators of the cognitive component at the end of the formative experiment, which is explained by the effectiveness of the proposed approach to the use of digital interactive technologies in the content of higher education and their further use in work activities in primary school.

At the beginning and end of the formative experiment in the CG, no significant differences were found, and in the EG, the number of respondents belonging to the constructive level and the creative level according to the cognitive criterion increased significantly.

At the beginning of the experiment in the EG, we observed a creative level of readiness of 4% of respondents, a constructive level of readiness of 16%, and at the end of the experiment, these indicators showed a creative level of readiness of 25% of respondents and a constructive level of readiness of 44% of respondents.

We see that the respondents' increase in the creative level of readiness is 17%, and in the constructive level of readiness the increase is 27%.

The number of future primary school specialists who demonstrated an elementary level – from 49% to 8% and a reproductive level – from 31% to 23% of mastering the knowledge system about the use of digital interactive technologies in primary school has decreased.

The knowledge of the respondents has acquired a systemic nature.

The data obtained from EG students after conducting a questionnaire indicated that EG respondents have a sufficient level of knowledge about the purpose, forms, ways, and methods of using digital interactive technologies in the activities of a primary school teacher. Knowledge about the technologies of using digital interactive technologies in the content of activities, integrated study of professional disciplines has increased. Future primary school teachers indicate that the level of their professional knowledge is sufficient, they feel the strength of knowledge.

At the stage of the formative experiment, the work carried out demonstrated the effectiveness of the selected

innovative digital educational technologies for the professional training of future primary school teachers.

The next stage of the experimental study was the monitoring of the development of the motivational component, which was carried out together with cognitive readiness in close connection.

Let's analyze the results of the formation of the motivational component of the professional readiness of future primary school teachers to use digital interactive technologies.

The reproductive level of motivational readiness of future primary school teachers to use digital interactive technologies was demonstrated at the beginning of the experiment in the EG by 51% of EG students, and at the end of the formative stage of the experimental work, the number of students in the EG was 40%. Accordingly, we observe an increase in this level.

The creative level of motivation was demonstrated by 17% of future teachers (at the beginning of the formative experiment, this indicator was 3%).

The constructive level of motivation was demonstrated by 34% of future teachers (at the beginning of the formative experiment, this indicator was 32%).

According to the motivational component, the average increase was 13%, which we consider quite sufficient.

At the formative stage, as shown by the results of the experimental work, we see a significant increase in the creative level of motivation of future primary school teachers in the EG and their desire for high-quality implementation of digital interactive technologies, orientation towards pedagogical cooperation, etc.

Thus, as a result of the implementation of certain pedagogical conditions for the professional readiness of future primary school teachers to use digital interactive technologies, a clear positive dynamics of increasing the level of professional readiness of students according to all research indicators was revealed.

CONCLUSIONS

The content and classification of interactive teaching technologies are disclosed; ways of complying with the requirements when using active and interactive teaching technologies for the formation of professional competencies in future primary school teachers are shown. The planning of the use of digital interactive technologies in higher education is described and the LearningApps service is characterized, which is a web 2.0 application for supporting interactive educational processes in higher education institutions. The role of auxiliary devices of interactive complexes is shown. The content of new digital interactive tools that are necessary for the professional training of primary school teachers and the use of digital interactive technologies is disclosed. The advantages of using digital interactive technologies in the process of professional training of primary school teachers are highlighted.

To conduct a pedagogical diagnosis of the professional readiness of future primary school teachers to use digital interactive technologies, a pedagogical experiment was conducted based on higher education institutions.

For use in the experiment, we selected only those methods that had been tested for validity and reliability, adequacy and standardization. The selected set of methods and techniques allowed us to effectively diagnose the levels of formation of the components of the professional readiness of future primary school teachers to use digital interactive technologies in the participants of the experiment and show qualitative and quantitative manifestations in them.

The generalization of empirical data at the ascertaining stage of the study on identifying the professional readiness of future primary school teachers to use digital interactive technologies based on the results of diagnostic work allows us to state that traditional established approaches to professional training of future primary school teachers in higher education do not allow for the formation of the professional readiness of future primary school teachers to use digital interactive technologies at the proper level, and therefore it is necessary to develop pedagogical conditions and verify their effectiveness at the formative stage of the experiment.

At the formative stage of the experimental work, we see a significant increase in the creative level of motivation of future primary school teachers of the EG and their desire for high-quality implementation of digital interactive technologies, orientation towards pedagogical cooperation, etc.

Thus, as a result of the introduction of certain pedagogical conditions for the professional readiness of future primary school teachers to use digital interactive technologies, a clear positive dynamics of increasing the level of professional readiness of students according to all research indicators was revealed.

We see prospects for further research in the direction of using digital interactive technologies in teacher training in the development of special methods for the formation of professional competence of future primary school teachers using interactive technologies; studying new digital interactive tools for implementation in the higher education process, studying the impact of interactive technologies on students' cognitive and motivation, development of the psychological state of the individual, etc.

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МУКАЧІВСЬКИЙ ДЕРЖАВНИЙ УНІВЕРСИТЕТ

89600, м. Мукачево, вул. Ужгородська, 26
тел./факс +380-3131-21109
Веб-сайт університету: www.msu.edu.ua
E-mail: info@msu.edu.ua, pr@mail.msu.edu.ua
Веб-сайт Інституційного репозитарію Наукової бібліотеки МДУ: http://dspace.msu.edu.ua:8080
Веб-сайт Наукової бібліотеки МДУ: http://msu.edu.ua/library/