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Published in the Slovak Republic
European Journal of Contemporary Education
E-ISSN 2305-6746
2021. 10(3): 638-652
DOI: 10.13187/ejced.2021.3.638
www.ejournal1.com

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Practical Activity on Developing a System of Tasks as a Condition for Training A Future Digital School Teacher

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Abstract

The problem that the research is aimed at is caused by the need to resolve the contradiction between the public demand for the quality of training the future digital school teacher regarding the formation of information culture, creativity, communication skills, the ability to work in a team, readiness for change, and the insufficiently developed methodological base for training graduates that meet these requirements.

The purpose of the study is to theoretically substantiate and experimentally test the need to involve students of pedagogical specialties in practical activities to design a system of specially selected tasks as an important condition for training future digital school tutors.

The methodology of the research is the analysis and generalization of scientific works on the organization of cognitive activity of students of pedagogical specialties. Learning.apps, interactive worksheets, cloud services, Learnis, etc. are used as software tools for the design of practice results.

The results of the study. The types of tasks (situational and motivational; reference; borderline) are identified. The development in the direction of intensification and extension is proposed for the system of tasks. The features of organizing practice and the methodological component are described on the example of studying topics of the theory and methodology of teaching computer science.

The conclusion gives findings confirming that involving students in practical activities to develop a system of their own tasks really contribute to the formation of professional competencies of future digital school tutors.

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Keywords: educational task, system-activity approach, perception, competence, digital environment, quality of training, professional activity.

1. Introduction

1.1. Relevance of the problem

The context of modern requirements for the quality of higher education, the formation of digital skills brings up to date the issues of additional study of pedagogical conditions that ensure the effective formation of professional competencies and personal qualities of future specialists (Soboleva, Karavaev, 2020). As M.A. Egorova notes, the search for answers to these questions (methodological, software-technical, content-oriented) is of particular importance for training students of pedagogical specialties (Egorova, 2017).

According to the professional standards, a future digital school teacher will be required to possess a high level of skills and abilities that make up the essence of digital literacy, teamwork, project management in the uncertain and contradictory conditions of the future (Soboleva, Perevozchikova, 2019). For a teacher to successfully fulfill his/her duties, it is important to be a creator, a researcher (Khutorskoy, 2017).

In addition, the transition of schools to the new federal state educational standards, according to O.M. Kryvonos, has designated an activity-based approach to learning as a priority (Kryvonos, 2014). The digital school teacher is given the function, without waiting for new textbooks, innovative methods and technologies, to change the traditional content, to transfer it from "knowledge" to "task". The implementation of this function assumes that at the level of training in a higher educational institution, the teachers will study and acquire the following competencies themselves:

- how to relate the task, the means of action (technique, rule, algorithm) and the new knowledge that students will be able to acquire later under the guidance;
- how to formulate a research problem;
- how to turn a specific practical situation into a learning task;
- how to motivate students and guide them along the path of "ignorance-knowledge-understanding".

In practice, as L.M. Kalyanova (Kalyanova, 2019) notes, the formation of the noted competencies and the required personal qualities of a student of a pedagogical specialty takes place mainly due to adaptation of a variety of innovative technologies, tools that intensify knowledge and activity in the digital environment. In other words, the range of possible tools of a professional teacher, the "portfolio", is expanding. However, the question remains open about the feasibility of using these tools, choosing the most effective one, corresponding to both the capabilities of the teacher and the individual needs of the student.

At the same time, there are various studies confirming that it is task-based learning that motivates obtaining new knowledge: to organize various forms of cooperation, resolve conflicts, intensify cognition (Chileva, 2018); to support the individual path of personal development, to promote career guidance and socialization in society (Kazakova, Klyoster, 2018).

Thus, there is an objective problem, which is expressed in the need to improve training of future digital school teachers, taking into account the requirements of professional standards, modern challenges and employers' demands for the quality of higher education.

1.2. Goals and objectives of the study

The goal of the study is determined by the need to involve students of pedagogical specialties in practical activities to design a system of specially selected tasks to improve training of future digital school tutors.

Research objectives:

– to specify the terms "educational task", "system of tasks" for the digital environment;

– to describe the types of tasks (situational and motivational; reference; border) for organizing the practice;

– to formulate the features of practical activity in the design of their own tasks on the example of studying topics on theory and methodology of teaching computer science: independent determination of the plot, development options in the direction of intensification and extension;

– to confirm experimentally the effectiveness of the proposed educational and cognitive activities for the formation of qualities and competencies of a teacher that determine his/her future professional activity in the digital environment.

2. Relevance

2.1. Review of Russian scientific and pedagogical literature

The provisions of the Standard of the teacher's professional activity define the competencies and personal qualities, which formation is most important to the quality of higher education taking into account the challenges of the time and the demands of employers (Prikaz Mintruda...). The corresponding changes in training of future teachers for theie successful performance of professional duties in the digital environment are defined by E.V. Soboleva, N.L. Karavaev, M. S. Perevozchikova (Soboleva et al., 2017). A.V. Khutorskoy justifiably notes that there was no period in the development of modern education comparable to the current changes in pace and quality characteristics (Khutorskoy, 2017).

O.I. Vaganova et al, also basing on the content of the current standards, believe that it is necessary to focus not only on the transfer of knowledge, but also on the acquisition of skills (Vaganova et al., 2020). The most important idea of the modern educational system, according to S. Skvortsova, is the acquisition of new knowledge through a task (Skvortsova, 2018). The solution of a system of educational, specially designed tasks supports the implementation of provisions of the system-activity approach to learning, the main theses of L. S. Vygotsky (Tolstykh, 2020). According to V. Chileva's conclusions, it is most important, within the framework of the system-activity approach demanded by the modern school, to organize practice for active application of knowledge and skills in practice (Chileva, 2018). Appropriate practice-oriented technologies are especially important in training students of pedagogical specialties.

D.B. Elkonin justifies that the activity approach in the digital educational environment is implemented through the task approach (Elkonin, 2020). A.P. Grigoriev, S.G. Burlutskogiy, A.O. Chernelevsky hypothesize that it is the task-based approach, the design of the system of educational author's tasks that will create additional didactic opportunities for the formation of the required competencies (digital literacy, teamwork, project management in uncertain conditions of the future) and personal qualities (creativity, systematic and analytical thinking, curiosity, self-organization, imagination, etc.) (Grigoryev et al., 2018).

The educational task that the teacher offers to the student, and which serves the goals of learning and development, as D.B. Elkonin points out, on the one hand, is focused on the assimilation of a certain way of action (Elkonin, 2020). This is its fundamental difference from the specific production task, aimed at obtaining results. On the other hand, the educational task as a component of cognitive activity allows you to implement the function of controlled influence. The task supports the direction of the subject of knowledge along the path from the zone of actual development to the zone of immediate development. Thus, the task approach starts the process of obtaining qualitatively new knowledge, it is directed by the teacher and is implemented using a system of specially selected tasks.

L.M. Kalyanova concludes that socially demanded specialists should be able to solve non-standard tasks, situational practice-oriented tasks. At the same time, the desire for success (positive goals) is, in her opinion, the driving force in cognition (Kalyanova, 2019).

M.G. Sergeeva et al. believe that the competence-based and practice-oriented approaches have become dominant in organizing independent work (Sergeeva et al., 2019). In order to achieve the necessary/socially demanded competencies, students should be involved in cognitive activities to solve practice-oriented tasks (Shmigirilova, 2018).

G.S. Larina, A.V. Kapuza determine that the main tasks of training a modern graduate should be the development of skills to solve unfamiliar problems, quickly navigate large amounts of information, make decisions in a situation of uncertainty (Larina, Kapuza, 2020). They provide examples of tasks that require analysis or evaluation, and are associated with a large cognitive load. For such tasks, according to G.S. Larina and A.V. Kapuza, students use "high-order cognitive processes". There are also examples of tasks, where you need to apply the mastered algorhythm of actions, solve an equation with two variables. It is experimentally proved that the system of tasks proposed by the teacher is a mechanism that triggers cognitive activity.

M.M. Abdurazakov et al. propose a model for designing a series of training tasks based on the concept of a three-component structure of mental actions (O-orientation, E-execution, C-control) (Abdurazakov et al., 2019). E.A. Vasenina, E.V. Harunzheva, M.V. Petukhova, and E.V. Soboleva (Vasenina et al., 2018) have described in detail the issues of organizing information interaction and working together to discuss the system of tasks. They distinguish the stages of designing a system of their own exercises for educational purposes: from the discussion of a ready-made system of tasks selected by the teacher for the lesson, to the development of author's tasks. However, they also note that the formation of appropriate skills in the framework of university training is complicated by a number of problems of a software-technical and methodological nature: how to choose reference and core tasks; where to start formulating your own author's tasks; how to start the process of their discussion, reflection; how to formalize and effectively present the results of cognitive activity.

2.2. Review of foreign studies

From the point of view of innovation in science and industry, the ability to formulate new tasks is no less important than the ability to solve ready-made ones. Moreover, A. Natsis, P. M. Papadopoulos, and N. Obwegeser note that this is a mandatory element in the design of modern vehicles, installations, and cyber-physical systems (Natsis et al., 2018). A. Semple emphasizes that works on the potential of the system of educational tasks in terms of training future socially demanded specialists are becoming relevant (Semple, 2020). The issues of information interaction in solving a system of practice-oriented tasks and non-standard situations are considered in the research of many modern scientists.

G.A. Zuckerman conducted an experimental study of student interaction, its structure and role in shaping the results of developing learning (Zuckerman, 2020). In his work, he adheres the theory and practice of educational activities developed by D.B. Elkonin, V.V. Davydov. He considered the problematic issues: what forms of cooperation and information interaction are most appropriate for the content of cognitive activity to acquire new knowledge; what is the role of cooperation with peers in the formation of the ways of action (i.e., skills and abilities). The author formulates new problems that teachers face when organizing such cognitive activities in a digital environment. According to the results, it is concluded that the provisions of the Elkonin-Davydov concept are effective for improving the quality of learning and cognition.

Using a system of dynamic tasks focused on the management of students' educational and cognitive activities, the paper reveals one of the possible approaches to the joint study of complex scientific material (Zarei et al., 2016). D. Milusheva-Boykina believes that the optimal process of forming elements of research activity is carried out through the methods of joint assimilation of theoretical content by students in the process of its practical application (Milusheva-Boykina, 2020).

A. Natsis, P.M. Papadopoulos, and N. Obwegeser justify the need to use digital technologies to formalize the results of task solving (Natsis et al., 2018). In addition, the research of M. Hamada, M. Hassan suggests that the inclusion of software tools is a support in forming digital literacy, professional competencies of the future specialist. They draw conclusions that information technologies support almost all areas of human activity (Hamada, Hassan, 2017).

P. Sullivan et al. justify the importance of including practical activities with an educational task in training future teachers (Sullivan et al., 2020).

The ability to automate activities, and thus the ability to successfully work and continue learning in a digital society, is determined by the ability of its members to use computers, or more precisely, information technologies, to solve practical problems. However, a person who seems to have mastered some digital technology (or rather, a set of methods and techniques for working with a specific software tool) often finds it difficult to relate the task facing him/her to it (Chen et al., 2018).

C. Roure, D. Pasco emphasize the potential of a system of educational tasks to support cognitive activity, curiosity, and creativity (Roure, Pasco, 2018). In addition, they believe that thinking through the history, content and conditions will contribute to implementing the principles of an interdisciplinary approach to learning, forming communication skills.

Learning in a digital environment should be accompanied by a systematic analysis of the results of students' feedback (completed tasks, responses to questions), recorded in workbooks (electronic or traditional), and take place in the format of an oral discussion (Semple, 2020). Only

this form of activity works as much as possible to improve the quality of training graduates, forming socially demanded professional competencies (Esquicha-Medina, 2018).

Thus, the analysis of the scientific and methodological literature made it possible to justify the need to improve training future digital school teachers, the importance of including the practice of designing a system of specially selected tasks in their educational and cognitive activities.

3. Materials and methods

3.1. Theoretical and empirical methods

The methodological basis of the research is based on the competence- and activity-based, personality-oriented and communicative approaches to the organization of training at the university. To obtain theoretical generalizations, we use the analysis of theoretical sources and documents from the field of education, generalization of the results of processing an array of empirical data.

The most important idea is acquisition of new knowledge through a task. The solution of the system of educational, specially designed tasks supports the implementation of the system-activity approach. Educational tasks, which are the object of construction, imply the need for a conscious search for an appropriate means to achieve an intuitive, but immediately inaccessible goal. The goal is achieved in the process of construction with the help of acquired methods.

The features of arranging practical activities for the construction of their own tasks are presented on the example of studying topics of theory and methodology of teaching computer science. Learning.apps, interactive work sheets, cloud services, Learnis, etc. are used as software tools for registration of practice results.

When developing specially selected, author's tasks, the following principles of designing a system of educational tasks were taken into account: setting the task; establishing links between the constructed task and the accumulated knowledge reserves; anticipating at least intuitively the result; critical analysis and drawing up a plan; plausible reasoning (the period of inspiration); full understanding of the relationship between the previous stages.

A special group consists of empirical methods (observation, analysis of the results of practice on designing a system of specially selected tasks) to obtain up-to-date information about changes in the level of qualities and competencies of students of pedagogical specialties that determine their future professional activity in the digital environment.

A special incoming and final control events were held, in which students were asked to perform tests on the topics of the school course of computer science (25 questions), on the methodology of teaching informatics (25 questions) and on working with the task condition (25 questions). The materials for the test were developed by the authors in accordance with the Standard of higher education in the field of training (Federal'nyi gosudarstvennyi obra-zovatel'nyi standart...., 2015). There are 75 tasks in testing, mostly of the open type.

Statistical analysis of the results reliability of the pedagogical experiment was evaluated using the Fisher criterion (Fisher angular transformation).

3.2. The base of research

The evaluation of the effectiveness of educational and cognitive activities in constructing a system of specially selected tasks for the formation of qualities and competencies of students of pedagogical specialties that determine their future professional activity in the digital environment was carried out in the course of a pedagogical experiment.

The study was carried out on the basis of the Vyatka State University as part of teaching the discipline "Theory and methods of teaching computer science". 120 students of the fourth and fifth years of the training field 44.03.05 Pedagogical education (with two training profiles, the level of bachelor's degree) took part in the practice of developing a system of author's tasks. The sample was not random. The experimental group included 60 % of girls and 40 % of boys, which is due to the specifics of the pedagogical specialty.

To fulfill the rules of probabilistic selection, the same teacher led the practice of all students in designing a system of author's tasks. Practical activities were organized in the same classrooms, on the same hardware and software. To carry out control events, the authors developed test tasks. All questions meet the requirements of the State federal educational standards for the given field of training.

3.3. Stages of research

The research was conducted in three stages.

The preparatory stage of the experiment included general assessment of the existing level of theoretical knowledge and scientific terms, skills of working with a ready-made system of tasks, and methods of working on the task.

As part of the control event, students were asked to complete tests on the topics of the school course of computer science (25 questions), on the methods of teaching computer science (25 questions) and on working with the task condition (25 questions). Types of tasks: correlate values, insert a missing word, remove odd ones, select the correct statement.

Thus, it was possible to collect data on 120 students. Further, the participants were divided into groups (60 in the experimental group, and 60 in the control group) to ensure that each group has the same qualities and competencies that determine the future professional activity of graduates in the digital environment. The sample was not random. The experimental group consisted of 60 % of girls and 40 % of boys, which is due to the specifics of the given specialty.

Further, as part of the forming stage of the experiment, the teacher conducted practical classes and seminars with all participants of the experimental group, during which cognitive activities were organized to work with the task plot, analyze its solution options, and develop their own system of tasks based on it. Initially, students could use educational literature, Internet resources, and the help of others to construct a sequence of tasks, namely as a system.

The third stage of the study covers the experimental teaching and organizing practical activities on the design of specially selected tasks for the formation of the qualities and competencies of students of pedagogical specialties that determine their future professional activity in the digital environment.

4. Results

4.1. Clarification of the essence of the basic concepts

The system-activity approach in the presented information educational environment is implemented through the task approach. It is based on the students' cognitive activity, which can be considered as a system of processes for solving various educational tasks. At the same time, the concept "educational task" can be interpreted quite broadly. For example, this is a task that forces the student to look for a common way to solve all problems of this type. Or "the objective result of the logical-psychological analysis of the content of learning". In general, the idea is that in the course of the work performed to solve the problem, the student receives qualitatively new knowledge. The system of tasks in the presented study is understood as the sequence of tasks, the solution of which accompanies students' activities in working with information resources, highlighting and selecting the main in the resource, team work, arguing the point of view and defending the opinion, beliefs and aspirations for research.

The development of own or the author's system of tasks involves independent determination of the plot (plot basis) of the task, options for modification due to its development, both in the storyline and in the method/methods of solution. At the same time, tasks should be designed so that their presentation directs students to acquire new knowledge. Arranging practical activities for the design of such a system of tasks is an important requirement for the training of a highly qualified teacher of a digital school, as it contributes to the development of qualities and competencies that are most in demand in the modern information society. For example, understanding the fundamental foundations of scientific disciplines, knowledge of digital technologies, readiness for creativity and innovation, ability to self-education, self-organization, multilingualism, communication skills, development of an analytical mind, etc.

The system of tasks in the presented study develops in two directions: extension and intensification.

The first direction involves the gradual development of the plot by connecting a new theoretical fact, condition, and constraint. An example of a system of task built on the principle of "breadth-first" development.

1.1. Depending on the number entered from the keyboard, display the corresponding message.

1.2. Depending on the number entered from the keyboard, perform an action on the data and display the result on the screen.

1.3. Calculate the value of a complex expression.

1.4. Create a program that outputs the following message: "Enter 1 if you want to see a circle, and 2 if you want to see a rectangle". Depending on the number entered, the corresponding figure is displayed.

In the second case, the problem develops due to the fact that a new method/technique of solution appears. At the same time, the very wording and plot basis are not changed.

An example of a system of tasks built on the principle of development "in depth". Let a and b be the values of the original variables. You need to change their values:

- using the additional variable «c»;
- without an additional variable:
- without an additional variable and so that the expression on the right side is the same in all three assignment operators.

4.2. Practical activity on designing the system of author's tasks

The practice of developing a system of own tasks was implemented both when studying the sections of algorithmization/programming (I/O commands, branch and loop constructs, strings and arrays), and when working with information technologies, forming the foundations of information security.

The procedure for selecting the first, main task, from the condition of which the students subsequently formulated the further development of the plot, the possible complication, took place in several stages:

Stage 1. The task formulation was suggested by the teacher.

Stage 2. The first task was selected from a textbook, a workbook, and methodological recommendations. A prerequisite was that it was necessary to use the printed version of the publication.

Stage 3. The students were looking for the plot of the task, condition on the Internet, electronic sources of information.

Stage 4. The idea, the plot of the task was suggested by one of the classmates. In the course of reasoning, general discussion, the formulation took on a complete form and was the starting point for further research.

Stage 5. The student was completely independent in formulating the first task for the system of tasks. A prerequisite was the subsequent general discussion of the resulting author's systems, their improvements.

The first recommendation: no plot, no idea, should be discarded, criticized. All the results obtained are the result of the student's creative and intellectual activity. Getting only a negative experience can push him away from further research studies.

The second recommendation. It is mandatory to work with printed copies of educational literature. A future digital school teacher should know, understand, and be able to work with paper publications. A word, a sentence, a text is the basis for the formation of communicative literacy in any society, especially in the information one.

The system of tasks was designed in electronic and printed forms. The results of the paper version were printed twice: before the discussion and after. Each option remained with all participants of the training. Joint practice in the group took place on the electronic version, which could be presented on a cloud service, using virtual sticker boards or special software tools (for example, LearningApps).

The practical activities on the development of a system of own tasks was carried out within the framework of the discipline "Theory and methods of teaching computer science" for the specialty 44.03.05 Pedagogical Education (with two training profiles). Next, we will present the author's systems of tasks compiled by future teachers to study fundamental foundations of algorithmization, formation of information security skills and competencies in the field of project management.

I. The system of tasks for studying basics of algorithmization and programming.

As a basic task, the teacher proposed the following task for students: "To develop a program that asks for the name of the user and greets him."

1. Using the calendar, determine how many days are left until the New Year and develop a program that will display a message with this number on the screen.

2. We have determined how many days are left until the New Year. Develop a program that will help you make a gift purchase plan.

3. Now let's make a program that counts the number of days remaining from the moment you buy a gift for a particular person until the New Year.

4. Imagine that you were asked to buy an avocado for the New Year and were given 150 rubles for the purchase. Upon arrival at the store, you found that the price tag shows the price for 100 grams of the desired product. How many kilograms of avocado can you buy if 100 grams of avocado are sold at 30 rubles?

5. You need to buy lots and lots of avocados and take them away on a sled. Let's use the following program to determine how many kilograms of avocado you can buy if you can only take 10 kilograms of cargo on a sled. Each kilogram of avocado is sold in boxes weighing 300 grams.

II. The system of tasks for the formation of the basics of information security.

Students had to take into account two training options: without a computer and with its help.

The variant where the computer was not used in the solution.

Task 1: correlate the terms with their definitions, filling in the gaps with the following phrases: confidentiality of information, information security, availability of information, threat, integrity of information.

Task 2: Determine which of the following applies to computer viruses, and which to antiviruses. Fill in the table.

Materials for work: Dr. Web, Avast!, Code Red I, Kaspersky Internet Security, Melissa, Nimda, Avira, McAfee, ILOVEYOU, Norton, "Storm", Trojan horse, Network worm.

Task 3. Determining the reliability of information.

Practical situation. In a social network, a good friend of yours, with whom you corresponded not so long ago, started a conversation. He asked how you were doing. He told you that he was doing well, too. After that, your friend said he wanted to make a call to you. But he just ran out of money on the phone. The promised payment has already been used. He asks you to "throw" 50 rubles to his phone.

Questions: How can you check if this is actually written by your friend? What actions should you take?

Task 4. Search for information. Practical situation. You were ill for a whole week and couldn't attend school. When you returned, it turned out that at computer science lessons the mates had already studied the topic "Information and its properties". The teacher recommended that you carefully study this topic in the textbook, for a better understanding, download the presentation from the Internet. You went to the site https://uchitelya.com/informatika/16673-prezentaciya-chto-takoe-informaciya-3-klass.html. What are the criteria for finding the "icon" that you need to click on to download the presentation to your computer? In the drawing, circle the element that you select to start downloading the presentation.

Task 5. Using the available knowledge, the material from the textbook, the Internet, make a memo-table on how to protect yourself from intruders on the network. Columns of the table: "Threat on the Internet", "Where can I deal with this threat?", "How can I protect myself from such a threat?"

The variant in which the computer is actively used to solve a system of tasks.

Task 1. Correlate the terms with their definitions, filling in the gaps with the following phrases (information resource: https://learningapps.org/display?v=pji11g04320).

Task 2. Determine which of the following applies to computer viruses, and which-to antiviruses. Fill in the table (information resource: https://learningapps.org/display?v=ph8oqr06j20).

III. The system of tasks for the development of competencies in the field of project management

Mind-fitness coach Aurelius, having worked in the profession for 5 years, accumulated a start-up capital and decided to open his own center for providing services. All this time, he rented a small room 30 square meters with a monthly payment of 350 rubles/month per 1 square meter. Since the area of the room was small, the specialist often had to go to the customer's territory. For example, to arrange collective trainings, if large groups were formed.

At the start of the business venture, Aurelius intended to rent a larger finished office. However, after learning more about the state support programs for small businesses, he decided to

build his own premises for the center with an area of 100 square meters from scratch. It is required to evaluate the economic efficiency of the project by performing calculations according to the following scheme:

1. Determine the costs required to start the project.
2. Make a forecast of the economic effect of the project.
3. Calculate the economic efficiency indicators of the project.

The first version of the task development. The project for the construction of the Center has been successfully completed. Further, Aurelius decided that part of the Center's area could be rented out for offices or creative studios. Perform an assessment of the economic efficiency of this project using a similar method: determine the costs for starting the project (for example, the construction of partitions, a separate entrance, etc.); make a forecast of the economic effect (one of its components can be considered rental income or payment of part of utility bills by the tenant); calculate the economic efficiency.

In addition, select the values of the interest rates and the duration of the project in such a way that it is really beneficial to the organizer.

The second variant of the task development. The project for the construction of the Center was successfully completed, Aurelius' business brought a good income and new visitors. There was a situation that he was even forced to refuse some customers. Therefore, the entrepreneur decided to expand his staff and attract another coach. You need to perform an assessment of the economic efficiency of the project using a similar method: determine the costs required at the start of the project (for example, to lay a salary fund for a specialist, organize his workplace, etc.)); make a forecast of the economic effect (for example, an increase in the price of services and the volume of sales of services); calculate the economic efficiency of the project. Also, select the values of the interest rates and the duration of the project to get a real benefit.

Thus, students of pedagogical specialties were actively involved in cognition, experiment and information interaction. They presented some of the constructed systems of tasks at international conferences (for example, the X International Conference-competition "Innovative information and pedagogical technologies in the IT education system») and they were marked by experts.

The results obtained correspond to the conclusions of G.A. Zuckerman on the influence of the choice of a traditional/developmental educational system on the quality of the knowledge received, on the style of thinking (stereotypical or innovative) (Zuckerman, 2020). At the same time, the recommendations formulated enlarge the proposals of E.V. Soboleva, N.L. Karavaev, and M.S. Perevozchikova on improving the training of future digital school teachers (Soboleva et al., 2017).

4.3. Experimental assessment

4.3.1. The ascertaining stage of the experiment

The preparatory stage of the experiment included a general assessment of the existing level of theoretical knowledge and scientific terms, skills of working with a ready-made system of tasks, and methods of working on the task.

As part of the control event, students were asked to complete tests on the topics of the school course of computer science (25 questions), on the methods of teaching computer science (25 questions) and on working with the task condition (25 questions). The materials for the test were developed by the authors in accordance with the Standard of higher education in the field of training. The test contained 75 tasks. Types of tasks: correlate values, insert a missing word, eliminate odd ones, select the correct statement.

Here is an example of the task on theory and methods of teaching computer science: "Choose the right statement that characterizes the essence of the Atlas of New Professions: a federal innovation platform among institutions of additional education; an almanac of promising industries and professions for the next 15-20 years; career guidance testing; a creative agency specializing in the development of advertising and marketing solutions for business."

The example of the task for a school computer science course: "Set the relationship between the hardware and the definition.

First list: Personal computer; Mobile phone; Smart-TV; PlayStation.

Second list: a device for receiving and displaying graphics, sound; an electronic device designed and created for video games; an electronic device designed for a single user operation; a tool designed to work in the networks of mobile operators".

The example of the task for working with a task condition. There is a formulation "Selection of array elements by criterion (recalculate, derive, add)". You can take from the list of tasks those that do not correspond to this type: find the sum of grades for a term, determine the number of unsatisfactory grades, calculate the arithmetic average for the subject.

Each test question was rated at 2 points. Thus, for completing the control event, students could score 150 points. The mark "credit" corresponded to the situation when the student scored 76 points or more. For all other cases, the mark was "no credit".

Thus, it was possible to collect data on 120 students. The input control event renealed almost the same initial level of readiness of the participants of the pedagogical experiment. We can consider them as a general sample. Then the experimental (60 students) and control (60 students) groups were formed. The sample was not random. The experimental group consists of 60 % of girls and 40 % of boys, which is due to the specifics of the specialty.

4.3.2. Forming stage of the experiment

As part of the forming stage of the experiment, the teacher conducted practical classes and seminars with all participants of the experimental group, during which cognitive activities were organized to work with the task plot, analyze its solution options, and develop their own system of tasks based on it. Initially, students could use educational literature, Internet sources, and the help of others to construct a sequence of tasks, namely as a system.

The study of the topics of the course "Theory and methods of teaching computer science", their detailed methodological analysis in the control group took place without a specially organized practice to develop a system of their own tasks. As a material for consolidating knowledge, forming skills and abilities that correspond to their future professional activities students used any ready-made task systems which were also discussed in the group. Based on the results of joint work, students were not required to develop their own/author's system of tasks.

After including in the study of the discipline "Theory and methods of teaching computer science" such cognitive activity, supported by various information sources and digital means, corresponding to all types of professional activity of a graduate of the specialty 44.03.05 Pedagogical Education (with two training profiles), another test was conducted. The questions for the test were developed in accordance with the principles described earlier.

Examples of tasks from the final control test.

The question on the theory and methods of teaching computer science: "From the list of scientists who have contributed to the informatization of education, delete the names of those who are not the authors of school textbooks on computer science and ICT. List: A.P. Yershov, A.G. Gein, V.G. Zhytomyrsky, I.V. Robert, A.G. Asmolov, K.K. Kolin, A.A. Kuznetsov".

The question on the course of school computer science: "Compare the object of the real world with its possible information models.

Object: Construction company, Cat, Saturn, Country house, Polyclinic patient, Flower, Chemical element, Kirov.

Information model: A verbal description of the plant, a house plan, a review on the official website, a photo of the animal, a Periodic Table, a globe, a city map, a patient's file".

The question on working with the task condition. When completing the task, the student received the value 11. From the proposed task formulations, choose the one that can lead to such a result.

1. How much information is contained in the message: "PlayStation".

2. Wanting to help his friends, the student carefully whispers the answer to the neighbor: "Chlorine". The last student wrote "Bor" in the answer. Only the first student received a score for this answer. How and how many times was the information corrupted?

3. Create a program that forms a character string consisting of N asterisks (5<=N<=25).

4.3. 3. Control stage of the experiment

The control stage of the experiment carried out recurrent testing which included also 150 questions. The results of testing before and after the experiment in Group 1 (control – C) and Group 2 (experimental – E) are presented in Table 1.

Table 1. The results of the test

	Before the experiment		After the experiment	
	Group 1(C)	Group 2(E)	Group 1(C)	Group 2(E)
Number of students with "credit"	30 (50%)	31 (51.7%)	34 (56.7%)	47 (78.3%)
Number of students with "no credit"	30 (50%)	29 (48.3%)	26 (43.3%)	13 (21.7%)

Verification of the results reliability is implemented by means of an online calculator for the Fisher criterion (https://www.psychol-ok.ru/statistics/fisher/). The critical value of the Fisher criterion for the significance level of 0.05 (φ_{cri}) is 1.64. The following hypotheses were accepted:

Hypothesis H0: the level of training of students of pedagogical specialties in Group 2 (experimental – E) statistically is equal to the level in Group 1 (control – C);

Hypothesis H1: the level of training in Group 2 (E) above the level of Group 1 (C). Empirical value of the Fisher criterion before the experiment equals 0,186 ($\varphi_{emp}=0.186<\varphi_{crit}=1.64$).

Therefore, before the experiment begins, the hypothesis H0 is accepted. The value of the Fisher test after the experiment is 2.558 ($\varphi_{emp}=1.64<\varphi_{crit}=2.558$). Hypothesis H0 is rejected and H1 is accepted.

So, the inclusion of students of pedagogical specialties in the practice of designing specially selected tasks really contributed to the formation of qualities and competencies that determine their future professional activities in the digital environment.

5. Discussion

The sample of students was not probabilistic, since the experimental and control groups were formed in such a way that it was guaranteed that each group had the same qualities and competencies that determine the future professional activity of students of pedagogical specialties in the digital environment.

For diagnostics, the results of the input control event were taken into account. The selection of participants for the experiment and the sample size are justified by the specifics of the study: the study of the theory and methods of teaching presupposes knowledge of the content of the school course of computer science, general pedagogy and psychology. Throughout the experiment, the work on designing specially selected tasks was carried out by the same teacher, using the same software in special classrooms. Both didactic principles and the specifics of computer science training were taken into account in implementation.

Designing a system of own tasks or selecting ready-made tasks that guide the student in cognition is characterized by: planning the work; flexibility of mind, the ability to look at the object of knowledge from different sides; persistance; open perception to the search for new solutions; the ability to realize, critically evaluate the results obtained.

Generalizing the experience of the participants of the experiment, we will formulate a number of methodological recommendations that should be followed by the teacher when teaching the theory and methodology of the subject:

1. Practical activities to develop a system of own tasks should include as a mandatory element learning through error. Being able to find mistakes, correct them, understand the causes, and predict their occurrence is a highly socially demanded competence in a digital society.

2. The development of a system of tasks will prepare a digital school tutor to predict the results of the behavior of the entire pedagogical system, the stage of his/her professional training includes cognitive activity to analyze possible options and outcomes. In this sense, tasks with the following plots are useful: "determine the result of the algorithm/program if ...", "take such input values for variables so as...", "which technology is optimal for...". Such tasks teach to think in terms of the possible future, i.e., foresight thinking, which is in demand in the digital society, is formed.

3. All participants of the practice should be active subjects of knowledge, which involves inclusion of interactive technologies and implementation of the feedback principle. In the present study, students of pedagogical specialties used LearningApps, interactive worksheets, cloud services, Learnis, etc.

4. In most cases, new knowledge should be obtained in the course of an independent search. "Ready-made" solutions should be avoided. Overcoming difficulties and limitations is an important skill of the user of the digital environment.

5. The work on the construction of a system of tasks and its solution should prepare the student of the pedagogical specialty to accept contradictory information. Such work is necessary in order to be able to draw new knowledge from the contradiction. For example, tasks where the addition of two positive integers results in a negative one will be useful.

6. To provide the ability to work with information sources of different nature, different types (e-learning resources, printed textbooks, scientific, technical and methodological literature, media, society, etc.).

7. Inclusion in the information educational environment of the system of educational tasks constructed in accordance with the above requirements implies the willingness of the teacher to manage multiple concurrent cognitive processes within one lesson.

In general, the dynamics of values by levels indicates a qualitative improvement in learning indicators and formation of the monitored qualities and competencies of the future digital school teacher in the experimental group (see Figure 1).

Performing a quantitative analysis of the above results, we can conclude that after organizing practical activities for designing a system of their own tasks, the share of students in the experimental group who successfully completed the test increased from 51.7 % to 78.3 %. In the control group, the proportion of students who studied the theory and methodology of teaching informatics in the traditional format also increased, but less significantly. Dynamics of positive changes: from 50 % to 56,7 %.

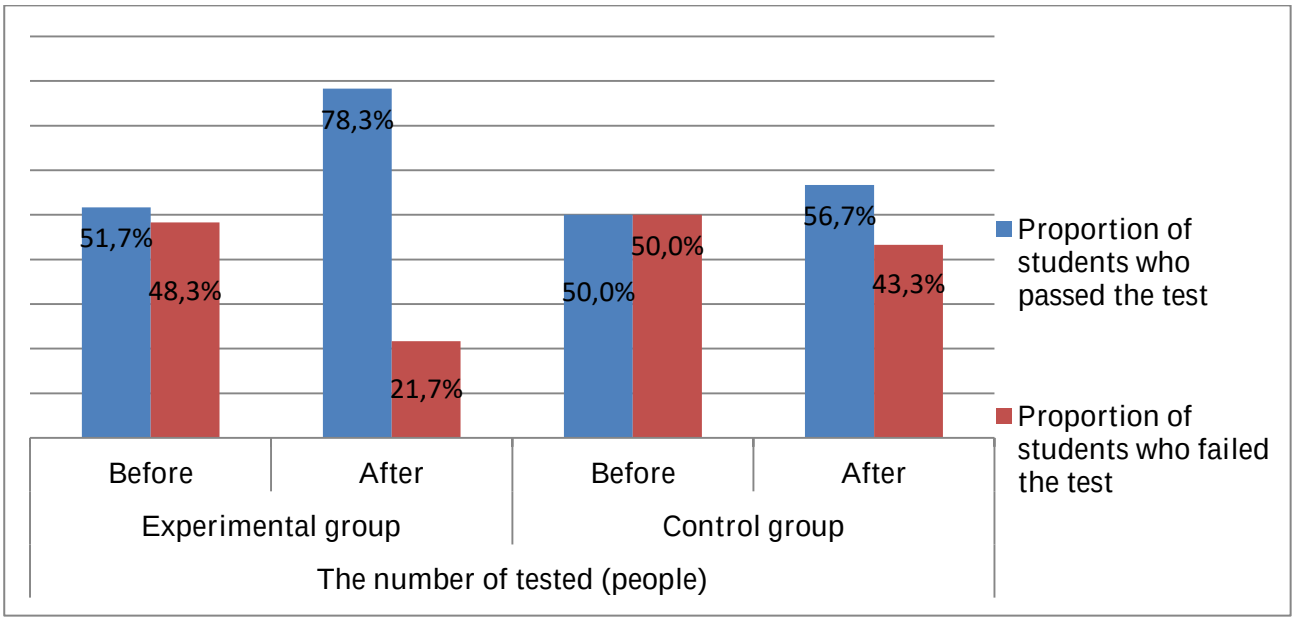

Fig. 1. Dynamics of changes in the level

Statistical analysis of the results reliability of the pedagogical experiment was evaluated using the Fisher criterion (Fisher angular transformation). The value of the Fisher test after the experiment is 2.558 ($\varphi_{emp} = 1.64 < \varphi_{crit} = 2.558$).

In the presented study, the following types of tasks were used: situational-motivational (encourage the search for new knowledge); reference tasks (set the direction for the development of the plot, conditions); borderline (serve as a basis for further research, connect the points of the path of the student's development from "existing knowledge to new knowledge"). All tasks

presented are practice-oriented. The developed task systems are the result of creative intellectual activity, so a specific ("excellent"," unsatisfactory") rating scale should be avoided.

Of course, the volume of independent research activities has increased, and the time for home preparation has increased. But the experiment proved that it really contributed to the formation of personal qualities and professional competencies of students.

6. Conclusion

The study presents a solution to the problem caused by the need to resolve the contradiction between the social demands for the quality of training of the future digital school teacher and the insufficiently developed methodological base for training graduates that meet these requirements. One of the features of teaching the theory and methodology of teaching the subject (in particular, teaching computer science) is that the applied technologies and teaching tools should be focused on the formation of personal qualities, skills and abilities of the future teacher, which form the basis of his/her professional competence.

The results of the study are both theoretical and practice-oriented. Scientifically significant theoretical achievements include: clarifying the terms "educational task", "system of tasks" in the context of the professional activity of the teacher in the digital educational environment. The definition of the essence of the concept "system of own/author's tasks" as a system of tasks, the construction of which implies an independent definition of the plot, options for its development, is presented. The types of tasks (situational and motivational; reference; borderline) are distinguished.

For the system of tasks, the paper suggests a development in the direction of intensification and extension. For each variant, examples are presented that illustrate the essence of these areas of modification.

As practical results of the research, we consider it important to note the formulated features of the organized practical activities for the development of a system of own tasks for digital school:

– special attention should be paid to the choice of the first, main task, from which the development of the plot will take place;

– when formulating the plot basis (the task plot), use various information sources and digital resources;

– be sure to provide an option for learning without a computer, when tasks are completed in a notebook;

– the system of tasks should guide the learner in cognition: from the actual zone to the zone of immediate development;

– avoid harsh evaluative criticism of the system of tasks designed by students of pedagogical specialties;

– mandatory oral discussion of the constructed task systems in the group;

– gaining experience in developing their own task system should prepare the digital school tutor for predicting the results of the behavior of the entire educational system, taking into account the uncertainty of the future.

The study describes in detail the potential of practical activities for the development of a system of author's tasks and its organization in the course of teaching the discipline "Theory and methodology of teaching computer science" in the direction of training of the specialty 44.03.05 Teacher education (with two training profiles).

The research materials can be used to improve the level of training of students of pedagogical specialties, to form the qualities and competencies that determine the professional activity of a teacher in the digital environment, through specially organized areas of support for students' practice in designing a system of author's tasks.

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