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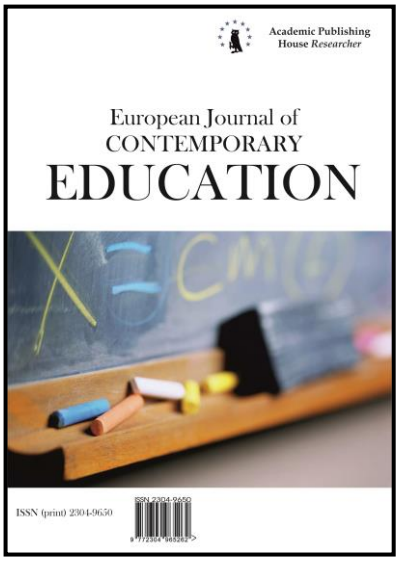


# Quest in a Digital School: the Potential and Peculiarities of Mobile Technology Implementation

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**Abstract**

The problem of the research is due to the need to realize the didactic and interdisciplinary potential of mobile applications which are able to support the quest technology. Teachers have to understand peculiarities of organizing such a game form of activity in a digital school.

The purpose of the study is to theoretically prove and experimentally test the effectiveness of using mobile game applications in the "quest" genre in order to form necessary competencies of future specialists in a digital school environment.

The research methodology is the analysis and synthesis of psychological and pedagogical work, methods of mathematical statistics, and methods of psychodiagnostics. The pedagogical experiment of the study is the assessment of the formation of basic competences which provide the base in the field of computer science, cybernetics and artificial intelligence required by the state and society.

Results of the study. The study proves the didactic potential of mobile applications which are able to support the quest technology in order to achieve high-priority objectives in the project "Digital School". The authors describe ideas of the methodical approach, which reflect the necessary changes in the support of students' cognitive activity through mobile game applications in the quest genre. The study shows levels of differentiation of education depending on the individual and age characteristics of students and the choice of digital means. The authors prove that the "quest" technology, focused work to solve education tasks, motivates future professional activities, and also with the help of modern digital means, contributes to the development of such necessary cross-professional competencies of future specialists as project activities, systems thinking, interaction and interindustry communication.

In conclusion, the authors confirm that the inclusion of mobile game applications in the "quest" genre in education activities will help to form key competencies and skills that meet the priorities of the digital school and are most in demand by society.

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## 1. Introduction

### 1.1. The urgency of the problem

New challenges and requirements to the education system determine the need to develop students' skills of information interaction and experimental activity in the digital world, training in data analysis, programming elements, creating digital projects for the future profession, in technology, digital medicine (Strategiya razvitiya..., 2013). The implementation of the project "Digital School" will make a number of significant changes in the Russian education system: it will help to update the content of education; teachers will have resources to improve the quality of educational programs; parents will be able to control the learning process of their child. The teacher will be a tutor who helps to develop an individual learning way, who will guide students according to their chosen priorities (Soboleva et al., 2018).

Thus, the important condition for the training of future professionals is the introduction of advanced forms of education based on digital technologies into the education system. Since one of priorities of the project "Digital School" is "student-centered education", a special information educational environment with this support, according to scientists like (SIE) is currently developed at school. According to M.A. Kholodnaya, E.G. Gelfman (Kholodnaya, Gelfman, 2016), this environment will change the nature and content of educational activities, reduce the proportion of reproductive activities and enhance research, experiment and creativity (Kicherova, Efimova, 2016). Despite the difficulties of organizing pedagogical support, practical work on the information object, working in a virtual software environment has considerable potential for developing thinking, communication, developing skills to apply the skills, design and construct (Papert, 1993).

In this regard, there are works on using the technology of additional reality (Navarro-Ibarra et al., 2017), gamification (Tcyplakova, 2016) etc. in the educational process. As an effective learning technology, many researchers single out the game activity in the form of a quest according to requirements of the digital school (Osyak et al., 2015).

### 1.2. The purpose and objectives of the study

The purpose of the study is dictated by the need to change support of schoolchildren's cognitive activity due to new priorities of a digital school and possibilities of mobile game applications in the quest genre to form the relevant necessary competencies of specialists of the future.

Objectives of the study are:

– to explore the potential of mobile applications which are able to support the quest technology in order to form necessary competencies of specialists of the future;

– to formulate basic methodological ideas of the approach, which reflect necessary changes in the support of students' cognitive activity with the help of mobile game applications in the quest genre;

– to present levels of differentiation of education depending on the individual characteristics, schoolchildren's age, and the choice of digital means;

– to prove experimentally the effectiveness of the proposed changes aimed to improve the quality of education, taking into account the requirements of a digital school.

## 2. Relevance

### 2.1. Review of Russian scientific and pedagogical literature

Due to the state support of the development of digital technologies, programming, mobile applications and game platforms, there is a need to develop new forms and means of education. Numerous studies are trying to clarify such basic concepts as "digital technology", "digital literacy", "mobile application", "mobile device", "educational game", and "gamification of learning". The most significant are works of E.O. Tsiplakova (Tcyplakova, 2016), E.V. Soboleva, E.G. Galimova, Z.A. Maydangalieva, K.K. Batchayeva (Soboleva et al., 2018), where the phenomenon of gamification of learning, the didactic potential of game platforms for educational purposes are described.

There is a practical, educational and public need to train specialists with competences in the field of programming and the application of modern digital technologies in order to solve a wide range of professional tasks (Vishnevskaya, Zudina, 2017).

Some studies prove the need to solve problems in the development of innovative didactic technologies, the importance of active use of digital technologies with the possibility of gamification of training (Bonsignore, 2016). In other words, the pedagogical resources of the digital educational environment should make maximum use of the didactic potential of software tools to support the non-linear nature of information presentation, variability and the personality-centered type of cognitive process (Kholodnaya, Gelfman, 2016).

One of such forms of organization both in educational and career-oriented activities is the "quest" technology. A.V. Khutorsky (Khutorskoy, 2017), S.A. Osyak, S.S. Sultanbekova (Osyak et al., 2015), M.N. Kicherova, G.Z. Efimova (Kicherova, Efimova, 2016), M.N. Popova, I.P. Popov (Popova, Popov, 2018) and other researchers study in detail the essence of the quest technology, its didactic capabilities and features of inclusion in the education process for the Russian school.

A. Ponomarev, I. Dezhina underline the need to change the content, organizational forms, methods and means of education in the conditions of the development of a digital school (Dezhina, Ponomarev, 2016). They suggest a model for determining the scientific and technological priorities of Russia, consider possible tools and their use. The authors examine in detail a wide range of service functions and various digital technologies which expand the interaction of participants in the digital educational environment.

Ya.M. Roshchina, S.Yu. Roshchin, V.N. Rudakov (Roshchina et al., 2018), A. Lagunov, N. Podorojnyak (Lagunov, Podorojnyak, 2017), D.A. Alexandrov, V.A. Ivanyushin, D.L. Simanovsky (Aleksandrov et al., 2017), T.A. Shulgina, N.A. Ketova, K.A. Kholodova, D.A. Severinov (Shulgina et al., 2018) and others deal with the development of online courses, descriptions of their features and software support.

At the same time, some new scientific research (Mokretsov, Zaslavskiy, 2018) reflect capabilities of mobile devices and applications in order to improve the educational process.

V.S. Zasedatel, V.A. Serbin have achieved significant results in theory and practice of using mobile technologies, including Russia (Zasedatel', Serbin, 2014). The authors investigate the specifics of pedagogical support for the use of mobile devices in education; identify their importance and didactic functions. Moreover, they describe in detail main advantages and disadvantages of mobile technologies, possibilities to put them into practice (Usol'tsev, Antipova, 2019). Authors also analyze existing mobile solutions, their interface, and technological support feature (Mokretsov, Zaslavskiy, 2018).

The gamification phenomenon is actively used in modern educational environments, allows to expand the range of possibilities of interactive tools and mobile applications for organizing information interaction, and to create conditions for improving the quality of education, aiming to the needs of the student's personality. D.O. Koroleva (Koroleva, 2016), E.O. Tcyplakova (Tcyplakova, 2016), D.A. Aleksandrov, V.A. Ivanushin (Aleksandrov et al., 2017) formulate and substantiate these possibilities in the studies.

However, at the moment, most of the existing mobile tools and applications are included in the cognitive process only at some separate stage of activity on solving a certain system of tasks for educational and career-guidance purposes (Shulgina et al., 2018), or for the development of mental processes: thinking, memory, attention and imagination (Kholodnaya, Gelfman, 2016). According to R.M. Mokretsov, M.M. Zaslavskiy, it does not meet the specifics of the implementation of the quest technology in the education process, priority areas of variation, personality-oriented education. These reasons significantly reduce the didactic potential of mobile applications to support the technology of the educational quest in the conditions of the formation of a digital educational environment (Mokretsov, Zaslavskiy, 2018).

### 2.2. Review of foreign literature

Some foreign researchers such as B. Dodge (Dodge, 2019), T. March (March, 1998), F. Chen, J. Birova (Chen et al., 2017), V.Hill V., K. B. Knutzen (Hill, Knutzen, 2017), P.-S. Seow, S.-P. Wong (Seow, Wong, 2016) deal with defining the phenomenon of the quest as a technology that has an interactive game character. For example, O. Saritas describes specific computing functions of a

smart device in education. The author notes that smart devices form a new ecosystem, a new paradigm for the intellectual environment (Saritas, 2013).

Many foreign researchers study widely possibilities of using not only traditional digital resources (online courses, electronic textbooks, websites, simulators), but also mobile applications of the game interactive format in order to improve the quality of education. In particular, D. Petko, R. Schmid, L. Müller, M. Hielscher (Petko et al., 2019) experimentally prove that mobile technologies open up new ways to stimulate thinking. J. Záhorec , A. Hašková, M. Munk (Záhorec, 2019) show that the potential of digital tools is not limited to student's motivation, but it also contains resources: for working with multimedia content, for necessary clues in intellectual activities, for the exchange of experience of all participants in the digital educational space.

V. Hill, K. B. Knutzen (Hill, Knutzen, 2017) underline the importance of using mobile applications to form "digital literacy" – a special set of knowledge, skills and abilities. The authors consider obtaining a special system of knowledge and skills, formation of digital literacy through remote interaction in the virtual simulator of the medieval world "The Quest" (project Camelot).

We note the works of M.V. Gruzdev (Gruzdev et al., 2018), M. Janelli (Janelli, 2018) in the field of digital research, confirming the need to coordinate the theory of eLearning, the practice of online learning and priorities of the educational environment.

E.M. Bonsignore (Bonsignore, 2016), Navarro-Ibarra et al., 2017 points out that working with digital environments and intelligent systems provides additional resources for motivating, encouraging students in the design and implementation of applications using specific programming languages. Moreover, foreign authors introduce a term "computational thinking"; its formation is most effective in solving a series of problem tasks (Nissen et al., 2018).

P.-S. Seow, S.-P. Wong (Seow, Wong, 2016), M. Chang (Chang et al., 2019) reflect the capabilities of mobile devices and applications to improve learning.

Summarizing the results of the analysis, we come to the conclusion that authors and developers of interactive mobile applications, able to support the educational quest technology with the potential to form the competencies and most demanded by modern society (Hill, Knutzen, 2017, Chang et al., 2019), do not discuss forms and content of resources with the participants of the digital educational environment (Bonsignore, 2016).

## 3. Materials and methods

### 3.1. Theoretical and empirical methods

Theoretical methods of the study are: analysis of psychological, educational, scientific and technical literature to consider the essence of "quest" technology as a form of modern digital educational environment. Analysis of specific developments of subject teachers helped to study functions of mobile applications and interactive gamification software in education.

When studying the practice of incorporating mobile applications and game technologies into training, the authors used praximetric methods in order to describe, characterize, and analyze the methods used, means, forms of organization and control. Moreover, the authors used methods of systematization and generalization of ideas and laws, and principles of didactics in teaching.

Empirical methods (observation, analysis of results of schoolchildren's research projects) is a special group aimed to obtain recent data on the formation of the required competencies and skills in designing mobile educational applications and the use of digital technologies.

For evaluating statistical differences in the levels of skills development demanded in a digital school Pearson's chi-squared test ($\chi^2$) was used.

### 3.2. The base of the research

The pedagogical experiment evaluated the effectiveness of using mobile gaming applications in the "quest" genre, taking into account requirements of a digital school. 192 high school students in the city of Kirov and the Kirov region took part in the experiment. Thus, the control group had 92 schoolchildren, while the experimental one had 100. The experiment was conducted in specially equipped computer classes, using the same software. Tasks from L.L. Bosova's developments were used in order to assess the input conditions (Bosova et al. 2012). This choice was due to the fact that the tasks presented in the methodical and training materials are based on long-standing experience of teaching, are respected in the scientific community and meet the requirements of the federal educational standard.

### 3.3. Stages of the research

The research had three stages.

At the first stage, the authors carried out an ascertaining experiment: they investigated the state of urgent didactic problems on including mobile educational games and digital technologies in the educational process. For this purpose, the authors analyzed the scientific literature on the research problem, studied and made a comparative analysis of teaching experience in Russia and other countries in order to identify the necessary changes.

The second stage was devoted to the development of ideas of a methodical approach to using mobile game applications in the quest genre aimed to improve the quality of learning. In addition, the authors analyzed priorities of the project "Digital School" and selected the most demanded competencies (Nadprofessional'nye navyki).

The third stage of the research covered experiential teaching and the improvement of the basic ideas of the approach in relation to the identified requirements of a digital school and the formation of key cross-professional competencies. Teaching is accompanied by constant monitoring of the results of student research projects, which allows to consistently improve the proposed methodological ideas. Discussion of the research results took place in the form of publications in journals and reports at conferences of various levels.

## 4. Results

### 4.1. Clarifying the basic concepts

The authors propose their own approach to reveal the content of a mobile educational application. It is an online application that allows to organize the educational process using portable devices. It may include an electronic journal, a library of electronic educational resources, digital opportunities for collective interaction of all participants in the educational process and other services.

When characterizing the essence of the "quest" technology in terms of mobile design, we keep the standpoint that digital game platforms provide a convenient tool for interaction with a user through application differentiation. A programmed choice of content, depending on the individual, age characteristics, life experience and interests allows mobile applications to fully realize the didactic potential of digital school technologies.

In terms of general didactics, a quest is: solving a problem task with game elements; a technology, which involves finding solutions, solving the mystery; an interactive and gaming method of working with students, which motivates them to study activities; a form of organization of the educational and cognitive process, which contributes to the organization of situations of communication, interaction with participants (Khutorskoy, 2017).

The quest has the following structure: introduction (script, distribution of roles); preparation of tasks (games, contests, role-playing sketches); algorithm of conducting (bonuses, penalties); results (diplomas, prizes).

For the experiment, we consider that for the successful and effective use of digital platforms in the organization of an educational quest it is necessary to prepare:

- a didactic component: goals and objectives, content, number of participants, motivation, etc;
- software and hardware support: the choice of a digital platform, a technical tool (phone, tablet, laptop), a programming system or a ready-made software solution, interface languages;
- a psychological component (ergonomics, individual age characteristics of participants, emotions, needs and interests);
- methodological support: organizational stage, methodological recommendations for teachers, rules for participants, evaluation principles and prizes;
- game educational space: plot, game space with rules, characters, levels, etc.

However, the greatest difficulty for a teacher who wants to incorporate a mobile educational application into the didactic process is the content of the educational game space.

The components described above determine the changes made to the implementation of the quest technology and broaden teachers' ideas about including such a game form of activity for the educational space of a digital school.

### 4.2. Mobile game applications in the "quest" genre

The proposed methodological approach is described on the example of “Castle in the forest”, an application in the “quest” genre.

The didactic component is implemented through a game of interactive activities to solve a series of educational and cognitive tasks. Tasks are differentiated. Each level has a specific substantive content, a certain specificity of training in a digital school.

Despite the obvious fact that it is difficult to form competencies from the entire system of soft skills, especially considering the preparation for the challenges of the future, it is possible to improve the quality of acquired knowledge. In the future, knowledge that contributes to effective action in non-standard situations will be in need (Hill, Knutzen, 2017). In fact, we are talking about competence, which implies a special type of organization of knowledge and allows to make decisions under conditions of uncertainty. In order to form such competence, it is necessary to determine the expected result after the inclusion of mobile game applications in the quest genre in students' learning and cognitive activity.

It should be noted that the same skill can be in the content of different competencies. We used the following skills as evaluation criteria: system thinking; algorithmization and programming; project management; work in conditions of uncertainty; principles of interaction and interdisciplinary communication (Vishnevskaya, Zudina, 2017).

Teachers choose the program component themselves. It could be Python, Scratch, Java, C ++, etc. In our research we used Android Studio. The choice of such a digital resource is due to the following factors: it contributes to the development of tracked skills; has a free version; easy enough to understand when introducing into object-oriented programming; has a preview of the image of the developed project; is one of the most convenient and popular programs for creating Android applications.

In the present study, an emotionally motivating component has a special role in supporting the quest as a game technology for learning. When planning a quest it is necessary to take into account needs of the participants, their professional goals, and individual-style features of working with information. Emotions, a special class of mental processes and states associated with instincts, needs and motives show how to regulate behavior in the theory of gamification of education.

We will describe in detail methodological support for the game educational space “Castle in the Forest” depending on the level of the game.

The main intrigue of the game is that the player must choose the right items to take to the forest, answer the problematic question and understand what the King has encrypted in the message using his favorite domino game. Only after having finished all these tasks, a student will be able to pass through the forest and continue his way. At the beginning of the game the participant enters the forest with a castle. In the castle he enters the corridor and sees three mysterious doors with mysterious names, which briefly tell the traveler about the proposed tasks.

Now we will describe the algorithm of the quest game with rules and recommendations.

1. To get out of the forest, a wanderer needs to go into the castle and pass all the tests – tasks of the King and his assistants. Only then the traveler will receive a map with a way out of the forest.

2. Before entering the last door (the third one), you need to go through the previous two doors.

Rules of the game: the user clicks on the door, gets a task, the correct solution of which is the exit to the castle corridor, where the next door is available. The number of attempts to open the door is unlimited, there is no time deadline. If the wanderer opens all the doors, he leaves the castle and returns to his way, otherwise he remains to serve the King in the castle.

Let us summarize: three levels - three doors (two of them are closed), each door has its own task. To complete the next task, you must complete the previous one (open the door and solve the problem).

The first level (the first door). If you click on it, it opens and you see the task. After solving it, the user goes into the corridor of the castle.

The second level (second door). After returning to the castle’s corridor, the second door opens in front of the wanderer (the lock disappears). The traveler enters it and sees the following problem. After solving it, the third door also becomes available.

The third level is similar.

At the end of the game you see a message that the King's unit will help you to get out, you can also take the opportunity to "Restart".

Let us describe the content of levels.

**The first level:** you should choose what to take to exit the forest. Items for selection are: a torch, fish, backpack, tomato, knife, and syringe. There should be a place for inventory, where selected things are displayed. Then the user confirms his choice, and if it is correct, he sees the message “You have passed the first test!” Then the traveller automatically moves to the corridor of the castle. Otherwise, the message is “You have made a mistake. Try again”. Here, the correct answer is a torch and a knife.

Recommendation: the first level should warm-up in order to adapt the user to the game space and understand how to manipulate information objects. As a didactic hint, we note that it is possible to overcome the level by trial and error.

**The second level.** The wanderer has one match. What should he ignite first to get out of the dark forest? He must choose among a fireplace, torch, kerosene lamp. If the choice is correct, he sees the message “You have passed the first test!” And the traveller automatically moves to the corridor of the castle. Otherwise, the message is “You have made a mistake. Try again”. The correct answer is a match.

Recommendation: the level should motivate the user to show ingenuity and work in conditions of uncertainty. The cognitive problem is to choose according to the requirements of the problem.

**The third level.** The king of the castle Bastian Forest likes to play dominoes. If the wanderer can solve his favorite task, the king’s detachment will help him to get out of the forest. The player is offered five dominoes in a row. Next, you need to guess what they mean (first 1-1, second 6-4, third 4-5, fourth 5-2, fifth 2-1). The correct answer is “detachment”.

If the answer is correct, the user sees the message “You have solved the riddle of the King, now our unit will help you get out of the forest.” Then he sees a map and the message: “You have passed all the tests!”

The third task is the most difficult as you need to show non-standard thinking. At first, everything seems complicated, but then different interpretations of these dominoes appear. The problem is only in choosing the right decryption strategy. Here is the correct logic: the figure below means the number of the letter in the word number above.

Recommendation: to solve a series of tasks, you should remember that the content for each mobile application should be chosen by students on their own, taking into account the specifics of possible professional problems and life experience. This feature should be reflected in the variants of projects for independent research activities.

For example, there are such quest ideas aimed to expand the horizons that do not require special training of programmers. The plot of the game "I want to go on vacation" is simple. You are a student, you have the last three lessons today and then you can go home. You need to complete three tasks. There is a diary and three recorded titles of tasks: "Mathematics", "Geography" and "Vacation".

The first task: "How many months in a year have 28 days?" The correct answer is the number 12, since there are 28 days in all months.

The second task. There is a compass pointing east and the words "West", "North", "South" and "East". In this case, the solution will be, for example, “South”, since the arrow points to this word.

The third task: "What comes after December 31?" Possible answers are "December", "January", "New Year" and "New Month". The answer will be “?” in the question task.

Having finished all the tasks, the student receives congratulations and virtually goes home on vacation.

Recommendation: the implementation of this quest in a mobile application is possible on the basis of the libraries of the described game “Castle in the Forest”.

### 4.3. Experimental evaluation

#### 4.3.1. The ascertaining stage of the experiment

At the first stage of the experiment, students had a control task to work with an information model in a software environment in accordance with the skills presented. Thus, it was possible to

collect experimental data on 192 students from various educational institutions (82 respondents in the 2017–2018 school year, 110 of the students in 2018–2019). Since, as a result of the preliminary control test, almost all the students, participants of the pedagogical experiment of three years, had the same initial level of readiness, we can consider them as a general sample of 192 people. Thus, we formed the experimental (100 people) and control (92 people) groups. The experimental group had 70 % of girls and 30 % of boys.

### 4.3.2. The forming stage of the experiment

Theoretical classes for students were conducted in the same way, but practical work in the computer class was different. Mobile game applications with educational content were included for students from the experimental group. The participants of the control group were involved in independent research activities organized in the traditional way in the form of practical computer work, performing tasks on specific topics and without active use of mobile games for educational purposes.

In order to evaluate the effectiveness of the proposed methodological approach, at the end of the educational process, students were given a test, which involved the implementation of an interdisciplinary project using digital technologies. We formulated a series of educational tasks, involving the use of systems thinking; algorithmization and programming skills; project management; work in conditions of uncertainty; interaction and interdisciplinary communication.

As it was previously noted, actually we evaluated the formation of competence, which implied a special type of organization of knowledge, which allowed to make decisions in conditions of uncertainty. For its evaluation, we formulated the following indicators: how many times students needed teacher's help during the project activity; correct interpretation of messages of the program environment (error messages); successful independent solution of problems (all levels of the quest); the ability to make the right conclusions on the results of passing levels.

To determine the level, we used the criteria "very low", "low", "medium", "high", "very high". For the first indicator, the student's complete independence in the course of research activity indicated a "very high" level. For "high" criterion, it was allowed to ask for help once or twice. If the teacher's help was required 3-5 times in the course of the project, it was the "average" level. The "low" criterion corresponded to 6-7 times of teacher's help. More intensive teacher's support meant "very low" criterion.

During educational and cognitive work on the proposed methodological approach, we paid special attention to the ability to interpret the messages of the program environment (error information). Understanding of all messages and knowledge of how to correct mistakes corresponded to a "very high" level. For the "high" criterion, the student basically understood situations and messages, but did not always know how to correct errors. If in the process of decision he understood some messages, it was the "average" level. The "low" level of the indicator corresponded to the case when the student tried to read, but did not understand the meaning of the messages. The criterion "very low" was determined if the student simply closed messages during the course of work without reading their text.

As for the third indicator, complete success in solving problems independently (all levels of the quest) met the "very high" criterion. For the "high" criterion, we denoted situations when the student completed 3-4 tasks. If he did only two tasks, then it was the "average" level. The "low" level was when a student successfully solved only one problem.

One of the stages of the proposed approach was the ability to draw correct conclusions on the results of passing levels. As for this indicator, fully right formulated conclusions indicated a "very high" level. For the "high" criterion, we denoted situations where the student basically made correct generalizations. If in the process of solving he made insignificant errors in the conclusions, the logic of the conclusions couldn't be traced, then it was the "average" level. The "low" level corresponded to the case when the student made conclusions with fundamental errors. The "very low" level was if the student did not draw any conclusions from the results of the study.

Table 1 shows an analysis of outcomes concerning formation of competence, which involves a special type of organization of knowledge, providing the ability to make decisions in conditions of uncertainty.

**Table 1.** The results of the experimental evaluation

| Level of formation | Number of students | | | |
|---|---|---|---|---|
| | Experimental group (100 students) | | Control group (92 students) | |
| | before | after | before | after |
| Very low | 17 (17%) | 4 (4%) | 16 (17%) | 12 (13%) |
| Low | 50 (50%) | 45 (45%) | 43 (47%) | 46 (50%) |
| Average | 25 (25%) | 33 (25%) | 27(30%) | 22 (24%) |
| High | 5 (5%) | 10 (10%) | 3 (3%) | 8 (9%) |
| Very high | 3 (3%) | 8 (8%) | 3 (3%) | 4 (4%) |

An “excellent” mark corresponded to levels “high” and “very high”, a “good” one – for the “average”, “satisfactory” – for “low” level. In all other cases, the mark was "unsatisfactory".

The diagram (percentage ratio) in Fig. 1 shows the qualitative change by levels in accordance with the results of an independent research project.

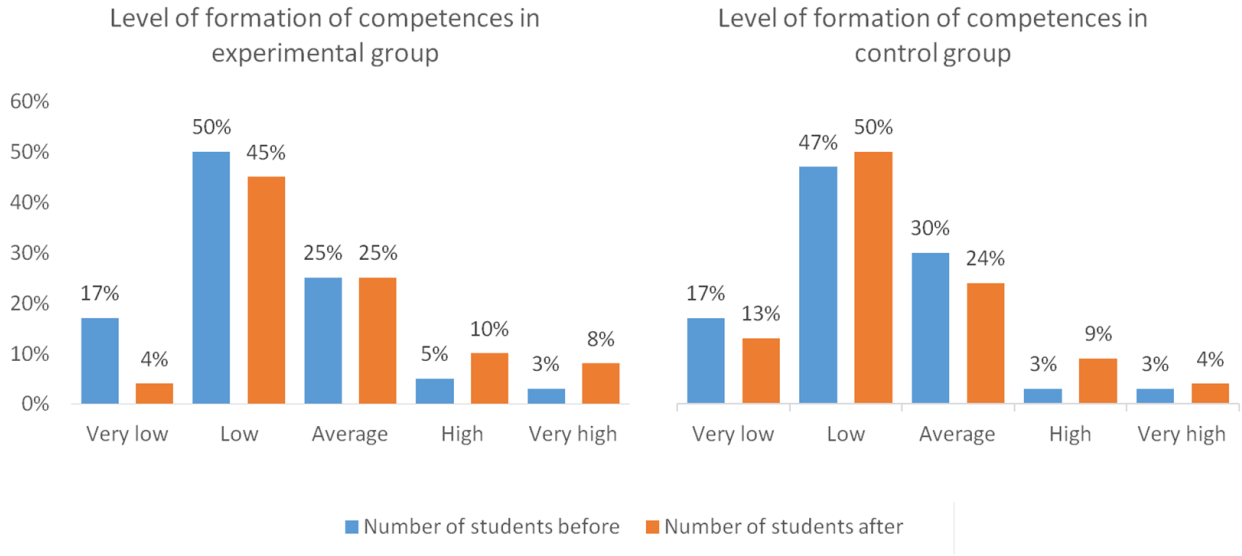


**Fig. 1.** Results of tests

Table 2 shows the results of the test before the experiment.

**Table 2.** Results if the test before the experiment

| Groups | Marks | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | |
| Experimental group | 8 | 25 | 50 | 17 | 100 |
| Control group | 6 | 27 | 43 | 16 | 92 |
| | 14 | 52 | 93 | 33 | |

Table 3 shows results of the implementation of an interdisciplinary project by means of digital technologies after the experiment.

**Table 3.** Results of the test after the experiment

| Groups | Marks | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | |
| Experimental group | 18 | 33 | 45 | 4 | 100 |
| Control group | 12 | 22 | 46 | 12 | 92 |
| | 30 | 55 | 91 | 16 | |

After a quantitative analysis of the results, we can conclude that 51 % of the students in the experimental group had a high level of skills and abilities (marks 4 and 5) at the end of the experiment, while initially this percentage was 33. It shows a qualitative improvement in the training indicators of the subjects of the experimental group. The level of skills and abilities in the control group also increased, but not so significantly: only 37 % of the students in the control group showed good results (compared to 35 % before the experiment) after the experiment, over 60 % of the subjects remained on average and low level.

### 4.3.3. The control stage of the experiment

Authors used Pearson's chi-squared test ($\chi^2$) to evaluate statistical differences in the levels of skills development demanded in a digital school in the control and experimental groups before and after the inclusion of mobile game applications in the quest genre in students' research activities.

Let us accept the following hypotheses. Students of the experimental group have a statistically equal level of skills demanded in a digital school to the level of skills of the students of the control group. Hypothesis H1: students of the experimental group have a higher level of skills demanded in a digital school than the level of skills of students in the control group.

Let us calculate the values of the chi-squared statistics before ($\chi^2_{observ.\,1}$) and after ($\chi^2_{observ.\,2}$) the experiment:

$$\chi^2_{observ.1} = \frac{1}{100*92} * \left( \frac{(8*100-6*92)^2}{8+6} + \frac{(25*100-27*92)^2}{25+27} + \frac{(50*100-43*92)^2}{50+43} + \frac{(17*100-16*92)^2}{17+16} \right) = 1{,}92$$

$$\chi^2_{observ.2} = \frac{1}{100*92} * \left( \frac{(18*100-12*92)^2}{18+12} + \frac{(33*100-22*92)^2}{33+22} + \frac{(45*100-46*92)^2}{45+46} + \frac{(4*100-12*92)^2}{4+12} \right) = 8{,}43$$

$\chi^2_{observ.} = 8{,}43$.

At the significance level $\alpha = 0{,}05$ and the number $c = 4$, the number of degrees of freedom is equal:

$$n = c - 1 = 3$$

According to the tables of distribution $\chi^2$ for $n = 3$ and $\alpha = 0.05$ the critical value of statistics is equal:

$$\chi^2_{critic.} = 7.82$$

Therefore, the following inequality is satisfied,

$$\chi^2_{critic.} < \chi^2_{observ.}$$

According to the decision rule, the null hypothesis must be rejected and an alternative hypothesis accepted.

Thus, the experimental assessment confirms the qualitative difference in the level of skills demanded in a digital school, and, accordingly, the development of competence, a special type of organization of knowledge, which allows to make decisions in conditions of uncertainty.

## 5. Discussion

In general, the pedagogical experiment allows to conclude that the inclusion of mobile applications able to support the quest technology in the educational space expands the interdisciplinary and didactic potential of this game form of activity in the context of digital school priorities.

The research has limitations due to not probabilistic sampling method. In city schools, if one of the classes was in the experimental group, then the second class from the parallel, where the

subject was taught by the same teacher, was in the control group. If a country school had only one class in a parallel, then a class from another school of the same district was in the control group.

Students of the experimental group significantly increased the level of skills in the field of digital technologies, and in the formation of most demanded competencies. The fact that the content for each mobile application was chosen by students on their own, taking into account the requirements of the digital economy is of particular importance for the solution of future professional tasks (Strategiya razvitiya..., 2017). This feature was also reflected in variants of projects for independent research activities. Examples are the project "Sort Garbage", focused on the development of environmental thinking or a project on the use of English verb tenses.

The analysis of students' cognitive activity also allowed to confirm that mobile educational games, due to their interactivity and strengthening of feedback, enhancing information interaction, create additional opportunities to target education to the challenges of future professions. On the other hand, in the course of the experiment, we had to solve didactic and methodological problems: psychological barriers to digital technology, a low level of language training, time and labor costs of both students and teachers.

Thus, materials of the experimental study confirmed the compliance of education results with challenges of the project "Digital School".

## 6. Conclusion

The research results prove that new challenges and requirements of society, state, and business to the education system demand to form competences in the field of active use of ready-made electronic resources, but also of designing and developing own software solutions.

The quest technology, as a game form of activity, allows organically to use digital school tools along with traditional methods and learning tools. One of the options is mobile game applications with educational content.

Mobile applications able to support the quest technology have interdisciplinary and didactic potential in terms of developing the demanded competencies of specialists of the future: skills in non-standard, creative thinking; decision-making skills in conditions of "uncertainty"; ability to transfer experience from one game space to another; teamwork skills etc.

A significant result of the work is the description of basic ideas of the approach, expanding the ideas of teachers about the features of the organization of this game form of activity in the context of the priorities of a digital school. The changes are presented in the didactic, methodical component.

The didactic component suggests that the quest should be preceded by the elaboration of the game scenario, a reasonable choice of software and hardware support; correlation of the emotional-psychological component with the content of the game educational space. When choosing mobile applications and technologies, the teacher should know the conceptual apparatus and the range of mobile games with educational content, be proficient in the design, development and evaluation of creative forms of activity.

When designing a game space for the implementation of the quest based on digital technology, you should consider: variability of software solutions for the implementation of the plot; individual and age characteristics of the participants of the game, their interests, life experience; requirements of modern school and challenges of the future.

The effectiveness of the proposed approach was confirmed by a pedagogical experiment, during which the result of cognitive activity was assessed according to a set of criteria corresponding to the essence of the competences of the professions of the future and the priorities of the project "Digital School".

The obtained results can be used:

– to expand the methodological system of training teachers in the field of computer science, cybernetics and artificial intelligence as promising sectors of the future;

– to provide individualization of education through specially-organized areas of support for creative, inter-sectoral, and cognitive research activities of students;

A promising direction for improving the proposed methodological approach is to supplement it with aspects related to the design and creation of digital technology tools for a personality-oriented educational environment with gamification elements.

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