The method of using the online course "Creative Thinking through Learning Elementary Maths" in the Mathematics teacher training system

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Abstract. The article offers the method of using the online "Creative Thinking through Learning Elementary Maths" and the results of checking the effectiveness of the implementation of this course in the mathematics teacher training system. The research substantiates the possibility of three methodological options for combining educational materials of the online course with the study of the educational discipline "Elementary Mathematics". The methodological options are chosen depending on the number of credits assigned to the study of the elementary mathematics course at the university. Practical tasks of the course were focused on the organization of students' activities (recognition, classification, solving and creation) with Rich tasks of three levels of complexity. The results of control tests in Elementary Mathematics give grounds for concluding about the effectiveness of the developed method.

1. Introduction

1.1. Problem statement and its topicality substantiation

As noted in the Professional Standard "Teacher of General Secondary Education" [1] and Standards for preparing teachers of Mathematics, developed by the Association of Mathematics Teacher Educators [2], creativity is an important component of the professional competence of a mathematics teacher. The formation and development of all the key personality qualities of a would-be mathematics teacher take place in the process of studying professional disciplines, which are divided into normative and variable. Elementary Mathematics is one of the key normative disciplines for the training of would-be mathematics teachers.

According to Vlasenko et al. [3, 4], it is during the study of this discipline that repetition, generalization and expansion of students' knowledge of mathematical concepts and facts, which were considered in the school mathematics course, takes place. In addition, the goal of studying the discipline is the formation of skills and abilities of would-be teachers to creatively use the acquired skills in practical activities. In the absolute majority of universities, Elementary Mathematics is studied from the first year, so in this process, students adapt to the requirements,

opportunities and features of learning at a Higher Education Institution, which increasingly goes beyond classrooms.

We agree with Bilousova et al. [5], Bringula et al. [6], Lin et al. [7], and Mintii [8], who note that in modern conditions of digitalization of society, traditional face-to-face education is being replaced by blended learning [9]. We also agree with Attard et al. [10], Fazal et al. [11], Kovalchuk et al. [12], and Martyniuk et al. [13] that the COVID-19 pandemic only accelerated the process of active implementation of blended learning, which was inevitable. Today, education faces the task of finding ways that enable the organization of mixed learning among students both in the classroom and outside the classroom. Therefore, in modern conditions of education development, online courses are becoming more and more widespread as a form of distance organization or a component of mixed learning. Therefore, it became appropriate to develop an online course "Creative Thinking through Learning Elementary Maths" [3], which focused on the development of creative thinking in the process of activity with systematized types of problems. This determines the relevance of the problem of organizing blended learning of Elementary Mathematics with the involvement of the online course "Creative Thinking through Learning Elementary Maths".

2. Literature review

2.1. Organization of blended learning of Mathematics

Rifa'i and al. [14], Fazal et al. [11], Attard et al. [10], Bringula et al. [6], Jamil et al. [15] investigate the organization of blended learning of junior high school students in Mathematics classes using smartphones and analyze the attitude towards the usage of smartphones in the educational process and the opportunities they provide for the organization of blended learning in Mathematics. Fazal et al. [11], compared the effectiveness of traditional and blended learning of Mathematics in middle-aged schoolchildren and concluded the special effectiveness of blended learning of Mathematics to overcome students' issues in the process of studying certain topics. Bringula et al. [6] analyzed the issues in the organization of blended learning of Mathematics in the conditions of the pandemic and possible ways to overcome these in the process of implementing online courses. Jamil et al. [15] investigated the effectiveness of blended learning of Mathematics using active learning methods. Attard et al. [10] investigated the usage of blended learning technologies in Mathematics by Australian schoolchildren in the context of the COVID-19 pandemic to improve the individualization and differentiation of mathematics learning, implement visualization and establish the relationship and interaction of the teacher and students.

All scientists agree that the organization of blended learning contributes to improving the performance and attitude of students toward Mathematics, and most researchers emphasize the expediency and effectiveness of using online courses within the framework of blended learning.

2.2. Development and method of online course implementation in mathematics education

Various aspects of the development and methodological aspects of the online courses' implementation in learning Mathematics are devoted to the study of Vlasenko et al. [16], Trenholm et al. [17], Ahn et al. [18], Radmehr et al. [19], Schallert et al. [20] and others. Research by Vlasenko et al. [16] presents the methodology for creating an electronic learning environment for training mathematics teachers. Trenholm et al. [17] present a thorough analysis of the differences between face-to-face and online learning and suggest ways to improve the organization of online courses. A study by Ahn et al. [18], devoted to the use of an open e-learning platform for the organization of learning based on an activity approach. Radmehr et al. [19] analyze the experience of switching to distance learning of Mathematics of Norwegian students and the importance of online courses in this process as well. Schallert et al. [20]

emphasize the effectiveness of the use of flipped learning technology in the process of organizing online courses in Mathematics.

The above-mentioned scientists agree that online courses are an effective component of both distance and blended learning of Mathematics and should be organized based on an activity-based approach to learning.

2.3. An active approach as a basis for building a Mathematics online course

An active approach in the process of organizing blended or distance learning is considered in the research of Noreen et. al. [21], Agyei et. al. [22], Hjalmarson [23], Negara et. al. [24] and others. Agyei et. al. [22] substantiated and experimentally proved the effectiveness of organizing group activities for solving problems using information technologies. Noreen et. al. [21] emphasized the importance and effectiveness of learning mathematics to elementary school students based on the activities of students with a specially selected system of problems. Negara et. al. [24] substantiated the feasibility and effectiveness of implementing activity-based online courses for learning Mathematics to high school students. The results of Hjalmarson's study [23] confirm that it is during specially organized practice-oriented activities in the distance learning process that all the key personality traits of a mathematics teacher development. The development of the idea of organizing practice-oriented activities can also be found in the work of Kajander et al. [25], who emphasize the importance of a specially selected system of tasks in this process.

Gojak [26], and Yeo [27] express similar views, agreeing with the expediency of developing students' creativity in the process of solving certain types of problems. Among the means, the usage of which promotes the development of student's creative thinking, scientists single out Rich tasks. This idea is consistent with the findings of the study by Vlasenko et al. [3].

Scientists consider Rich tasks from Elementary Mathematics as problems that contribute to increasing interest in Mathematics as a science, because they allow students to 'discover' new mathematical rules (concepts, regularities), act outside the norm, develop creative thinking, and interest in creating their mathematical product. In the same paper, open and integrative Rich tasks are distinguished as five main components of the development of student's creative thinking. There are the ability to identify and pose a problem, the ability to generate a significant number of ideas; flexibility or the ability to produce different ideas, originality or the ability to act out of the box, and the ability to improve the subject with added details. For the effective formation of the specified components of creative thinking, scientists recommend the development of an online course 'Creative Thinking through Learning Elementary Maths' [28]. The idea of creating this online course was caught on by the International Conference 'ICon-MaSTed' [29]. The model for organization training with the online course was also approved [29]. While developing the course application methodology, it was taken into account the opinion of Attard et al. [10]. Online courses can be not only an independent component of distance learning but also an effective component of blended learning. Therefore, the purpose of the article is to present the method of using the online course 'Creative Thinking through Learning Elementary Maths' [28] as a component of the study of Elementary Mathematics and to confirm the effectiveness of the implementation of this course in the process of training would-be Mathematics teachers.

3. Method

An active approach to learning was the basis of the development of the method for using the 'Creative Thinking through Learning Elementary Maths' [28]. Based on the analysis of the opinions of scientists presented in table 1 and the experience of the authors, a method of using an online course in the process of studying Elementary Mathematics was developed. This method provides three options for combining an online course and learning Elementary Mathematics.

These options are detailed below.

Table 1. Analysis of the views of scientists and online resources regarding the combination of blended learning of the discipline and the usage of an online course at the same time.

Scientists	Used during the study (subject, age group)	How the online course and the study of the discipline were combined
Rifa'i and Sugiman [14]	Mathematics, students in high school	Two forms of interaction: an online course is offed only for theoretical support of flipped learning and an online course for support of flipped learning (including online consultations)
Attard & Holmes [10]	Mathematics, students in primary school	The online course is considered an aid in blended learning of the subject
Lin, Tseng, Chiang [7]	Mathematics, students in primary school	The online course is considered an aid in blended learning of the subject
Ahn and Edwin [18]	Mathematics, students in higher school	Two forms of interaction: the online course is considered as an aid in blended learning of the subject and the online course is a course to support flipped learning (including conducting online consultations).

(i) Students who studied the course of Elementary Mathematics during classroom training or blended learning simultaneously studied the online course "Creative Thinking through Learning Elementary Maths". If necessary, in addition to online consultations on the platform [28], offline consultations were received.

(ii) Students used the online course as a platform to support flipped learning. That is, they familiarized themselves with the material of the lectures and performed practical tasks presented on the online course platform. Most of the practical tasks were presented and discussed by the students during the study of Elementary Mathematics. Depending on the epidemiological situation, the discussion took place in an online format or an offline format (in the audience). This group of students worked with the online course during the semester they were finishing their Elementary Math course.

(iii) Students used online course materials as part of flipped learning (lecture sessions). Students received practical tasks as part of studying Elementary Mathematics and reported in the online or offline format during classes or consultations. The third option differed from the second one in that students used the online course platform to get answers to questions related to both online course learning and Elementary Mathematics learning in general.

It is described the structure and the general aspects of the organization of studying Elementary Mathematics using the online course and features for each of the groups separately. The online course is provided in Ukrainian and is designed for four weeks. The course contains six topics, each of which involves lectures and practical tasks. The course considers the concept of creative thinking and the role of Elementary Mathematics in the process of its development. Also, in the course of classes, students get acquainted with Rich problems and their types.

The choice of the option in which the online course is used may depend on the number of hours allocated to studying the Elementary Mathematics course at the university.

According to the first option, students started their studies in the online course at any

convenient time for them during the last semester in which Elementary Mathematics was studied. Students worked through the online course at their own pace. The only requirement was to complete the online course three weeks before the test (exam) in Elementary Mathematics. The total estimated time of working on the course is 24 hours. The content of the course and the course learning model is described in detail in [29]. It should be noted that the completion of all problems of the online course: 1) allows students to score 6 "bonus" points in elementary mathematics; 2) contributes to the development of their creative thinking, which is reflected in the results of passing the test (exam) in Elementary Mathematics.

The second option provided that students who worked with the online course were instructed to process the materials of six lecture classes by a specific deadline. For example, students had to familiarize themselves with the first lecture on "Creative thinking and its structure" before the first-semester colloquium. During the colloquium or (in its absence) at the final class of a certain content module, a short discussion was held based on the lecture material, the teacher answered the questions that arose from the students. For example, the question of the interdependence of creative abilities and creative thinking caused a lively discussion.

The second lecture was on the topic "The role of Elementary Mathematics in the development of creative thinking. Rich tasks" students were introduced to a certain practical class (as a rule, the final class of the first or second content module of the course). A short discussion was organized, and aspects that were not clear to individual students were discussed. For example, several students were interested in the relationship between traditional and Rich tasks in the learning process aimed at developing creative thinking. To which the teachers noted that the ratio of Rich tasks and other tasks depends on the purpose of training and the level of preparedness of the students. If we are talking about the development of creative thinking, Rich tasks should prevail.

With the final sixth lecture on the topic "Types of integrative problems in Elementary Mathematics", students were introduced to the last or penultimate lecture (if there are lectures on Elementary Mathematics in the university curriculum. During the discussion, the students actively discussed whether it is appropriate to single out STEM problems as a separate type of integrative problem or to equate STEM problems with integrative problems. Summarizing the results of the discussion, the teachers emphasized that STEM problems are only a subset of the third type of integrative problems, that is, problems that arose outside the boundaries of Mathematics, but their solution requires the use of mathematical methods.

After working through the theoretical classes, the students completed the relevant practical tasks posted on the online course platform and presented them at the practical classes. Practical tasks were focused on the following activities from the Rich task: recognition, classification, solving, and creation. For example, students performing practical tasks before the second class analyzed the problems proposed by the developers of the online course and substantiated whether they belong to the Rich task. In the same session, students presented their examples of problems that, in their opinion, belong to the Rich task. We will give two examples of problems proposed by students.

Problem 1. It is necessary to place a lighting device above the centre of the circular platform. The radius of the site is 10 m. At what height is the best place to place the lighting device so that it illuminates the path bordering the site as best as possible?

Problem 2. What method is used to solve this problem? Find all values of the parameter a for which the equation $a^2 \cos^4 x + x^2 - a = 0$, has a single root. Give two examples of inequalities that are solved in the same way.

Note that according to the second option, students could also score 6 "bonus" points in Elementary Mathematics.

Students who worked with the online course in the third option worked with lecture tasks in a similar mode to the second group. At the same time, they received practical tasks from teachers. Depending on the mode of study of the university, students presented the performance of tasks and participated in the discussion either remotely or in the classroom. For example, with the third lecture on the topic "Open problems in Elementary Mathematics", students were introduced to the second-semester colloquium or before the end of half of the content modules of the Elementary Mathematics course this semester. During the discussion, students actively debated the full or almost complete transition to learning (including schooling) through Rich tasks. Summarizing the results of the discussion, the teachers emphasized that the complete rejection of traditional ("closed") problems is not advisable, since they are necessary for the formation of algorithmic activity skills, the formation in the shortest possible time of the ability to solve basic problems on a certain topic.

Students were introduced to the fifth lecture on "Integrative problems in Elementary Mathematics" before the last practical class of the penultimate content module of the Elementary Mathematics course. The issue of the balance of interdisciplinary and intradisciplinary integration caused a lively discussion. The majority of students were interested in problems that demonstrate the application of Elementary Mathematics in other mathematical disciplines (for example, Linear Algebra, Mathematical Analysis) and other sciences (Physics, Biology, Economics, etc.). So, teachers emphasized the importance and role of the integration of abilities, skills and experience in several sections of Elementary Mathematics.

In table 2 shows several examples of problems aimed at implementing the main types of activities from the Rich task.

Table 2: Examples of problems aimed at the implementation of the main types of activities with the Rich task.

Type of activity with Rich task	Class's number	Example task	Methodical comment
Recognition	1-2	1. Which of the following problems can be classified as open Rich tasks? Justify your opinion. • Solve the inequality $\sqrt{x^4-2x^2+1} > 1+x$, • Based on the analysis of textbooks on Elementary Mathematics, identify the methods of solving logarithmic equations and inequalities and the approximate bases of activities using these methods.	While solving tasks, such a component of creative thinking as the ability to pose a problem and such components of mathematical and key competencies as the ability to analyze, compare and draw conclusions are formed.

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Table 2 – continued from previous page

Type of activity with Rich task	Class's number	Example task	Methodical comment
Classification	3-6	What types of Rich tasks are the problems? • Eight friends decided to hold a chess tournament so that everyone would play one game against each other. Can Peter win if he loses 4 games and draws 2? • A stand for stationery has the shape of a regular triangular prism without an upper base. The perimeter of the side face of this stand is 40 m. Complete the condition (no more than one condition can be added), create 3 problems and solve them. • Two rooms are separated from each other by a wall with an area of $S = 12x^2$. The sound pressure levels in the rooms where the sound source is located and where the sound is perceived are Ł$_e$ = 110 dB and Ł$_0$ = 63 dB. Determine the sound absorption in the room where the sound is perceived, if the sound insulation level of the wall is $R = 41$ dB.	While solving such a problem, students determine whether the given problems belong to open or integrative Rich tasks, in the future, they learn to distinguish between open and integrative Rich tasks. The such activity contributes to the formation of such components of creative thinking as the ability to pose a problem and flexibility, as well as such components of mathematics and key competencies as the ability to analyze, compare, classify, and draw conclusions.

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Table 2 – continued from previous page

Type of activity with Rich task	Class's number	Example task	Methodical comment
Solving	3-6	1. A sphere is inscribed in a straight prism, the sides of which are equal to 8, 9, and 10 m. Create at least three problems using these conditions (you can add no more than one condition). Divide tasks according to difficulty levels. 2. Classify the types of problems from the topic "Polygons", and indicate the main methods of solving problems according to two of the types proposed by you. 3. Andriy poured little buckwheat groats into the pot, which has the shape of a cylinder, and asked his mother: "How much water do you need to pour to cook delicious porridge?" – "That's very simply answered by my mother. – Tilt the pan, tap so that the cereal spills over and covers exactly half of the bottom. Now fix a point on the wall of the pan near the edge to which the groats have risen. It is necessary to pour water to this level." – "But cereals can be poured more or less, and the pans are different – wide, narrow," said Serhiy. – "It doesn't matter, this method will come in handy in any case" – answered mother. Is it so?	While completing tasks, students learn to generalize, apply mathematical apparatus outside the boundaries of Mathematics, and understand the relationship between Elementary Mathematics and Mathematical Analysis (while solving the third problem). They develop such components of creative thinking as the ability to generate a significant number of ideas, flexibility and originality.

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Table 2 – continued from previous page

Type of activity with Rich task	Class's number	Example task	Methodical comment
Creation	4-6	1. Create two problem situations from the section "Planimetric shapes". 2. Create one problem at a time with an open ending, in the condition of which the following will appear: inequalities, polygons, vectors. 3. Create one problem each, the solution of which will contribute to the understanding of the relationships between Elementary Mathematics and Mathematical Logic, Mathematical Statistics and Mathematical Analysis.	While constructing varieties of open and integrative Rich tasks, students develop such components of creative thinking as the ability to generate a significant number of ideas, flexibility, originality, the ability to improve the subject, and such components of mathematical and key competencies as the ability to establish relationships between elementary and individual sections of Higher Mathematics, ability to systematize types of tasks.

Students presented the results of tasks in classes or during consultations. Completing all the tasks of the online course allowed students to score 6 "bonus" points in Elementary Mathematics.

4. Results

The effectiveness of the implementation of the online course in the mathematics teacher training system was tested in February-December 2021 for students of the 1st-2nd years of Berdyansk State Pedagogical University, Kryvyi Rih State Pedagogical University, Pavlo Tychyna Uman State Pedagogical University, Oleksandr Dovzhenko Hlukhiv National Pedagogical University. 98 students of 1-2 second years participated in the experiment. At the beginning of the experiment, the participants were randomly divided into a control group (CG) and an experimental group (EG). In the control group, 47 students studied a course in Elementary Mathematics using traditional methods. In the experimental group, 51 students studied Elementary mathematics in parallel with the online course 'Creative Thinking through Learning Elementary Maths' [28]. All three options for using the course described above were used (17, 16, and 18 students for each option).

The homogeneity of the groups at the beginning of the experiment was checked based on the results of control tests in Elementary Mathematics. The results of performing diagnostic tests on Elementary Mathematics at the beginning of the experiment are shown in table 3.

As we can see in table 3 and figure 1, the results of the control test in the control and experimental groups at the beginning of the experiment almost do not differ. In particular, the largest difference of 2% was observed between students who scored 76-89 points in favour of the EG. To make sure that the existing difference between the results of the control test in the control and experimental groups is not statistically significant, Fisher's statistical test φ^* was used.

We formulated statistical hypotheses: Null hypothesis H_0 : the level of formation of students' educational achievements of the control and experimental groups at the beginning of the experiment does not differ statistically significantly.

Table 3. The results of diagnostic tests in Elementary Mathematics at the beginning of the experiment.

The level of educational achievements of CG students				of EG students			
1–49 points	50–75 points	76-89 points	90–100 points	1–49 points	50–75 points	76-89 points	90–100 points
1 (2 %)	17 (36 %)	19 (41 %)	10 (21 %)	1 (2 %)	19 (37 %)	20 (39 %)	11 (22 %)

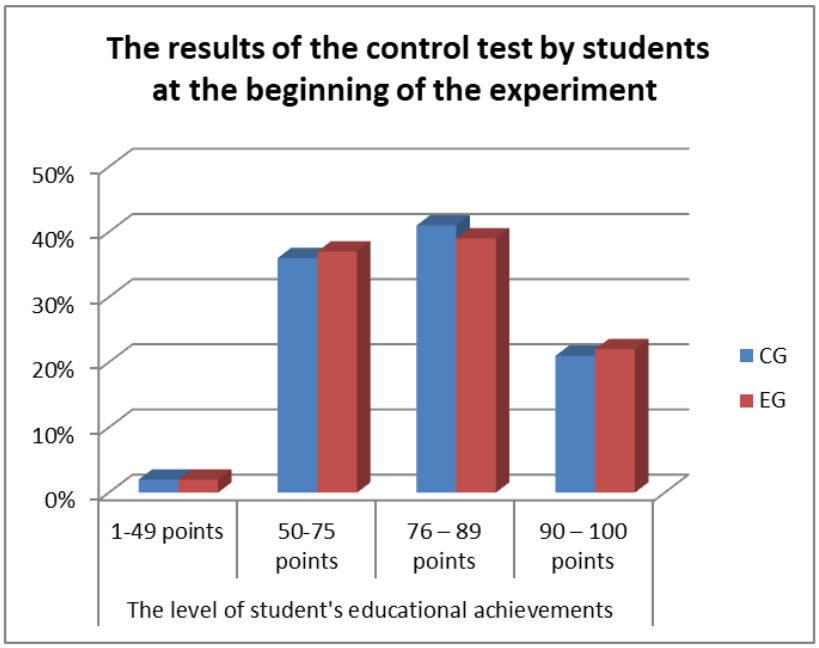

Figure 1. The results of the control test by students at the beginning of the experiment.

Then the alternative hypothesis H_1 : the level of students' formation of educational achievements in the control and experimental groups at the beginning of the experiment is statistically significantly different.

In table 4 for calculating φ^* when comparing the level of students' educational achievements at the end of the experiment.

According to the angle determination table φ :

$\varphi_1(62\%) = 1.813$ and $\varphi_2(61\%) = 1.793$.

Hence, we have an empirical value φ^* :

$\varphi^*_{emp.} = (\varphi_1 - \varphi_2)\sqrt{\frac{n_1 n_2}{(n_1+n_2)}} = 0.099$.

At the same time, the critical value φ^* for any n_1, n_2 is equal to: $\varphi^*_{cr.} = 1.64$ $(p < 0.05)$ or $\varphi^*_{cr.} = 2.31$ $(p < 0.01)$.

Since $\varphi^*_{emp.} < \varphi^*_{cr.}$ the hypothesis H_0 is accepted and H_1 rejected. Thus, the level of formation of educational achievements of students of the control and experimental groups does not differ statistically significantly.

CG students studied a course in Elementary Mathematics at universities using traditional

Table 4. Table for calculating Fisher's statistical test when comparing the level of students' educational achievements at the the beginning of the experiment.

Group	"There is an effect", and received points from 76 to 100	"There is an effect" received points from 1 to 75	Together
Control	29 (62 %)	18 (38 %)	47
Experimental	31 (61 %)	20 (39 %)	51
Together	60	38	98

methods. EG students studied the same course in parallel with the online course "Creative Thinking through Learning Elementary Maths" on the online platform "Higher School Mathematics Teacher" [28]. At the same time, with the help of the Google Class service, students had the opportunity to send the completed problems to the teacher for review. Assessment of problems was carried out on a scale of "passed" or vnot "passed". The teacher pointed out mistakes and drawbacks in the completed problems and provided an opportunity to correct them in the event of receiving a "failed" grade.

At the end of the experiment, the students also passed elementary mathematics tests, which consisted equally of traditional and Rich tasks. The students' results are shown in table 5 and figure 2.

Results of tests in Elementary Mathematics at the end of the experiment.

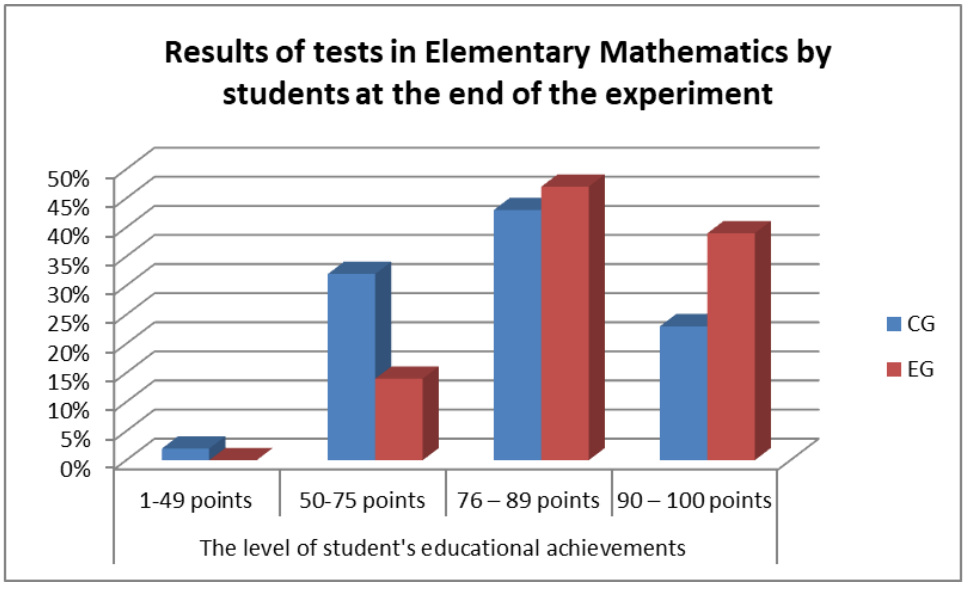

Figure 2. Results of tests in Elementary Mathematics by students at the end of the experiment.

As we can see in table 5 and figure 2, the results of the tests in the control and experimental groups at the end of the experiment are significantly different. In particular, the largest difference of 18% was observed between students who scored 50-75 points in favour of the CG, while a difference of 16% was observed between students who scored 90-100 points in favour of the EG.

To make sure that the existing difference between the results of the tests in control and experimental groups is statistically significant, Fisher's statistical test φ^* was used.

Table 5. The results of diagnostic tests in Elementary Mathematics at the end of the experiment.

The level of educational achievements of CG students				of EG students			
1–49 points	50–75 points	76-89 points	90–100 points	1–49 points	50–75 points	76-89 points	90–100 points
1 (2%)	15 (32%)	20 (43%)	11 (23%)	0 (0%)	7 (14%)	24 (47%)	20 (39%)

It formulated statistical hypotheses: Null hypothesis H_0 : the level of formation of students' educational achievements in the control and experimental groups at the end of the experiment does not differ statistically significantly.

Then the alternative hypothesis H_1 : the level of formation of students' educational achievements in the control and experimental groups at the end of the experiment is statistically significantly different.

In table 6 for calculating φ^* when comparing the level of students' educational achievements at the end of the experiment.

Table 6. Table for calculating Fisher's statistical test when comparing the level of students' educational achievements at the end of the experiment

Group	"There is an effect", and received points from 76 to 100	"There is an effect" received points from 1 to 75	Together
Control	31 (66 %)	16 (34 %)	47
Experimental	44 (86 %)	7 (14 %)	51
Together	75	23	98

According to the angle determination table $\varphi_1(86\%) = 2.373$ and $\varphi_2(66\%) = 1.897$. Hence, the empirical value φ^* is: $\varphi^*_{emp.} = 2.36$. At the same time, the critical value φ^* for any n_1, n_2 is equal to: $\varphi^*_{cr.} = 1.64$ ($p < 0.05$) or $\varphi^*_{cr.} = 2.31$ ($p < 0.01$). So, according to $\varphi^*_{emp.} = 2.36$ it is got that $\varphi^*_{emp.} > \varphi^*_{cr.}$.

Since $\varphi^*_{emp.} > \varphi^*_{cr.}$, the hypothesis H_0 is rejected and H_1 accepted.

And the data presented in table 5 gave grounds for asserting that the level of student's educational achievements at the EG is higher than at the CG.

Statistically, the verification based on the results of the tests allowed us to assert the effectiveness of using the online course "Creative Thinking through Learning Elementary Maths" [28] in the mathematics teacher training system.

5. Discussion

As pointed out by Balentyne et al. [30], Fazal et al. [11] and Boyd [31] the present and the future of modern education are related to the active implementation of blended learning. This is consistent with the conclusions of Attard et. al. [10], who claim that one of the effective forms of organizing blended learning of Mathematics is the combination of studying a certain discipline

in face-to-face or mixed format with studying an online course. At the same time, the online course can be either a course to support and accompany the academic discipline or a course that complements and expands individual components of the study of the academic discipline. This is exactly what the online course "Creative Thinking through Learning Elementary Maths" is.

The development of the method for using the online course was based on the ideas of Rifa'i et al. [14], Lin et. al. [7], and Evendi et al. [32]. We singled out three options for using the online course in the mathematics teacher training system: the parallel study of the online course "Creative Thinking through Learning Elementary Maths" and the Elementary Mathematics course; the usage of the online course as a platform to support flipped learning in two options: only for familiarization with theoretical material and obtaining practical tasks, or for organizing feedback.

In the development of the method for the implementation of the online course in the training of mathematics teachers, we took into account the researcher's opinions of Hjalmarson [23], Klang et al. [33] and Jojo [34] regarding the importance of a special selection of activities for the development of student's personal qualities. It is in the process of four types of activities (recognition, classification, solving, creation) with Rich tacks that both the students' mathematical competencies and the components of their creative thinking are formed. For example, to solve Rich Tacks, it is necessary to be able to formulate a problem (formation of the ability to identify and pose a problem), "discover", propose an unusual (unknown) method, and method of solving (formation of originality and the ability to generate a significant number of ideas), clarify, change the course of solving in case of difficulties (formation of flexibility and ability to improve the subject, add details). To create Rich Tacks, you need to be able to think outside the box, modify, improve the condition, and adapt them to the needs of students (formation of originality, flexibility and the ability to generate a significant number of ideas). All these skills and abilities are integral components of key and mathematical competencies.

6. Conclusions

The analysis of resources and research papers confirmed the relevance of using online courses in the mathematics teacher training system. One of the possible options for such use is the combination of studying Elementary Mathematics and the online course "Creative Thinking through Learning Elementary Maths" [28]. Such a combination, depending on the number of credits assigned to the study of Elementary Mathematics at the university, should be carried out in three options: the parallel study of Elementary Mathematics and the online course; using the platform [28] to get acquainted with the theoretical material, subject to the presentation and taking problems in Elementary Mathematics classes and using the platform to get acquainted with the theoretical material and receive feedback on issues related to both the online course and from the study of Elementary Mathematics. In any case, placing the course on the "Higher School Mathematics Teacher" platform [28] made it possible to provide a wide range of students with access to it, and with activities with Rich tasks of three levels of complexity.

For the effective learning of Elementary Mathematics and the development of student's creative thinking, it is advisable to organize students' activities on recognition, classification, solving and creation of open and integrative Rich tasks. Such activities positively contributed to the development of the ability to analyze, compare, pose a problem, generate new ideas, classify, do conclusions, establish relationships between elementary and separate sections of Higher Mathematics, flexibility and originality. Experimental verification of the implementation of the developed course with the usage of diagnostic tests confirmed the effectiveness of using the course for the formation of mathematical competencies and the development of creative thinking of students.

We see further prospects in the development of methods of using online courses, focused on the formation of mathematical competencies and the development of creative thinking of

students based on activities with Rich tacks in Higher Mathematics and Mathematics in high school.

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