

Pedagogical bases of professional training of future teachers – mathematicians to development of pupils' creative abilities

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Abstract: The article is devoted to the analysis of professional training of future teachers to the development of creative abilities of pupils. Process of implementation of professional training of future teachers to creative development of school students can be divided into four periods: a) orientation of future teachers on creative character of the chosen profession, strengthening of interest, definition of motives of a choice of this profession; b) practical participation of future teachers in creative process, assimilation of value and content of creativity, accumulation of creative experience; c) generalization of knowledge and abilities of future teachers in the field of creative development of pupils', effective use of pedagogical technologies, creation and introduction of new elements of technologies; d) implementation of professional activity of future teachers in the field of creative development of school students, modifying of skills and abilities, self-checking and self-assessment development.

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1. Introduction

The changes which have happened in our country after finding of independence, owing to informatization of society have strong impact on its various areas and branches including on professional teaching activity. This question was concretized by the head of state in the Appeal - 2050: "We have to introduce intensively innovative methods, decisions and tools in a domestic education system, including distance learning and training online, available for all comers. It is necessary to get rid of outdated or unclaimed scientific and educational disciplines; having at the same time strengthened the demanded and perspective directions. To change an orientation and accents of curricula of secondary and higher education, having included there programs on training in practical skills and obtaining practical qualification"[1].

Information technologies bring opportunity and need of change of the model of educational process: transition from reproductive training — "modulation" of knowledge from one head in another, from the teacher to students — to creative model (when in educational audience by means of new technological and technical support the life situation or process is modelled, students under the leadership of the teacher have to apply the knowledge show creative abilities for the analysis of a modelled situation and develop decisions on objectives). As scientists consider, today the education problem is

not in technologies, but in the person, in the teacher who comes to audience [2]. The teacher is a weak link from the point of view of information technologies. Besides, the majority of experts working in higher education institutions often don't have pedagogical education. Therefore the main attention in an education system first of all has to be directed on pedagogical preparation of teachers [3,4]. Having combined pedagogical education and education in the field of new information technologies, it will be possible to provide break in creation of the new educational environment [5, 6, 7].

Long-term experience of the teacher shows that our pupils can't creatively think; show the identity, their creative abilities are developed poorly. Teachers are guilty that couldn't teach them to creative thinking, couldn't develop their creative abilities [8,9,10]. Therefore the problem of professional training of future teachers to development of creative abilities of school students becomes actual.

The purpose of the work is to reveal a professional level of future teachers to development of pupils' creative abilities and to provide its realization by methodical system.

2. Methods

The methods that have been used are supervision over educational process, questioning, analysis, experimental work, systematization of data and their statistical processing.

For the purpose of identifying professional trainings of future teacher to creative development of schoolchildren, the special experiments were conducted which consisted of several stages: stative experiment, forming experiment. While conducting stative experiment, students' creative activities, indexes of creative thinking, realization of creative peculiarities of the specialty were identified.

3. Results and discussion

Students' creative activity consists of following abilities: the degree of making decisions independently, choice of means for executing an action, mobility of the accepted decisions, capacities of forming and modeling action that refuse the prepared programs, ability of transferring to another program, inclination for improving the content of the executed work [11,12]. The results of the questionnaire that was conducted are shown in the table below:

Table 1. The results of the questionnaire

Results of control groups						Results of the experimental groups						d ²			
№	questions					Medium index	grad e	№	questions					Medium index	grad e
	1	2	3	4	5				1	2	3	4	5		
1	5	5	5	3	3	4,2	1	1	3	3	3	3	2,6	5	16
2	3	3	3	3	3	3	4	2	3	3	3	3	3	3	1
3	1	0	0	3	0	0,8	13	3	1	0	0	0	0,8	13	0
4	5	3	0	0	0	1,6	11	4	1	3	0	0	0,8	14	9
5	5	3	5	0	0	2,6	6	5	1	3	0	0	0,8	15	81
6	1	3	0	0	0	0,8	14	6	1	3	0	0	0,8	16	4
7	3	3	3	0	3	2,4	7	7	3	3	3	0	2,4	7	0
8	3	3	0	3	3	2,4	8	8	3	3	0	3	2,4	8	0
9	1	0	0	3	0	0,8	15	9	5	3	3	5	3,8	1	196
10	5	3	3	3	3	3,4	2	10	5	3	3	3	3,4	2	0
11	5	3	3	0	0	2,2	9	11	1	3	3	0	1,4	11	4
12	1	3	3	0	0	1,4	12	12	1	3	3	0	1,4	12	0
13	3	3	3	3	3	3	5	13	3	3	3	3	2	4	1
14	1	0	0	3	0	0,8	16	14	1	3	3	3	2,6	6	100
15	3	3	3	0	0	1,8	10	15	3	3	3	0	1,8	10	0
16	5	3	3	3	3	3,4	3	16	1	3	0	3	2	9	36
Medium index						2,16		Medium index						2,06	448

As it is shown in the table, only one student of the control group showed the highest level of creative activity, 7 students showed the medium-level, 8 students showed the lowest level of the creative activity, and in the experimental group one student showed the highest level of creative activity, 6 students showed the medium level, 9 students showed the lowest level of creative activity.

In each group the medium indexes of students' creative activity are shown in the following table Table 2.

Table 2. Initial indication of students' creative activity

	Self-mark	Expert mark	Medium index
Control group	2,16 ± 1,7	1,9 ± 1,4	2,0 ± 1,5 (50%)
Experimental group	2,06 ± 1,5	1,8 ± 1,1	1,9 ± 1,3 (43,8%)

Thus, the analyses of students' creative activity of the control and experimental group show that the level of students' creative activity of control and experimental group does not differ much.

As the indexes of the experiment are not the same, the accuracy of the indexes is coefficient of the grade correlation. In this case:

$$R = 1 - \frac{6 \sum d^2}{n^3 - n} = 1 - \frac{6 \cdot 448}{16^3 - 16} \approx 0,341;$$

$$R_{0,05} = 0,306;$$

$$R > R_{0,05} \quad (0,341 > 0,306) .$$

That is, the coefficient of correlation R = 0,341 is more than tabular indexes 0,306, which corresponds the mistake 0.05, that confirms the correctness of the results.

The following type of the stative experiment is the identity of the information that characterizes students' creative thinking.

To get the information characterizing the medium-indication of students' creative thinking on the course of teaching mathematics, we have formed the system of tasks that evaluate on 100 score system. It is presented in the following criteria:

For the speed of thinking -10 scores;

For the ability to think -10 scores;

For specification of thinking -10 scores;

For the creativity -70 scores.

Each task enabled the identification of these criteria. Results of fulfilling the tasks on the identification are given in the table below (Table 3).

Table 3. Primary average indication of the students' creative thinking

Type of creative thinking	Average indication of the type of creative thinking	
	Experimental group	Control group
Speed	9,1 ± 0,4	9,2 ± 0,4
Ability	7,2 ± 1,1	6,9 ± 1,4
Peculiarity	8,3 ± 1,4	8,4 ± 1,2
Creativity	34,5 ± 0,6	32,8 ± 1,1

As it is seen in the table the analyses of the students' creative thinking of the control and experimental groups show that the indexes of the students' creative thinking of control and experimental groups are identical.

The level of thinking speed (the ability of expressing thoughts) and creativity (the ability to explain the thoughts dividing them in different fragments) of the students of the control and experimental groups do not differ much.

But on the indications of the ability to think (the ability to offer different ideas) and the peculiarity of thoughts (the ability to make own ideas), the medium-indication of the control and experimental group differs much, and we think that this is the fact of different information or motivation.

Thus, after conducting the stative experiment we come to the following:

- the levels of knowledge on subjects of the control and experimental groups, in comparative aspect, are identical;
- the level of the pupils' creative thinking and creative activity is low;
- the level of realization of the creative characteristics of pedagogical specialty in low.

The following stage of the experiment – is a forming experiment. In this stage, students can form the ability of working out the lessons, rational integration of the interrelationships of a teacher and a student, the right motivation was composed, the necessary psychological conditions and emotional background were planned, and all of these things were inculcated into the process of math classes.

While conducting the forming experiment, results of problematic tasks that are executed by students on the lessons were analyzed. The analysis of results examined the level of creative thinking development, the level of forming the elements of creative activities in organizing the teaching process by students.

The method of teaching a subject usually consists of following components: in which form the certain subject is taught, the time that is needed for conducting the subject is taken into account, how many hours are spent on the subject, what kind of textbooks are used for teaching the certain subject, what methodological textbook the teacher uses, what didactic materials are used, what methods are used. The practical and laboratorial lesson with the pupils of the control group was conducted on this scheme.

However, in the experimental groups, much attention was paid for the organization of learning motivation. This was conducted by the help of the following questions: "What are the difficulties that the pupils face in preparing homework? What are the methodical questions that arisen in preparing the homework? How would you reply to these questions?", and so on. The obligatory terms in solving methodical problems, in creative activities are the formation of students' creative activity. The students of the experimental groups executed the task independently, they asked questions on the material of lectures from each other, that helped us to know how the students are ready for the classes.

The results of the creative thinking, elements of creative activity in the process of organizing according to five-score system: 0 score – for having no qualities, 1 score –for a low level, 2,3score – for a medium-level, 4 score – for a high level. These results of the experimental group for two terms are shown in the following table (Table 4).

Table 4. The results of the experiment

Ordinal number of the students	6 term		7 term	
	Level of creative thinking	Level of inculcating creative activity in learning process	Level of creative thinking	Level of inculcating creative activity in learning process
1	2	1	3	3
2	1	0	2	3
3	3	2	4	4
4	0	0	1	2
5	2	1	3	4
6	0	0	1	1
7	3	2	4	4
8	1	1	3	3
9	0	0	0	1
10	2	2	4	4
11	1	0	2	2
12	2	1	3	3
13	0	0	1	2
14	2	1	3	3
15	3	2	4	4
16	2	0	3	3
Having no qualities	25%	43.75%	6.25%	0
Medium score	1.5	0.8125	2.625	2.875
Low level	18.75%	31.25%	18.75%	12.5%
Medium level	56.25%	25%	50%	56.25%
High level	0	0	25%	31.25%

The table shows the development of dynamics of students creative thinking. Also, the results of inculcating elements of creative activities during the organization of teaching process are high. Thus, the students' creative thinking can be developed with the help of self-work by offering them to prepare a difficult task, by giving them opportunity to solve the methodical tasks. For example, students were required to compose cards for different themes, and to define on which stages these cards can be used. The same tasks were offered to the students' of the control group. The analysis of tasks on cards was determined by the following criteria:

- rich content;
- accessibility;
- Problematic;
- Logicality

The rich content of the task on cards on each criteria was evaluated by 5score system (Table 5).

Table 5. Results of the experiment

№	Experimental group				Control group				
	1-cr	2-cr	3-cr	4-cr	1-cr	2-cr	3-cr	4-cr	
1	5	3	5	5	1	5	3	4	
2	4	5	3	3	2	3	3	3	
3	4	4	4	5	3	4	4	3	
4	5	5	4	3	4	4	5	2	
5	3	3	3	5	5	4	3	4	
6	4	5	5	5	6	4	4	3	
7	5	4	3	4	7	5	2	2	
8	4	4	4	3	8	2	3	3	
9	4	4	3	4	9	3	4	2	
10	5	4	4	5	10	4	5	4	
11	3	5	4	3	11	3	2	3	
12	4	5	3	4	12	2	3	4	
13	5	4	4	4	13	5	4	2	
14	4	3	3	3	14	4	2	3	
15	2	5	4	4	15	2	3	3	
16	4	4	3	4	16	2	4	2	
					17	4	3	3	
					18	3	2	4	
Medium index	4.1	4.2	3.7	4	Medium index	3.5	3.3	2.8	3.2
Results of the initial statistic working up									
Criteria of the selection	1	2	3	4	1	2	3	4	
Medium index	4.1	4.2	3.7	4	3.5	3.3	2.9	3.2	
Dispersion	0.7	0.6	0.5	0.7	1.1	0.9	0.6	0.9	
Standart diversion	0.9	0.8	0.7	0.8	1.0	0.9	0.8	0.9	
Mediana	4	4	3.5	3.5	3.5	3.5	4.5	2.5	3
Mode	4	4	4(3)	3	3	3	3	4(3)	

The results show that the students of experimental group are better in completing the given tasks. During the forming experiment after learning methodological course on teaching mathematics, control works were conducted among students of control and experimental groups. The results are shown in Table 6.

Table 6. Medium index of students' creative thinking after learning the course of teaching mathematics methodology

Type creative thinking	Medium index	
	Experimental group	Control group
Speed	9,8±0,2	9,4±0,1
Ability	8,4±0,1	7,6±0,3
Peculiarities	9,2±0,1	8,8±0,1
Creativity	53,0±0,1	39,8±0,1

The results of forming experiment allowed us to identify the dynamics of creative thinking.

Table 7. The changes of students' creative thinking level in the process of conducting experiment

Level	Quantity of students			
	Control groups (92 people)		Experimental groups (98 people)	
	The initial stage of learning	The last stage of learning	The initial stage of learning	The last stage of learning
High	12 students	29 students	10 students	34 students
Medium	39 students	45 students	35 students	52 students
Low	41 students	18 students	53 students	12 students

The level of changes in students' creative thinking in conducting forming experiment is shown in the histogram (Picture 1).

We defined the efficiency of the forming experiment according to the formula "criterion of x-square" (χ^2 - criterion). In our case χ^2 - criterion was worked out by the formula:

$$\chi^2 = \sum_{i=1}^n \frac{(F_i' - F_i'')^2}{F_i' + F_i''}, \text{ where } F_i' \text{ and } F_i''$$

F_i'' are frequency mark that are faced in the choices of 1 and 2, under the condition $n_1 = n_2$. The number $\chi^2 = 16,44$ for the control group is more than 9,21 in the table with mistakes 0,01, under the free level $n-1=2$.

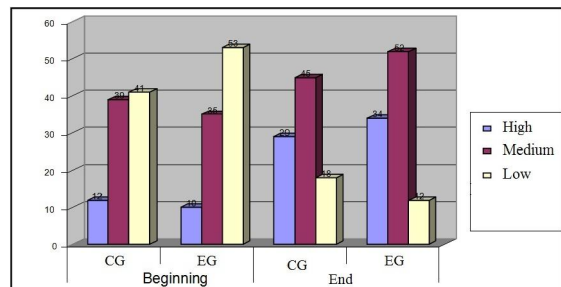


Figure 1. The initial and the last results of experiment

Moreover, the number $\chi^2 = 42,27$ that is taken for the experimental groups is more than the number 13,82 in the table that is taken for the control groups. Therefore, it can be confidentially stated, that

the evaluation of students' creative thinking in conducting the forming experiment is more above than before conducting the forming experiment. The number $\chi^2 = 16,44$ shows that there is much influence on students' creative thinking in conducting the methodological course of teaching subject and in the control groups, that once again proves the efficiency of our teaching methods.

In conducting the forming experiment we could notice that creative abilities heightened because of the Improving creative activity. Diagnosing the results of forming experiment enabled us to get the following information: in conducting the teaching methods of mathematics the level of creativity of the experimental group heightened by 31.2%, and the level of students' creativity in the control group has heightened by 12.5% (Table 8).

Table 8. Evaluation of the level of students' creative activity after conducting the methodical courses

	Self-evaluation	Expert evaluation	Medium index
Control group	2,6 ± 1,9	2,8 ± 1,6	2,7 ± 1,7 (62,5%)
Experimental group	3,7 ± 1,3	3,5 ± 1,1	3,6 ± 1,2 (75%)

Thus, after the methodical course of teaching mathematics the level of students' creative activity has improved that shows the efficiency of our methods.

The initial and the last results of students' creative activity in the control and experimental groups are shown in the following histogram (Picture 2).

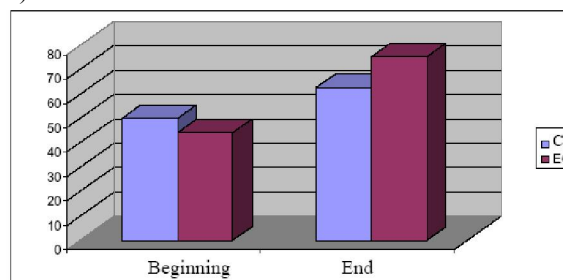


Figure 2. The changes of the level of students' creative activity (according to the results of the methodical courses)

In the last stage of the forming experiment, the students of the control and experimental groups had opportunities to inculcate the elements of creative activities into learning process. The questionnaire was taken that allowed students to evaluate themselves for the level of inculcating the elements of creative activity into learning process, and it also allowed the teachers to evaluate students for

inculcating the elements of creative activity into the learning process in the practice on 4- score scale.

The results of professional training of future mathematic-teachers to the development of pupils' creative abilities are: creativity of the students of the experimental group rose from 3- grade to 5-grade, and creativity of the students of the control group was on 4-grade. The results are reflected in Table 9.

Table 9. Evaluation of the ability to inculcate the element of creative activity into the learning process

	Self-evaluation	Evaluation of the expert	Medium index
Control group	2.1 ± 0,1	1,8 ± 0,2	1,9 ± 0,1 (57,5%)
Experimental group	2,6 ± 0,2	2,4 ± 0,1	2,5 ± 0,1 (70%)

4. Conclusion

1. Professional trainings of future teacher for the creative development of pupils are based on specific *principles* (general- didactic principles, developing principles, principles of personality, principles of humanity, principles of variability, principles of cultural -peculiarities, principles of nationality, influence, consequence, accordance) and *methodological approaches* (forming creative personality, professional training of future teachers, development of pupils' creative abilities).

2. The model of creative self-development of future teachers orients them to the pupils' development in creative direction. Structural model supplies the process of training which influence on the connection of development and formation of professional training of future teachers to the pupils' creative development and criteria and indexes which define the creative level to increase the effectiveness of forming components of future teachers' training.

3. We divided process of implementation of professional training of future teachers into four periods: a) orientation of future teachers on creative character of the chosen profession, strengthening of interest, defining of motives of a choice of this profession; b) practical participation of future teachers in creative process, assimilation of value and content of creativity, accumulation of creative experience; c) generalization of knowledge and abilities of future teachers in the field of creative development of pupils, effective use of pedagogical technologies, creation and introduction of new elements of technologies; d) implementation of professional activity of future teachers in the field of creative development of pupils, modifying of skills and abilities, self-checking and self-assessment development.

The importance of this research consists that in teaching and educational process the concept and methodical system of professional training of future teachers of development of creative abilities of pupils are introduced. Results of research can be used in the high special educational institutions, at institutes of professional development. The full solution of a complex and multilateral problem of research wasn't included into a field of our sight.

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