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PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

RESULTADOS DO ESTUDO PARA O TREINAMENTO METODOLÓGICO DE PROFESSORES DE MATEMÁTICA EM CONDIÇÕES DE INOVAÇÃO

STUDY RESULTS FOR METHODOLOGICAL TRAINING OF TEACHERS OF MATHEMATICS IN CONDITIONS OF INNOVATION

РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЯ МЕТОДОЛОГИЧЕСКОЙ ПОДГОТОВКИ УЧИТЕЛЕЙ МАТЕМАТИКИ В УСЛОВИЯХ ИННОВАЦИЙ

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RESUMO

O estágio contemporâneo da reforma educacional exige muito da formação de professores e do domínio das mais recentes técnicas e tecnologias de ensino. Em todo o mundo, busca-se novos sistemas educacionais mais democráticos, diversificados e eficazes do ponto de vista dos interesses do indivíduo e da sociedade. Isso requer, por um lado, maneiras novas e mais eficientes de organizar o processo educacional na universidade, em particular, revisando a estrutura e o conteúdo da formação metodológica dos estudantes. Por outro lado, o próprio conceito de “atividade pedagógica profissional de um professor” está passando por certas mudanças. Este estudo teve como objetivo identificar com que eficácia o treinamento metodológico de futuros professores de matemática aumentará com base na introdução de técnicas e métodos de ensino inovadores e como a metodologia de ensino de disciplinas matemáticas nas condições de inovação poderá ser aprimorada. Duzentos e treze pessoas participaram do trabalho experimental, incluindo professores de matemática e estudantes em período integral, estudantes de graduação, doutorado e jovens professores da universidade. Os resultados do experimento determinante tornaram-se a base para a revisão dos propósitos da formação metodológica e profissional de futuros professores de matemática e possibilitaram concluir sobre a necessidade de aperfeiçoar o suporte metodológico do sistema para o ensino de disciplinas matemáticas no ensino superior. Por isso, a formação de um professor de matemática deve torná-lo um matemático experiente, como uma pessoa com uma alta cultura pedagógica e geral, que, ensinando, educaria a geração mais jovem no espírito da modernidade. Pode-se supor que o conteúdo dos cursos de uma universidade pedagógica em disciplinas matemáticas deve, por exemplo, em um nível acadêmico moderno, abranger os assuntos que o professor comunica na escola.

Palavras-chave: *ensino de disciplinas matemáticas, processo educacional, programação neurolinguística.*

ABSTRACT

The contemporary stage of education reform puts high demands on teacher training and on mastering the newest teaching techniques and technologies. All over the globe, there is a search for new education systems that are more democratic, diversified and effective from the standpoint of the interests of the individual and society. This requires, on the one hand, new, more efficient ways of organizing the educational process at the university, in particular, reviewing the structure and content of the methodological training of students. On the other hand, the very concept of “professional pedagogical activity of a teacher” is currently undergoing certain changes. This study aimed to identify how effectively will the methodological training of future mathematics teachers increase based on the introduction of innovative techniques and teaching methods and how the methodology of teaching mathematical disciplines in the conditions of innovation may be improved. Two hundred thirteen people took part in the experimental work, including teachers of mathematics and full-time students, undergraduates, doctoral students, as well as young teachers of the university. The results of the ascertaining experiment became the basis for revising the purposes of the methodological and professional training of future mathematics teachers and made it possible conclude on the necessity of improvement of the system-methodological support for teaching mathematical disciplines in higher education. Because of this, the training of a mathematics teacher should form them as a knowledgeable mathematician, as a person with a high pedagogical and general culture, who, by teaching, would educate the younger generation in the spirit of modernity. It can be assumed that the content of courses in a pedagogical university in mathematical disciplines should, for instance, at a modern academic level, cover those matters that the teacher communicates at school.

Keywords: *teaching mathematical disciplines, educational process, neurolinguistics programming.*

АННОТАЦИЯ

Современный этап модернизации образования предъявляет повышенные требования к профессиональной подготовке преподавателей и освоению ими новейших методик и технологий обучения. Во всем мире идет поиск новых систем образования, более демократичных, диверсифицированных и результативных с позиции интересов личности и общества. Это требует, с одной стороны, новых, более эффективных путей организации учебно-воспитательного процесса в вузе, в частности, пересмотра структуры и содержания методической подготовки студентов. С другой стороны, само понятие «профессиональная педагогическая деятельность преподавателя» подвергается в настоящее время определенным изменениям. Цель данного исследования заключается в определении эффективности совершенствования методической подготовки будущих учителей математики при внедрении инновационных техник и методов обучения, а также улучшении методологии преподавания математических дисциплин в условиях инноваций. В экспериментальной работе приняли участие двести тринадцать человек, в том числе учителя математики и студенты дневного отделения, магистранты, докторанты, а также молодые преподаватели университета. Результаты констатирующего эксперимента стали основой для пересмотра целей методической и профессиональной подготовки будущих учителей математики и позволили сделать вывод о необходимости совершенствования системно-методического обеспечения преподавания математических дисциплин в высшей школе. Учитывая это, подготовка должна сформировать учителя математики как грамотного преподавателя, человека с высокой педагогической и общей культурой, который способен воспитать молодое поколение в духе современности. Содержание курсов в педагогическом университете по математическим дисциплинам на современном академическом уровне должно охватывать те вопросы, с которыми преподаватель сталкивается в школе.

Ключевые слова: *преподавание математических дисциплин, учебный процесс, нейролингвистическое программирование.*

1. INTRODUCTION:

It is assumed that students who are now finishing a pedagogical university at the age of 22-23 years will, on average, work as teachers for 40-45 years. In this time, new fields will emerge in mathematical science that currently does not exist; school teaching will change in many ways, it will include such problems of mathematics that our students may not yet be studying (Arkhangelsky, 1980; Avramidis and Norwich, 2002; Frade et al., 2013; Stockero, 2013; Van Zoest et al., 2016; Stockero et al., 2017; Bayanov et al., 2019). Therefore, future mathematics teachers have to be taught not only those branches of mathematics that are currently important but also those regarding which there is reason to believe they will develop shortly or will become the basis of future branches of science. In other words, this means that the thinking of students must be developed in such a way that later they can learn new sections of mathematics that they may need to teach in the future at school, even if they do not study them at the moment (Miguel and Mendes, 2010; Mendes, 2013; Mendes and Silva, 2018).

The main trends characteristic and necessary for the preparation of future mathematics teachers as future specialists (Kravets, 2011; Cohen, 2011; Schejbal, 2012; Stockero and Van Zoest, 2013; Leatham et al., 2015; Seitova et al., 2016; Seitova et al., 2018):

– from a “knowing person”, armed with a system of knowledge, skills, to "a person prepared for life", that is, a person capable of active and creative thinking, and acting, self-developing intellectually, morally and physically;

– from the concept of “Education for life” to understanding the need for education through life, the psychological readiness for further education and retraining, including the willingness to take them at face value, and not as a life catastrophe, should be formed in the course of modern professional education;

– development of initiative; initiative can guarantee success in life, a person’s mobility, readiness to solve various kinds of problems, the action must not only be maintained but also purposefully, consistently formed;

– from knowledge to competencies; the knowledge-centric model of education doesn’t satisfy the real needs of the development of society and the individual; it is necessary to involve students as future specialists in the process of hard and diverse work in teaching, acquiring the skills necessary to study the material, it is important to promote cooperation.

Against the backdrop of significant social changes since the early nineties, the education system in many countries of the world is undergoing reform (Pligin, 1997; Breitigam and Karakozov, 2004; Vilensky et al., 2004; Dalinger, 2014; Maslova, 2015; Anamova et al., 2019; Natolochnaya et al., 2020). The need for reforms is caused, in particular, by the fact that in higher education, for example, in Russia, as shown by the results of A.A. Verbitsky (Verbitsky, 1991), V.I. Kagan (Kagan and Chebyshev, 2000), Yu.T. Tatura (Tatur, 2000), O.V. Dolzhenko, V.L. Shatunovsky (Dolzhenko and Shatunovsky, 1990) and others, in some areas there was a significant gap between the global needs of society and the results of education; between the objective requirements of time and the general insufficient level of education; between professional orientation and the need of the individual to satisfy a variety of cognitive interests; between modern methodological approaches to advanced sciences and the archaic style of teaching (Abdudlina, 1976; Babansky, 1982; Yansufina, 2003; Peterson and Leatham, 2009; Bray, 2011; Herbst and Chazan, 2012; Mendes, 2012; Rauner, 2013; Uglev and Ustinov, 2014; Bartell et al., 2015; Lee and Cross Francis, 2018).

I.A. Kolesnikova gives a slightly different interpretation of the issue, analyzing innovation as a form of manifestation of a new quality of pedagogical reality, as a way of future development in pedagogy, thereby outlining the philosophical and teaching foundations for the development of teaching innovation as a scientific and practical field (Kolesnikova, 1999; National Council…2014; Lineback, 2015; Van Zoest et al., 2017).

The works of foreign authors cover certain theoretical and practical aspects of innovative processes as change processes in the educational system, based on various pedagogical innovations. The studies of American and English educators (H. Barnett, J. Bassett, D. Hamilton, N. Gros, M. Miles, R. Eden and others) analyze the management of innovative processes, the organization of changes in education, the conditions necessary for "activity" of innovations, planning of innovations, ways of regulation of pedagogical innovations.

The socio-psychological aspects of the distribution of innovations are well-developed. In essence, a typology of participants in innovation processes, their attitude to innovations, readiness to accept new ideas, reasons for the emergence and ways to overcome psychological barriers, factors for the development of innovative activity (K. Angelowski, E. Rogers, L.A. Korostyleva, O.S. Sovetova, A.M. Khon, M.V. Croz, L.M. Podlesnaya). The matters of managing innovative processes in education are considered in sufficient detail (A.P. Volchkova, O.G. Khomeriki, V.P. Kvasha, N.V. Konoplina, G.A. Krasyun, A.M. Voronin, V.F. But, etc.).

The purpose of the study is to test ways of implementing system-methodological support for innovation in the teaching of mathematical disciplines at the university with an experiment.

The general research question of this study was as follows: how effectively will the methodological training of future mathematics teachers increase based on the introduction of innovative techniques and teaching methods. How may the methodology of teaching mathematical disciplines in the conditions of innovation be improved?

2. MATERIALS AND METHODS:

In the course of the study, there were conducted an analysis of scientific and educational literature on the topic of research, a generalization of empirical material, modeling, questioning, testing, methodology with the choice of tasks, observation, recording the results of training and formation, a teaching experiment.

This study describes and analyses the experimental work on the implementation of the methodology for the formation of the readiness of future mathematics teachers to organize innovation in teaching mathematical disciplines at the university. In this case, the experimental work acts as the research method, which allows to scientifically substantiate, prove the idea that the implementation of the developed methodology provides an increase in the level of formation of the readiness of future mathematics teachers to organize innovation. The goals, the content of the stages, the results of the pedagogical experiment are revealed. The purpose of the experimental work was to test the hypothesis of the study. As a constructive basis for its design and implementation, the developed methodology for implementing the innovative orientation in the teaching of mathematical disciplines at the university was adopted following modern requirements for the training of future specialists.

Two hundred thirteen people took part in the experimental work, including teachers of mathematics and full-time students, undergraduates, doctoral students, as well as young teachers of the university. Innovative work is represented by ascertaining, searching, and educational experiments.

The ascertaining experiment, wherein 120 people took part, was carried out in two stages. The first stage of the ascertaining experiment was carried out through a survey to identify among teachers of mathematics (70 people) their attitude to work in conditions of innovation, whether the development of changes is necessary for the advancement of the educational system, and whether specialists possess the required level of competence for the development of innovative works. Analysis of the results of the survey showed that only less than 50% of the tested teachers were able to positively answer the questions in the amount of 60% and above. The data obtained indicate a low assessment of the attitude towards the process of introducing innovations into the educational process. Moreover, it hints at a low level of formation of the necessary infrastructure for the development and implementation of changes. The second stage of the ascertaining experiment was to identify the levels of creation of the ability to introduce innovative approaches upon teaching mathematical disciplines for students (50 people) of the Faculty of Natural Sciences, specialty “Mathematics” before studying the subjects of methodological training (2nd year) and after (3rd year). Since in the 3rd year, students begin to explore disciplines of a methodological nature and further embark on pedagogical practice.

During the searching experiment, where full-time students and undergraduates took part (93 students), individual innovative teaching methods were tested, effective teaching methods were identified, the research hypothesis was clarified. The educational experiment was organized and conducted in vivo in the educational process of studying "Methods of Teaching Mathematics" by third-year students (47 people) of the Faculty of Natural Sciences of Zhetysu State University named after I. Zhansugurov (Kazakhstan, Taldykorgan).

The objectives of the educational experiment: 1) to identify the pedagogical conditions of the system-methodological support of the innovation in the teaching of mathematical disciplines at the university; 2) to prove the efficiency of the developed methodology for the application of innovative technologies in the preparation of future mathematics teachers (on the example of the discipline "Methods of teaching mathematics"). Proof of the efficiency of the developed methodology for teaching future mathematics teachers to work in an innovative environment requires a description of diagnostic measures to determine the level of formation of the corresponding skill.

All procedures performed in studies involving human participants were following the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

3. RESULTS AND DISCUSSION:

As a diagnostic tool, a test consisting of 4 parts was developed, each of which corresponds to one of the indicators. In the first part of the test, students' knowledge in the field of mathematical training was assessed, in the second – their ability to solve typical problems in this area, and in the third and fourth – knowledge and skills that form the basis of the methodological unit of the formed ability. The maturity of each of the indicators was assessed on a 10-point scale. The indicator was considered mature if the student scored 9 or 10 points in the diagnostic event. The test results are presented in Table 1.

It was found that with increasing value h_0, the amplitude of displacements increases against the direction of the axis Ox, and the amplitude of displacements in the direction of the axis Ox decreases. With increasing value h_0, the maximum and average values of thermoelastic stress σ decreases.

Thus, it was established that only by changing the value h_0, (and not T_{amb0}), i.e., by changing the environmental properties of the surrounding cross-sectional area where heat transfer occurs, the thermally stressed state of the rod under investigation can be changed. For data measured in an ordinal scale, it is advisable to use the homogeneity criterion 2. Objective: to determine the accuracy of coincidences and differences for a pair of experimental data measured in an ordinal scale using the uniformity criterion 2.

A description of the 2nd year group is a point vector on an ordinal scale with L = 5 different points (levels): n1 = (n1, ..., n1L), 30. A description of the 3rd year group is a point vector: n2=(n2,…,n2L), 20. At a significance level of a=0.05, using the uniformity criterion 2, check the null hypothesis H0: differences in the distribution of students of groups of 2nd year and 3rd year by the maturity level of their methodological training in the conditions of innovation.

The empirical value of the criterion χex2 = 4.78346, the critical value = 9.46. As a result, a statistical conclusion is obtained. Since χex2< the null hypothesis H0 is not rejected, the descriptions of the compared samples coincide at the significance level a = 0.05. This means that the experimental results do not confirm the effect of the applied method with a confidence coefficient of 95%. Thus, it is necessary to increase the efficiency of teaching future mathematics teachers to advance innovation in the teaching process by implementing the author's methodology of applying innovative technologies in the learning process.

Students from the control and experimental groups were tested to determine the initial level of maturity of the ability to work in conditions of innovation. Implementation of the developed methodology took place upon studying the sections "Methods and forms of teaching mathematics" and "Psychological and pedagogical foundations of teaching mathematics". The following diagnostic measures were performed: 1) academic conferences and independent work, which were performed to assess the maturity of the indicators p1 and p2, respectively; 2) questions of express-testing (from 0 to 2 points for each), which were developed with so as to assess the maturity of the indicator p3; 3) individual work and homework, which was evaluated up to 4 points (0.2 for each), which were offered to students for assessment of the maturity of the indicator p4.

The indicator was considered formed if, according to the results of all diagnostic measures aimed at its evaluation, the student scored more than 7 points (from 8 to 10 inclusive). The results of the experiment are presented in Table 2. Paired comparisons shall be done. First, accuracy of coincidences and differences for a pair of experimental data shall be measured on an ordinal scale using the homogeneity criterion 2. At this significance level, the null hypothesis H0: X1 = X2 about the homogeneity of the two samples is checked. The algorithm is as follows:

1. For the two compared samples, the value 2 and the empirical value of the 2 X criterion is calculated using the (Equation 1).

2. Further, this value is compared with a critical value (Equation 2), where α – significance level, $\chi^2_{(v,q)}$ – quantile of the Pearson distribution at level q with the number of degrees of freedom *v*.

As a result, a statistical conclusion is obtained. If $\chi^2 > \chi^2_{cr}$, then the null hypothesis is rejected, the descriptions of the compared samples vary at the significance level *a*. If $\chi^2 \le \chi^2_{cr}$, then the null hypothesis is not rejected; the descriptions of the compared samples coincide at the significance level *a*. The statistical significance of the compared samples is verified at the significance level *a = 0.05*. Then the critical value $\chi^2_{cr}=\chi^2_{(4,095)} = 9.46$.

Comparison of the experimental group before the start of the experiment with the experimental group after the end of the experiment. According to the original Table 2, to calculate the empirical value of the criterion according to the Equation (1) an auxiliary Table 3 shall be made.

Next, the empirical and critical values of the criterion (Equation 3) are compared. Since $\chi^2 > \chi^2_{cr}$, the null hypothesis is rejected, the descriptions of the compared samples differ at the significance level *a = 0.05*. Comparison of the experimental group before the start of the experiment with the control group before the start of the experiment. According to data from the initial Table 2, to calculate the empirical value of the criterion according to the equation (1) an auxiliary Table 4 shall be created.

Then, the empirical and critical values of the criterion (Equation 4) should be compared. Since $\chi^2 \le \chi^2_{cr}$, the null hypothesis is not rejected, the descriptions of the compared samples differ at the significance level *a = 0.05*. Comparison of the experimental group before the start of the experiment with the control group after the end of the experiment. According to the data of the initial Table 2, to calculate the empirical value of the criterion according to the equation (Equation 1) an auxiliary Table 5 is created.

Further, the empirical and critical values of the criterion (Equation 5) are compared. Since $\chi^2 \le \chi^2_{cr}$, the null hypothesis is not rejected, the descriptions of the compared samples differ at the significance level *a = 0.05*. Comparison of the experimental group after the experiment with the control group before the experiment. According to the data from the initial Table 2, to calculate the empirical value of the criterion according to the

(Equation 1), an auxiliary Table 6 is created.

Next, the empirical and critical values of the criterion (Equation 6) are compared. Since $\chi^2 > \chi^2_{cr}$, the null hypothesis is rejected, the descriptions of the compared samples differ at the significance level *a = 0.05*. Comparison of the experimental group after the end of the experiment with the control group after the end of the experiment. According to data from the initial Table 2, to calculate the empirical value of the criterion according to the Equation 1, an auxiliary Table 7 is created.

Then, the empirical and critical values of the criterion (Equation 7) are compared. Since $\chi^2 > \chi^2_{cr}$, the null hypothesis is rejected, the descriptions of the compared samples differ at the significance level *a = 0.05*. Comparison of the control group before the start of the experiment with the control group after the end of the experiment. According to the data from the initial Table 2, to calculate the empirical value of the criterion according to the equation (Equation 1), an auxiliary Table 8 is created.

Further, the empirical and critical values of the criterion (Equation 8) are compared. Since $\chi^2 \leq \chi^2_{cr}$, the null hypothesis is not rejected, the descriptions of the compared samples differ at the significance level *a = 0.05*. The results of paired comparisons are presented in Table 9. The critical value $\chi^2_{\mathrm{cr}} = 9.46$. General results of the statistical analysis of paired comparisons are created. Sample descriptions coincide with a significance level of 5% for the following pairs of samples:

– “Experimental group before the start of the experiment” and “control group before the start of the experiment”;

– “Experimental group before the start of the experiment” and “control group after the end of the experiment”;

– “Control group before the start of the experiment” and “control group after the end of the experiment”;

Significant differences were identified for the following pairs of samples (95% confidence):

– “Experimental group before the start of the experiment” and “experimental group after the end of the experiment”;

– “Experimental group after the end of the experiment” and “control group before the start of the experiment”;

– “Experimental group after the end of the experiment” and “control group after the end of the experiment”;

An analysis of the results shows that there are no significant differences at the beginning of the experiment between the experimental and control groups; however, at the end of the experiment, the results obtained in the experimental and control groups differ significantly. This is explained by the implementation of the methodology for the innovative technologies in the experimental group and the improvement of future mathematics teachers’ methodological training.

4. CONCLUSIONS:

Pilot testing is represented by the ascertaining, searching, and educational experiments. In the course of an ascertaining investigation (2016-2017), a survey was conducted among teachers of mathematics, undergraduates and doctoral students of the specialty "Mathematics," including young university teachers. The results of the ascertaining experiment became the basis for revising the purposes of the methodological and professional training of future mathematics teachers and made it possible to conclude on the necessity of improvement of the system-methodological support for teaching mathematical disciplines in higher education.

The training of a mathematics teacher should form them as a knowledgeable mathematician, as a person with a high pedagogical and general culture, who, by teaching, would educate the younger generation in the spirit of modernity. It can be assumed that the content of courses in a pedagogical university in mathematical disciplines should:

1) at a modern academic level, cover those matters that the teacher communicates at school;

2) provide for students' breadth of knowledge in mathematics, familiarize them with advanced mathematics and its problems as much as possible. Therefore, courses in higher mathematics should shed light on those fundamental issues of modern mathematics, which currently serve as its basis and determine its face. This will provide for a certain fundamental level of mathematical culture for a future mathematics teacher;

3) contain sufficiently rich applications of higher mathematics to science and technology. In the process of teaching, this will allow the future teacher of mathematics to provide the students with an idea of life application of the concepts and

processes that will be studied in the elements of higher mathematics at school;

4) teach to think mathematically, that is, to be able to solve mathematical problems and be able, in the simplest cases, to form various problems arising in other sciences in the language of mathematics;

5) ensure the educational nature of training, that is, the development of a common culture and the formation of the student's worldview and personality.

The tasks of the searching experiment (2016-2018) were solved in the course of teaching students: to construct the content of academic disciplines and find the main means of learning; identify indicators of development and develop diagnostic material.

In the course of the educational experiment (2018-2019), providing for the experimental training of students in the natural conditions of the educational process, was proven the efficiency of the proposed methodology for teaching future mathematics teachers in conditions of innovation.

Improving the methodological training of future specialists requires the introduction of a special course "Methodological support for the preparation of future mathematics teachers in an innovative orientation" in the program of training students of the "Mathematics" educational program, where scientific (educational) materials helping to form professional qualities and improve the methodological training of future specialists will be considered.

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$\chi^2=\frac{1}{N_1 N_2}\sum_{j=1}^{L}\frac{(N_2 n_{1j}-N_1 n_{2j})^2}{n_{1j}+n_{2j}}$. (Eq. 1)

$\chi_{cr}^2=\chi_{(L-1,1-\alpha)}^2$, (Eq. 2)

$\chi^2=\frac{1}{25*25}(8601.19+625+625+3125+8750)=34.8>\chi_{cr}^2$ (Eq. 3)

$\chi^2=\frac{1}{25*22}(449.161+142.231+625+625+625)=4.48<\chi_{cr}^2$ (Eq. 4)

$\chi^2=\frac{1}{25*22}(973.241+330.286+1250+625+625)=6.92<\chi_{cr}^2$. (Eq. 5)

$\chi^2=\frac{1}{25*22}(4681.14+1188.1+4.5+1204.17+5339.27)=22.6>\chi_{cr}^2$ (Eq. 6)

$\chi^2=\frac{1}{25*22}(3536.33+1632.36+261.333+1204.17+5339.27)=21.8>\chi_{cr}^2$. (Eq. 7)

$\chi^2=\frac{1}{22*22}(8+32.266+161.333+0+0)=0.582<\chi_{cr}^2$. (Eq. 8)

Table 1. *Results of the second ascertaining experiment*

Skill maturity levels	2 year	3 year
Zero	4 (12.5%)	5 (19.57%)
First	15 (51.79%)	9 (43.48%)
Second	8 (30.36%)	3 (21.74%)
Third	2 (3.571%)	2 (13.04%)
Fourth	1 (1.779%)	1 (2.17%)
∑	30 (100%)	20 (100%)

Table 2. *Data obtained during the educational experiment*

Skill maturity level	Experimental group, number of people		Control group, number of people	
	Start of experiment (n_{1j})	End of experiment (n_{2j})	Start of experiment (n_{3j})	End of experiment (n_{4j})
Zero	19 (76%)	2 (8 %)	12 (54.5%)	10 (45.5 %)
First	6 (24 %)	3 (12%)	7 (31.8%)	8 (36.4 %)
Second	0 (0 %)	1 (4 %)	1 (4.55 %)	2 (9.09 %)
Third	0 (0 %)	5 (20 %)	1 (4.55 %)	1 (4.55 %)
Fourth	0 (0 %)	14 (56%)	1 (4.55 %)	1 (4.55 %)
∑	25 (100%)	25 (100%)	22 (100%)	22 (100%)

Table 3. *Comparison of the experimental group before the start of the experiment with the experimental group after the end of the experiment*

J	n_{1j}	n_{2j}	$N_2 n_{1j}$	$N_1 n_{2j}$	$(N_2 n_{1j} - N_1 n_{2j})^2$	$n_{1j} + n_{2j}$	$\frac{(N_2 n_{1j} - N_1 n_{2j})^2}{n_{1j} + n_{2j}}$
1	19 (76%)	2 (8%)	475	50	180.625	21	8,601.19
2	6 (24%)	3 (12%)	150	75	5.625	9	625
3	0 (0%)	1 (4%)	0	25	6.25	1	625
4	0 (0%)	5 (20%)	0	125	15.625	5	3125
5	0 (0%)	14 (56%)	0	350	122.500	14	8750

Table 4. *Comparison of the experimental group before the start of the experiment with the control group before the start of the experiment*

j	n_{1j}	n_{2j}	$N_2 n_{1j}$	$N_1 n_{2j}$	$(N_2 n_{1j} - N_1 n_{2j})^2$	$n_{1j} + n_{2j}$	$\frac{(N_2 n_{1j} - N_1 n_{2j})^2}{n_{1j} + n_{2j}}$
1	19 (76%)	12 (54.5%)	418	300	13924	31	449.161
2	6 (24%)	7 (31.8%)	132	175	1849	13	142.231
3	0 (0%)	1 (4.55%)	0	25	625	1	625
4	0 (0%)	1 (4.55%)	0	25	625	1	625
5	0 (0%)	1 (4.55%)	0	25	625	1	625

Table 5. *Comparison of the experimental group before the start of the experiment with the control group after the end of the experiment*

j	n_{1j}	n_{2j}	$N_2 n_{1j}$	$N_1 n_{2j}$	$(N_2 n_{1j} - N_1 n_{2j})^2$	$n_{1j} + n_{2j}$	$\frac{(N_2 n_{1j} - N_1 n_{2j})^2}{n_{1j} + n_{2j}}$
1	19 (76%)	10 (45.5%)	418	250	28.224	29	973.241
2	6 (24%)	8 (36.4%)	132	200	4.624	14	330.286
3	0 (0%)	2 (9.09%)	0	25	2.500	2	1.250
4	0 (0%)	1 (4.55%)	0	25	625	1	625
5	0 (0%)	1 (4.55%)	0	25	625	1	625

Table 6. *Comparison of the experimental group after the experiment with the control group before the experiment*

j	n_{1j}	n_{2j}	$N_2 n_{1j}$	$N_1 n_{2j}$	$(N_2 n_{1j} - N_1 n_{2j})^2$	$n_{1j} + n_{2j}$	$\frac{(N_2 n_{1j} - N_1 n_{2j})^2}{n_{1j} + n_{2j}}$
1	2 (8%)	12 (54.5%)	44	300	65.536	14	4.681.14
2	3 (12%)	7 (31.8%)	66	175	11.881	10	1.188.1
3	1 (4%)	1 (4.55%)	22	25	9	2	4.5
4	5 (20%)	1 (4.55%)	110	25	7.225	6	1.204.17
5	14 (56%)	1 (4.55%)	308	25	80.089	15	5.339.27

Table 7. *Comparison of the experimental group after the end of the experiment with the control group after the end of the experiment*

j	n_{1j}	n_{2j}	$N_2 n_{1j}$	$N_1 n_{2j}$	$(N_2 n_{1j} - N_1 n_{2j})^2$	$n_{1j} + n_{2j}$	$\frac{(N_2 n_{1j} - N_1 n_{2j})^2}{n_{1j} + n_{2j}}$
1	2 (8%)	12 (54.5%)	44	250	42436	12	3536.33
2	3 (12%)	7 (31.8%)	66	200	17956	11	1632.36
3	1 (4%)	1 (4.55%)	22	50	784	3	261.333
4	5 (20%)	1 (4.55%)	110	25	7225	6	1204.17
5	14 (56%)	1 (4.55%)	308	25	80089	15	5339.27

Table 8. *Comparison of the control group before the start of the experiment with the control group after the end of the experiment*

j	n_{1j}	n_{2j}	$N_2 n_{1j}$	$N_1 n_{2j}$	$(N_2 n_{1j} - N_1 n_{2j})^2$	$n_{1j} + n_{2j}$	$\frac{(N_2 n_{1j} - N_1 n_{2j})^2}{n_{1j} + n_{2j}}$
1	12 (54.5%)	10 (45.5%)	264	220	1936	22	88
2	7 (31.8%)	8 (36.4%)	154	176	484	15	32.266
3	1 (4.55%)	2 (0.09%)	22	44	484	3	161.333
4	1 (4.55%)	1 (4.55%)	22	22	0	2	0
5	1 (4.55%)	1 (4.55%)	22	22	0	2	0

Table 9. *Paired comparison results*

	Experimental group before the experiment	Experimental group after the end of the experiment	Control group before the experiment	Control group after the experiment
Experimental group before the experiment	0	$34.8> \chi_{cr}^2$ differences are statistically significant	$4.48 < \chi_{cr}^2$ differences are not statistically significant	$6.92 < \chi_{\mathrm{cr}}^2$ differences are not statistically significant
Experimental group after the end of the experiment	$34.8> \chi_{cr}^2$ differences are statistically significant	0	$22.6 > \chi_{cr}^2$ differences are statistically significant	$21.8 > \chi_{\mathrm{cr}}^2$. differences are statistically significant
Control group before the experiment	$4.48 < \chi_{cr}^2$ differences are not statistically significant	$22.6 > \chi_{cr}^2$ differences are statistically significant	0	$0.582 < \chi_{cr}^2$ differences are not statistically significant
Control group after the experiment	$6.92 < \chi_{cr}^2$ differences are not statistically significant	$21.8 > \chi_{\mathrm{cr}}^2$. differences are statistically significant	$0.582 < \chi_{\mathrm{cr}}^2$. differences are not statistically significant	0