# Professional Training of a Future Teacher for the Organization of Pupils' Innovative Activity in the Educational Process

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***Abstract* – The study concept is based on the awareness of the process of training of a future physics teacher for the organization of pupils' innovative activity as an important component of modern professional education, which makes it possible to form a teacher as a competitive specialist capable of creative pedagogical work. The main study method was statistical methods: the methods of testing statistical hypotheses using Pearson, Wilcoxon-Mann-Whitney and binomial tests, the method of empirical data analysis using convolution matrices, the methods of visualizing experimental results. Four universities of Ukraine were the base for the formative pedagogical experiment: Zaporizhzhya National University, Berdyansk State Pedagogical University, Pavlo Tychyna Uman Pedagogical University, and Kherson State University. The measurement and comparison of the levels of readiness of the members of the control and experimental groups for the organization of pupils' innovative activity was carried out for separate components of readiness (motivational-value, cognitive, activity-creative ones) and as a whole.**

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## 1. Introduction

The statement that the future of Ukraine depends on solving the problem of educating young people who are able to set and solve new tasks is undeniable. It is impossible to solve this problem without proper professional training of future teachers.

Since the demands of modern Ukraine can be satisfied only on the solid basis of advanced science and production, a significant number of new tasks are expected in the scientific and technical areas (these tasks, in particular, are closely related to the problems of energy independence and defense capability of the country).

Therefore, the problem of training of physics teachers to carry out innovative search in professional activity (specifically, in the area of the organization of pupils' innovative activity in the educational process) is particularly relevant. Its solution requires the implementation of a holistic theoretical-methodical approach.

Innovative activity in a higher education institution (HEI) together with scientific-technical activity is a mandatory component of educational activity [1]. The main goal of these types of activity at HEIs is to acquire new scientific knowledge by carrying out scientific research and development and using it for the creation and implementation of new competitive technologies, types of equipment, materials, etc. to ensure the innovative development of society and the training of innovative specialists [2].

The purpose of the study is to substantiate the theoretical and methodical foundations of the training of a future physics teacher for the organization of pupils' innovative activity in the educational process.

Together with the terms "innovative educational activity" and "innovative activity in the education system" the term "innovative pedagogical activity" is used with a similar interpretation.

For example, study [3] considers innovative pedagogical activity as one that is oriented towards the change and development of the educational process with the aim of achieving higher results, obtaining new knowledge, and forming a qualitatively different pedagogical practice. In the context of training of school teachers for innovative pedagogical activity, Wrigley and Straker [4] highlight the latter's focus on designing, creating, and using new ideas, tools, and pedagogical technologies in the educational process and conducting an analysis of their implementation. Henriksen [5] includes the following as important functions of innovative pedagogical activity: identifying and justifying the relevance of changes in the pedagogical system (in educational programs, technologies, personnel, material-technical base, etc.); identification of modern developments, the use of which should improve the quality of educational activity.

According to Chang [6], educational and innovative activity is a type of educational and creative activity aimed at solving educational and creative tasks of transforming the creative results of pupils' project activities into possible variants of subjectively new products and services for their intended commercialization. At the same time, the study does not consider the subject aspect of the training of pupils for innovative activities, and there are no instructions on the specifics of training of future teachers for the organization of these activities [7].

Considering the methodical aspects of the organization of pupils' research activities in physics, the scientists [8] believe that it is necessary to involve pupils in research activities from the first physics lessons, since it is at this age that pupils become interested in conducting research independently.

## 2. Methodology

A set of methods was used to achieve the set goal and solve the problems.

Theoretical methods: analysis (comparative and content analysis), generalization, comparison of different views on the problem under study for the purpose of identifying the state of its development; classification, systematization, and modeling (to determine the conceptual and categorical apparatus of the study; the content and structure of the future teacher's readiness to organize innovative activities of pupils; substantiation of the author's concept and model of training of future physics teachers for the organization of innovative activities of pupils).

Empirical methods: diagnostic methods — didactic surveys, questionnaires, testing, analysis of creative achievements of future physics teachers and pupils (to obtain experimental data on the formation of components of the readiness of future physics teachers for the organization of pupils' innovative activities and to evaluate the creative achievements of students and pupils); observation of the educational process in higher education institutions and the physics teaching process in general secondary education institutions (to find out the specifics of the organization of innovative activities and the content of its characteristic stages); pedagogical experiment (to analyze the state of the problem and test the conceptual model of training of future physics teachers).

Statistical methods: the methods of testing of statistical hypotheses using the Pearson, Wilcoxon-Mann-Whitney and binomial tests, the method of analysis of empirical data using convolution matrices, the methods of visualization of experimental results (to process and present experimental data for the purpose of verification of the effectiveness of the conceptual model of training of future physics teachers, and to confirm the effectiveness of the author's technology of the organization of quasi-professional activities).

Pedagogical experiment stages: To verify the effectiveness of the conceptual model of training of future physics teachers for the organization of pupils' innovative activity, a pedagogical experiment was conducted. It consisted of the following four stages.

1. Ascertainment stage (2012–2014). Goal: Study the state of the research problem, confirm the relevance and pedagogical expediency of its research, select educational institutions as a base for the experiment. At this stage, the criteria, indicators and levels of readiness of future physics teachers for the organization of pupils' innovative activities were also determined.
2. Search stage (2015–2016). Goal: Develop a conceptual model for training of future physics teachers for the organization of pupils' innovative activities, approbation of the elements of this model; select diagnostic tools to find out the level of readiness of future physics teachers for the organization of pupils' innovative activities.
3. Formative stage (2017–2019). Goal: Implement a conceptual model of training of future physics teachers for the organization of pupils' innovative activities. Specifically, during this stage, there were implemented the developed organizational and methodical principles of this training in the conditions of the educational process in the higher education institutions of Ukraine, and the technology for the organization of the quasi-professional activities of future physics teachers for involving pupils in innovative activities.

4. Control stage (2020–2021). Goal: Statistical analysis of the significance of differences in the levels of formation of readiness of students of the experimental and control groups for the organization of pupils' innovative activities in teaching physics, and checking the effectiveness of the author's technology for the organization of the quasi-professional activities of future physics teachers for involving pupils in innovative activities. According to the results obtained at this stage of the experiment, a conclusion was made about the effectiveness of the conceptual model and acceptance of the general study hypothesis.

The following methods were used during the ascertainment stage of the experiment: observation of the educational process in HEIs and GSEIs; conversations with HEI lecturers, teachers of secondary schools, and students — future physics teachers and pupils; survey of physics teachers and students of physics and physics and mathematics faculties (masters, specialists, and three- and four-year bachelors).

The ascertainment stage of the experiment was carried out on the basis of ZNU, Kherson State University, Berdyansk State Pedagogical University, and among GSEI pupils of Zaporizhzhia region (Zaporizhia city, Vasylivskyi and Pologivskyi districts). Totally, 178 people took part in the experiment at this stage: 23 HEI lecturers, 86 school teachers, 42 students and 27 schoolchildren.

The conclusions made during the ascertainment stage of the experiment were based on the analysis of the percentage distribution of the answers given by the participants of the experiment in the questionnaires, which aimed to determine the readiness of future physics teachers for the organization of pupils' innovative activities in teaching physics, and to study the opinions and considerations of teachers regarding difficulties that deter the organization of innovative search for pupils.

The survey of teachers (secondary schools, vocational and technical education institutions, HEIs of the I-II levels of accreditation) was carried out using a questionnaire. Mostly, the surveys were carried out during the annual regional (Zaporizhzhia region) and city (Zaporizhia city) scientific and methodical seminars for physics teachers held at the physics faculty of ZNU. The survey of student was conducted during instructional conferences on pedagogical practice. Totally, 86 teachers and 42 students took part in the survey.

## 3. Results

Determining the levels of the students' qualification to organize the pupils' innovative activities was based on the comprehensive consideration of their individual indicators of the separate qualification components (motivational-value, cognitive, and activity-creative ones). The student's general qualification to organize the pupils' innovative activity was matched to a certain level of its formation, if each qualification component exceeded a certain critical level.

To formulate the statistical hypotheses, the following symbols were introduced: $v_{1i}, v_{2i}$ ($i$=1,2,3) — the probability that a randomly selected student of the control and experimental groups, respectively, has the i-th level of formation of the qualification to organize the pupils' innovative activities. Hypotheses:

$G_0 : v_{1i} = v_{2i}$ for all levels ($v_{11} = v_{21}, v_{12} = v_{22}, v_{13} = v_{23}$). This will mean that the students of the control and experimental groups do not have statistically significant differences in the levels of formation of the qualification under study;

$G_1 : v_{1i} \neq v_{2i}$ at least for one of the levels.

The critical value of the criterion at the significance level $\delta$ = 0.05 is found by the distribution of $\chi^2$ with degrees of freedom $\chi^2_{cr}$ = 5.99.

Since $\chi^2_{emp} > \chi^2_{cr}$ (26.9> 5.99), according to the decision-making rule for the criterion $\chi^2$, the null hypothesis was rejected.

The empirical value of the criterion is found by formula:

$$\chi^2_{emp} = 114 \times 96 \times \left[ \frac{(0.623-0.271)^2}{71+26} + \frac{(0.324-0.573)^2}{37+55} + \frac{(0.053-0.156)^2}{6+15} \right] = 26.9$$

That is, the differences in the levels of qualification of the students of the control and experimental groups to organize the pupils' innovative activities are significant (Table 1).

*Table 1. The results of a comparison of the formation levels of the qualification (by components and in general) of future physics teachers of the control group (CG) and the experimental group (EG) to organize the pupils' innovative activities at the control stage. (Source: author's study)*

| Levels | CG ( $m_1$ = 114) | | EG ( $m_2$ = 96) | | Criterion value | | Hypothesis |
|---|---|---|---|---|---|---|---|
| | $m_{1i}$ | $m_{1i}/n_1$, % | $m_{2i}$ | $m_{2i}/n_2$, % | Empirical | Critical ( $\delta = 0.05$ ) | |
| **Motivational-value component** | | | | | | | |
| **Low** | 27 | 23.7 | 7 | 7.3 | $\chi^2_{emp} = 10.7$ | $\chi^2_{cr} = 5.99$ | $G_1$ |
| **Sufficient** | 49 | 43.0 | 46 | 47.9 | | | |
| **High** | 38 | 33.3 | 43 | 44.8 | | | |
| **Cognitive component** | | | | | | | |
| **Low** | 53 | 46.5 | 21 | 21.9 | $K_{emp} = 12092$ | $K_{cr\uparrow} = 10850$ | $G_1$ |
| **Sufficient** | 48 | 42.1 | 49 | 51.0 | | | |
| **High** | 13 | 11.4 | 26 | 27.1 | | | |
| **Activity-creative component** | | | | | | | |
| **Low** | 61 | 53.5 | 22 | 22.9 | $\chi^2_{emp} = 22.9$ | $\chi^2_{cr} = 5.99$ | $G_1$ |
| **Sufficient** | 43 | 37.7 | 56 | 58.3 | | | |
| **High** | 10 | 8.80 | 18 | 18.8 | | | |
| General qualification | | | | | | | |
| **Low** | 71 | 62.3 | 26 | 27.1 | $\chi^2_{emp} = 26.9$ | $\chi^2_{cr} = 5.99$ | $G_1$ |
| **Sufficient** | 37 | 32.4 | 55 | 57.3 | | | |
| **High** | 6 | 5.3 | 15 | 15.6 | | | |

So, based on statistical analysis of the results using the Pearson test ( $\chi^2$ ) (for the motivational-value and activity-creative components) and the Wilcoxon-Mann-Whitney test (for the cognitive component), conclusions were drawn about significant differences in the levels of formation of separate components of the qualification to organize the pupils innovative activities in the students of the control and experimental groups, and in the levels of formation of this qualification in general. The H0 that the students of the control and experimental groups did not have statistically significant differences in the levels of qualification was rejected at the significance level of $\delta$=0.05 based on the fulfillment of the condition $\chi^2_{emp} > \chi^2_{cr}$ (26.9 > 5.99).

This result, together with the effectiveness of the author's technology for organizing the quasi-professional activities of future physics teachers regarding the involvement of pupils in innovative activities proved the effectiveness of the developed conceptual model of training of future physics teachers for the organization of the pupils' innovative activities in the educational process and the effectiveness of measures for implementing this model.

The results of the assessment of the levels of formation of the motivational-value component of qualification in students of both groups are presented in the form of a diagram (Figure 1).

Clarification of the significance of the differences in the distribution of students of the groups according to the indicated levels was carried out on the basis of the homogeneity criterion ("chi-square").

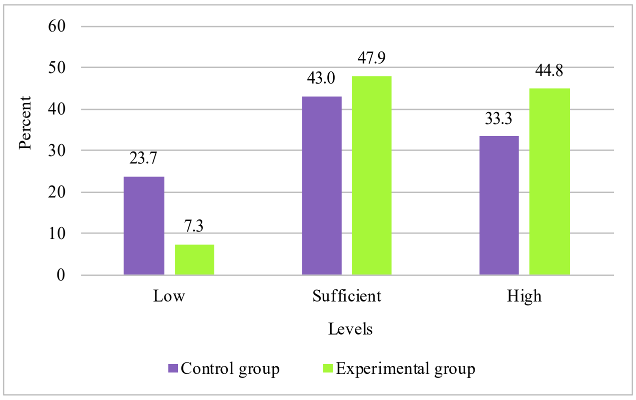


*Figure 1. Diagram of the distribution of students of the control and experimental groups according to the levels of formation of the motivational-value component*

The following symbols were used to formulate the null ( $G_0$ ) and alternative ( $G_1$ ) hypotheses: $v_{1i}, v_{2i}$ ( $i$ =1,2,3) —the probability that a randomly selected student of the control and experimental groups, respectively, has the i-th level of formation of the motivational-value component of qualification. Hypotheses:

$G_0 : v_{1i} = v_{2i}$ for all levels ($v_{11} = v_{21}, v_{12} = v_{22}, v_{13} = v_{23}$). This will mean that students of both groups do not have statistically significant differences in the levels of formation of the motivational-value component of qualification.

$G_1 : v_{1i} \neq v_{2i}$ at least for one of the levels.

The empirical value of the criterion is found by formula:

$$\chi^2_{emp} = 114 \times 96 \times \left[ \frac{(0.237 - 0.073)^2}{27 + 7} + \frac{(0.43 - 0.479)^2}{49 + 46} + \frac{(0.333 - 0.448)^2}{38 + 43} \right] = 10.7$$

The results of measuring the formation level of the theoretical component of the students' qualification were scores from zero to forty (by the number of correct answers to the test questions of the theoretical block of diagnostic work). The authors present them in the form of variation series for the experimental and control groups (at this point, the (experimental) group is considered the first).

The Wilcoxon-Mann-Whitney test was used to find out the significance of differences in sample characteristics [9]. The selection of this criterion is justified by the large size of samples ($m_1, m_2 > 50$) and a significant number of different values ($\geq 10$) in each of them.

To formalize the analysis, random variables were introduced: $O$ — the number of scores received by the students of the experimental group; $U$ — the number of scores received by the students of the control group. These random variables are presented by $(o_1, o_2, ..., o_{m_1})$ and $(u_1, u_2, ..., u_{m_1})$. If the samples are homogeneous, it can be assumed that they are from the same general population and, therefore, their distribution functions are equal to one another for any value of the argument (presented as $O$): $F_1(o) = F_2(o)$.

The primary ("visual") comparison of the given samples revealed the trend: $O > U$ (that is, the students of the experimental group had slightly better results). This gave grounds to use the one-sided Wilcoxon–Mann–Whitney test with the following formulation of the null ($G_0$) and alternative ($G_1$) hypotheses:

$G_0$: $F_1(o) = F_2(o)$, that is, the samples are homogeneous.

This will mean that the students of the experimental and control groups do not have statistically significant differences in the levels of formation of the cognitive component of qualification to organize pupils' innovative activities;

$G_1$: $F_1(o) < F_2(o)$, that is $O > U$ (inequality $F_1(o) < F_2(o)$ is equivalent to inequality $V(O < 0) < V(U < u)$, which relates the corresponding probabilities). That is, the scores of the students of the experimental group are statistically higher compared to the scores of the students of the control group. Therefore, the former have a higher level of formation of the cognitive component of the qualification to organize the pupils' innovative activities.

To find the empirical value of the criterion $K_{emp}$, the variants of both samples were arranged in the ascending order, i.e. in the form of one (combined) variation series. Each value of this series is assigned the rank $P$, which is equal to the ordinal number of the place of this value. According to the rules for using the Wilcoxon-Mann-Whitney test, if several variants of only one sample were the same, in the combined variation series they were assigned the ranks equal to their usual ordinal numbers (that is, as if these variants were different). If the variants of different samples coincided, they were assigned the ranks equal to the arithmetic mean of the numbers of positions of these variants in the combined variation series.

The empirical value of the criterion $K_{emp}$ is the sum of the ranks of the smaller sample (in this case, it is the experimental group).

$$K_{emp} = \sum_{i=1}^{m_1} P(o_1), \tag{1}$$

where $P(o_1)$—the rank assigned to the i-th variant of this sample (n = 96).

The lower critical point $K_{cr}$ of the criterion is found using the formula:

$$K_{cr\downarrow}(\delta, m_1, m_2) = \frac{(m_1 + m_2 + 1) \times m_1 - 1}{2} - x_{cr} \times \sqrt{\frac{m_1 \times m_2 \times (m_1 + m_2 + 1)}{12}}, \tag{2}$$

where $\delta$ —the level of significance, $\delta = 0.05$; $x_{cr}$ —the argument of the Laplace function found from the equality $\phi(x_{cr}) = (1-2\delta)/2$; with $\delta = 0.05$, $\phi(x_{cr}) = 0.45$; with the help of the Laplace transform table [10] $x_{cr} = 1.65$ is found.

$$K_{cr\downarrow}(0.5;96;114) = \frac{(96+114+1)\times 96-1}{2} - 1.65\times\sqrt{\frac{96\times 114\times(96+114+1)}{12}} = 9404$$

The upper critical point $K_{cr\uparrow}$ of the criterion is found using the formula:

$$K_{cr\uparrow} = (m_1 + m_2 + 1)\times m_1 - K_{cr\downarrow} \quad (3)$$

If there are matching variants in the samples, it is recommended to make a correction in the formulas for the critical value of the criterion (in particular, in the formula (3)) by introducing the term $\sum A$ in the square root expression:

$$\frac{m_1 \times m_2 \times (m_1 + m_2 + 1)}{12} - \sum A \quad (4)$$

The term $\sum A$ in the formula (4) is the sum of values $A = (a^3 - a)/12$, where $a$ is the number of members of the combined series (only those identical variants that belong to both samples are taken into account), $\sum A$ =1,222.5. Taking into account the correction of $\sum A$, the improved value of the upper critical point of the criterion was found: $K_{cr\uparrow}$ = 10,850.

According to the decision-making rule for the alternative hypothesis used, based on the inequality $K_{emp} > K_{cr\uparrow}$ (12,092 > 10,850), the null hypothesis was rejected.

Therefore, the students of the experimental group had a higher level of formation of the cognitive component of the qualification compared to the students of the control group.

The evaluation of the students' qualification to organize the pupils' innovative activities involved comprehensive consideration of the formation of individual components of this qualification (motivational-value, cognitive, and activity-creative ones). Therefore, for further comparison, the results of measuring the formation of the theoretical component of the qualification are also presented using an ordinal scale with three gradations–levels (Figure 2).

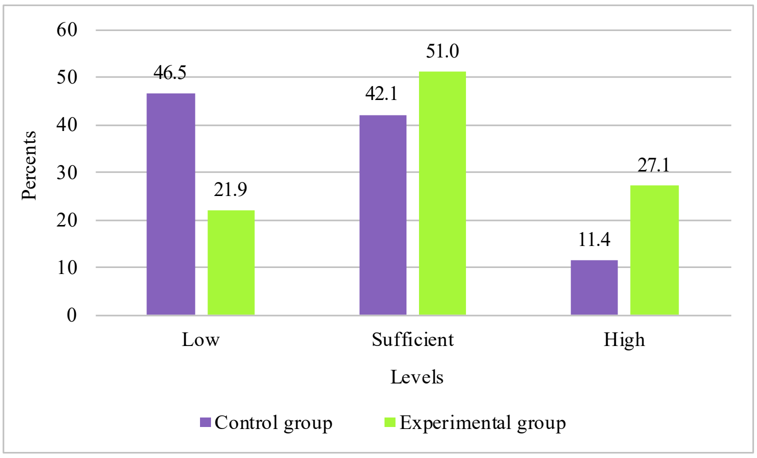


*Figure 2. Diagram of the distribution of the students of the control and experimental groups according to the levels of formation of the cognitive component of the qualification to organize the pupils' innovative activities (Source: author's study)*

The results of measuring the levels of formation of this qualification component are presented in Figure 3. To find out the significance of the differences in the distribution of students of both groups according to the above levels, the homogeneity criterion $\chi^2$ was used.

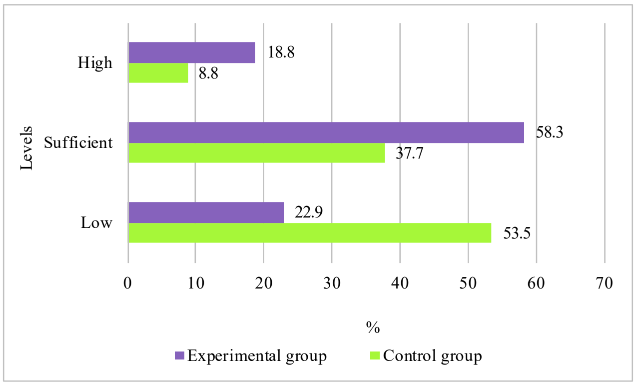


*Figure 3. Diagram of the distribution of the students of the control and experimental groups according to the levels of formation of the activity-creative component of the qualification to organize the pupils' innovative activities (Source: author's study)*

To formulate the null ($G_0$) and alternative ($G_1$) hypotheses, the following symbols were introduced: $v_{1i}, v_{2i}$ ($i$=1, 2, 3)—the probability that a randomly selected student of the control and experimental groups, respectively, has the i-th level of formation of the activity-creative component of the qualification.

To formulate the null ($G_0$) and alternative ($G_1$) hypotheses, the following symbols were introduced: $v_{1i}, v_{2i}$ ($i$=1, 2, 3)—the probability that a randomly selected student of the control and experimental groups, respectively, has the i-th level of formation of the activity-creative component of the qualification. Hypotheses: $G_0 : v_{1i} = v_{2i}$ for all levels ($v_{11} = v_{21}, v_{12} = v_{22}, v_{13} = v_{23}$). This will mean that students of both groups do not have statistically significant differences in the levels of formation of the activity-creative component of the qualification: $G_1 : v_{1i} \neq v_{2i}$ at least for one of the levels.

Determining the levels of the students' qualification to organize the pupils' innovative activities was based on the comprehensive consideration of their individual indicators of the separate qualification components (motivational-value, cognitive, and activity-creative ones). The student's general qualification to organize the pupils' innovative activity was matched to a certain level of its formation, if each qualification component exceeded a certain critical level.

Particularly, a high level was recognized when three qualification components had a high level. The lower limit of the sufficient level of the general qualification corresponded to sufficient levels of all components of this qualification. If the level of at least one of the components was low, the level of general qualification was also recognized as low. The measurement results are given in Figure 4.

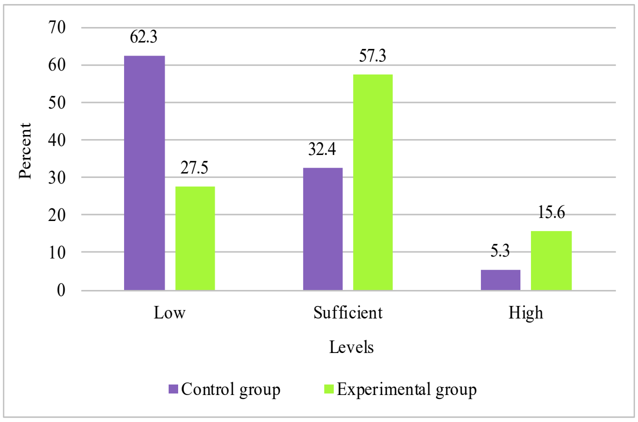


*Figure 4. Diagram of the distribution of the students of the control and experimental groups according to the levels of formation of the qualification to organize the pupils' innovative activities (Source: author's study)*

The critical value of the criterion at the significance level $\delta$ = 0.05 is found by the distribution $\chi^2$ with degrees of freedom $\chi^2_{cr} = 5.99$.

Since $\chi^2_{emp} > \chi^2_{cr}$ (22.9> 5.99), according to the decision-making rule for the criterion $\chi^2$, the null hypothesis was rejected. That is, the differences in the levels of formation of the motivational-value (activity-creative) component of the students' qualification of the control and experimental groups are significant.

## 4. Discussion

A necessary condition for a teacher to carry out search activities is the presence of innovative potential — a set of socio-cultural and creative characteristics of the teacher's personality, which shows readiness to improve pedagogical activity, the presence of internal means and methods capable of ensuring this readiness [11]. The following components of the teacher's innovative potential are distinguished:

- The creative ability to generate new concepts and ideas, which is determined by a professional attitude towards achieving the priority goals of education; skills to design and model the ideas in practice [12];

- High cultural and aesthetic level, education, intellectual depth and versatility of the teacher's interests; the uniqueness of the personality, self-assessment of socio-cultural and intellectual levels of development; the selection of various forms of cultural, scientific, and creative activity [13];
- The openness of the teacher's personality to the understanding and acceptance of various ideas and opinions, which are based on the tolerance of the personality, the flexibility of his thinking [14].

According to [15], innovative teaching in a modern institution of general secondary education (GSE) is a process that significantly contributes to the creation and establishment of those subjective conditions that make possible the future creativity of both teachers and pupils in the learning process.

According to [15], it is innovative teaching that forms a personality capable of making innovative changes in the current culture and environment, successfully solving problem situations that arise both in front of an individual and in front of society. Such teaching involves the constant involvement of pupils in active educational and cognitive activities, characterized by intensive multilateral communication of the subjects of activity, exchange of information and activity results.

According [16], the core of innovative activity is specific innovative thinking that is aimed at ensuring innovative activity and carried out at the cognitive (creation of new knowledge through internal reflection) and instrumental (objectification and implementation of new knowledge in practical activities) levels. The above scientists highlighted the main characteristics of innovative thinking.

Such thinking must be: creative (leads to subjectively new results); scientific-theoretical (corresponds to the current level of development of science); socially-positive (corresponds to the ideas of humanism; the problems being solved have social significance); constructive (related to the ability to realistically and diagnostically set problems and select adequate methods and means for solving them, plan a sequence of actions, determine the level of goal achievement and, if necessary, adjust one's actions); transformative (not limited to the development of models, in particular drawings, schemes, algorithms, etc.; these models should find a real embodiment, which contributes to the transformation of the material world and society); pragmatic (not limited to the discovery and its theoretical substantiation, but also involving the introduction of an innovative product and obtaining practical results from it).

The authors share the opinion of Anderson [17] that the training of pupils for future innovative activities should be systemic.

The effectiveness of this training increases, in particular, under the condition of the integration of elements of research, invention and innovation activity into the structure, content and organizational forms of the school educational process. Scientists consider educational research and project activities of pupils as effective means of training for innovative activities. Special attention is paid to the possibility of commercialization of the creative result achieved by pupils.

## 5. Conclusion

Checking the effectiveness of the conceptual model of training of future physics teachers for the organization of pupils' innovative activities in the process of their education was carried out with the help of a pedagogical experiment consisting of four stages: ascertainment; search; formative and control ones. During the ascertainment stage, the initial assessment of the level of qualification of physics teachers (future and experienced teachers) to organize the innovative activity of pupils in physics education was carried out by means of a questionnaire, which was based on self-assessment of qualification for its implementation.

It was established that, despite significant interest in this problem, almost half of the respondents showed a low level of appropriate qualification (48%) (students (58%); young teachers with up to ten years of work experience (46%); experienced teachers with work experience more than ten years (42%)). The results of this stage confirmed the relevance of the research and the need to implement the author's conceptual model of training of future physics teachers for the organization of pupils' innovative activities in the process of their education.

The measurement of the levels of formation of students' qualification to organize innovative activities of pupils was based on the comprehensive consideration of students' individual indicators of separate components of qualification (motivational-value, cognitive, and activity-creative ones). So, based on statistical analysis of the results using the Pearson test ($\chi^2$) (for the motivational-value and activity-creative components) and the Wilcoxon-Mann-Whitney test (for the cognitive component), conclusions were drawn about significant differences in the levels of formation of separate components of the qualification to organize the pupils innovative activities in the students of the control and experimental groups, and in the levels of formation of this qualification in general.

This result, together with the effectiveness of the author's technology for organizing the quasi-professional activities of future physics teachers regarding the involvement of pupils in innovative activities proved the effectiveness of the developed conceptual model of training of future physics teachers for the organization of the pupils' innovative activities in the educational process and the effectiveness of measures for implementing this model. All this confirms the validity of the general study hypothesis.

The conducted study does not exhaust all aspects of the problem of professional training of future physics teachers for the organization of innovative activity of pupils in the educational process. The perspective areas of development of the main ideas of the study are as follows: study the specifics of the remote form of management of the innovative activities of students in the process of their professional training and pupils in the system of extracurricular work in physics; develop the theoretical and methodological principles for training of future teachers of natural sciences for the organization of pupils' innovative activities; create the integrative technologies for the organization of pupils' innovative activities, considering the interdisciplinary relationships of physics, informatics, chemistry, biology, and ecology, etc.

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