Innovative Structural Composition of Academic Classes of Students when Mastering Program Material in Physics as Part of Professional Training

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Abstract.
Relevance of the study due to a plurality of factors, among which the leading importance in the context of the formulated topic low motivation and lack of interest to master complex educational material, insufficient level of mastery of educational material in subjects related to the knowledge component abstract presentation of information material, unable to be represented as a sensory perceived phenomenon, emphasis on theoretical knowledge and solution of typical problems, blocking students' creativity and lack of cross-curricular connections, characterized by the lack of full integration of physics with other academic disciplines. The combination of factors that negatively affect the academic performance of students and their level of professional readiness determined the nature of the contradictions that have developed in the physics teaching system, and determined the problem of research, which consists in finding innovative ways to organize academic classes in the discipline «Physics» with future subject teachers.

The purpose of the study there was a scientific justification and experimental testing of the innovative organization of classes with student's discipline «Physics», providing for the activation of their creative potential and motivational interest in acquiring the conceptual foundations of the academic subject.

Results of the study they indicate significant positive changes in the level of professional readiness of students in the experimental group compared to the control group, whose students attended classes implemented in accordance with the classical, traditional structural organization. The results achieved emphasize the effectiveness of the proposed organization, which can significantly influence the academic achievements of students, which indicates the high practical significance of the structural composition of the lesson we proposed.

Keywords: vocational education, physics, physics teachers, structural composition of classes, simulation of situations

Інноваційний структурний склад навчальних занять студентів при засвоєнні програмного матеріалу з фізики як складової професійної підготовки

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Анотація.
Актуальність дослідження зумовлена множинністю факторів, серед яких провідне значення в контексті сформульованої теми мають низька мотивація та відсутність інтересу до оволодіння складним навчальним матеріалом, недостатній рівень оволодіння навчальним матеріалом з предметів, пов'язаних зі складовою знань, абстрактним поданням інформаційного матеріалу, нездатним бути представленим як сенсорно сприймається явищем, акцент на теоретичних знаннях та розв'язанні типових задач, блокування творчих здібностей студентів та відсутність міжпредметних зв'язків, характеризується відсутністю повної інтеграції фізики з іншими навчальними дисциплінами. Сукупність факторів, що негативно впливають на успішність студентів та рівень їх професійної підготовленості, визначила характер суперечностей, що склалися в системі викладання фізики, та визначила проблему дослідження, яка полягає в пошуку інноваційних шляхів організації навчальних занять з дисципліни «Фізика» з майбутніми вчителями-предметниками.

Метою дослідження було наукове обґрунтування та експериментальна апробація інноваційної організації занять з дисципліни «Фізика» студента, що передбачає активізацію їх творчого потенціалу та мотиваційного інтересу до засвоєння понятійних засад навчального предмета.

Результати дослідження свідчать про значні позитивні зміни в рівні професійної підготовленості студентів експериментальної групи порівняно з контрольною групою, студенти якої відвідували заняття, виконані відповідно до класичної, традиційної структурної організації. Досягнуті результати підкреслюють ефективність запропонованої організації, яка може суттєво впливати на академічні досягнення учнів, що свідчить про високу практичну значущість структурного складу запропонованого нами уроку.

Ключові слова: професійно-технічна освіта, фізика, вчителі фізики, структурний склад класів, моделювання ситуацій

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Introduction.

Systematically carried out testing of students – future physics teachers in order to establish the current level of development of professional competencies on an ongoing basis demonstrates a decrease in the motivational interest of students in overcoming difficulties in mastering program material. In turn, the motivational factor negatively affects the academic success of students, which undoubtedly requires special attention from the scientific community for targeted activities to resolve pedagogical conflict. Building on the pedagogical tools available in all institutions vocational education, in the present study the activities have been systematized in the aggregate capable of ensure an optimal resolution of the current situation, taking into account current trends in the training of competitive teaching staff.

Initially, we carried out a theoretical analysis and understanding of the possibilities of eliminating the contradiction between modern requirements for physics teachers and the absence / the insufficiency of theoretical and methodological grounds for their observance in the educational process of professional training of teachers. As part of the analysis, issues of organizing educational classes in the discipline «Physics» were studied by establishing options for their understanding by scientists whose research activities lie in the practical plane of various aspects of teaching and learning.

Relevance. The relevance of the issues we raised is determined by a set of factors that together determine the problems of organizing high-quality education in the discipline «Physics» for students of pedagogical specialties. In particular, such factors, which do not relate to problems of an economic nature, are

1) low motivation and lack of interest to master complex educational material in view of its divorced presentation in the context of the topics proposed by the program. In this regard, there is an obvious violation of the relationship between the information component of the academic subject and the practice of applying knowledge in future professional activities;

2) insufficient level of mastery of educational material in subjects related to the knowledge component (for example, mathematicians), which in the end makes it difficult to understand and, accordingly, to master physical concepts;

3) abstract presentation of information material, unable to be represented as a sensory-perceived phenomenon (for example, quanta);

4) emphasis on theoretical knowledge and solution of typical problems, blocking the creative potential of students and preventing them from developing the research skills necessary in the modern realities of the competitive environment for professional training of teachers;

5) lack of cross-curricular connections, characterized by the lack of full integration of physics with other academic disciplines (for example, mathematics, chemistry, computer science), and, as a result, the lack of a holistic picture of the world among students.

A comprehensive understanding of the problem that has developed in the professional and educational environment should also be solved on an integrative basis of knowledge, and timely achievement of the goal will significantly increase the quality of professional training of graduates – future physics teachers. The relevance is explained by the severity of the situation, which requires timely elimination of existing contradictions.

Purpose of the study. The purpose of the study is scientific substantiation and experimental testing of the innovative organization of classes with students in the discipline «Physics», which involves intensifying their creative potential and motivational interest in acquiring the conceptual foundations of the academic subject.

Analysis of previous studies and publications. The theoretical analysis of the research results of scientists, this research interest touches on certain aspects of the task of this scientific work we formulated and made it possible to identify and systematize the key meanings of the problem. In research D. Tucel as part of the direct conversation with students conducted by the researcher, all the difficulties they encounter in their cognitive activities when mastering program material are highlighted (Tucel Deprem, Çakıroğlu, Öztekin & Kıngır, 2023, p. 1072). A similar author's position was found in scientific works E. Özdemir who, in the course of searching for an innovative methodological approach to organizing physics classes, comes to the conclusion about the need to distance himself from classical teaching methods and introduce discussion material that provokes students to research activities (Özdemir & Kocakülah, 2021, p. 177).

R. Almadrones in his research, he repeatedly emphasizes the importance of the transition from an abstract representation of physical phenomena to a symbolic description of physical concepts, with the addition of verbal accompaniment, which together provide the possibility of organizing a laboratory experiment (Almadrones & Tadifa, 2024, p. 638). The significance of the practice-oriented approach is evident to another author of the studies J. D. Stanton, within which they describe the pedagogical tools for the possibilities of designing experimental activities of students in the field (Stanton, Sebesta & Dunlosky, 2021).

The consequence of the above proposals is the removal by the majority of authors of the classical approach to teaching students physics, in general, focused on the teacher and, to a large extent, on the translation of ready-made knowledge. Physics teachers often focus on two main aspects of the educational process – laboratory work and tasks with numerical programming (Banda & Nzabahimana, 2023, p. 140).

The focus of modern academic classes with students primarily includes an overview of the previous topic as an introduction to a new topic, theoretical development on

a new topic, a few numerical examples and, if possible, small laboratory works (Wang, Chen & Yen, 2021). The disadvantage of this approach is that a significant temporary part of the lesson is focused on students mastering the information material offered verbally by the teacher with little participation from the students themselves (Pei-Lin, 2024; Salame & Makki, 2021).

In such a situation, there is a decrease in concentration, and by the time it is proposed to begin laboratory activities in which students play a leading role, their concentration, interest and attention are insufficient to fully understand the educational material (Yu, Liu, Ma, Le & Ba, 2022, p. 14). The combination of current circumstances significantly reduces the overall productivity of the lesson. The first problem, which has already been noted in the scientific and scientific-methodological literature by the majority of authors, is the students' poor understanding of the conceptual ideas of physics (Lin & Sumardani, 2023, p. 13).

When focusing on theoretical formulations of laws and complex mathematical abstractions, basic physical ideas tend to escape students' attention and understanding (Tong et al., 2025). Pupils sometimes feel that they should excel in language and mathematics in physics lessons – in language, knowing the correct word order for formulating a physical law, disregarding its semantics, and in mathematics, knowing how to calculate and provide information, overlooking the most important – physical interpretation of laws and phenomena (Yang et al., 2022, p. 14]. The second problem faced in the classical approach is this is a decrease in concentration during the first twenty minutes, when the teacher presents the topic orally, finding the correct relationship with the previous topic, and clarifying the correct formulation of a specific law or definition. In this case, students do not take an active part, and their attention is absorbed by foreign objects (Hasnunidah, & Undang Rosidin, 2025, p. 3892).

Materials and Research Methods.

Initially, it should be emphasized that this study does not propose an alternative, but a categorically different approach to the discipline «Physics» currently in force in classes implemented as part of the tasks of professional training of future physics teachers. Unlike the traditional approach, the beginning of our classes is built on «memories of» past topics with the help of mathematical concepts or the laws of physics. The goal is not to distance students who do not have prior knowledge of the previous topic but engage them in the process of finding answers to simple questions from everyday life with which they are familiar. This part of the lesson does not provide for the introduction of physical terms and phenomena. After the introductory questions, students mentally immerse themselves in the topic and prepare to become familiar with the physical terms used in new ones, i.e. intended for them to master the laws of physics. However, since this is an introduction, the teacher still invites students to ask questions and discuss in order to create a research environment in which some terms can arise initially spontaneously. Thus, the introduction of new terminology for students occurs in the absence of specific definitions.

At the end of the introductory part of the lesson, the teacher begins to implement its main part. In this part, the teacher develops topic, introducing physical terms and objects, and demonstrates a specific phenomenon in practice, resources and conditions permitting educational environment. This is not always necessary to conduct a full-fledged experiment but is clearly present at the lesson to simulate the experimental situation. The most important thing in this part of the class is the transition from everyday language used for introduction to scientific or physical language, which is necessary as the basis for subsequent mathematical constructions and physical modeling.

After completing the simulation of the experiment and moving from the everyday language used in the water part of the lesson to the scientific or physical language needed as the basis for subsequent mathematical constructions, the teacher continues the discussion with the students, asking additional questions. At this stage, students are immersed in studying a certain topic and are able to draw up a logical conclusion on their own. The aim is to place students in a familiar environment and focus attention on the almost spontaneous development of the logical concepts needed to learn new terminology.

Of course, we should not lose sight of the fact that students do not always answer as the teacher expects. That is why this approach is based on hints and input data that the teacher offers to students without giving a completely correct answer to the previously formulated question. Upon completion of this process, the teacher helps students formulate their own conclusions using the correct terminology.

In the present research used quasi-experimental approach s continuous monitoring (statement, formative and control stage of the pedagogical experiment) and impact assessment organizational structure of classes in the discipline «Physics» p future ones physics teachers bachelor's degree (n = 39), divided by two groups: control (KG, n = 19), which I stuck to it traditional methods of training, and experimental (EG, n = 20). The results of the study were supposed to demonstrate the degree of student involvement in the educational process through the identification of values in the information-practical, operational, activity and evaluation components. The main one a tool was author's a questionnaire created based on the provisions of the theory of the level approach with the identification of a three-level scale: minimum (low), acceptable (medium) and optimal (high). The quantitative range was defined as follows up to 1.00 – low, from 1.01 to 2.00 –acceptable, from 2.01 to 3.00 - optimal.

To ensure the possibility of obtaining generalized data during the initial processing of results, we focused on

average statistical indicators and determining the average score (using the method of calculating the arithmetic mean). In this case, a generalized result for each criterion and level of readiness students to professional activities it was calculated according to the assumption that at a 5% level of significance, the distribution of random variables obeys the normal distribution law.

Results.

The main difference between the approaches we considered is that in the traditional version of organizing classes with students, the teacher assumes knowledge of the subject program and understanding of the topic based on previously studied material, ensuring that students understand the topic based on the logic of the content itself (Özdemir & Kocakülah, 2021, p. 177]. As part of our proposed approach, we do not assume that students previously had formal knowledge of to the studied subject, and also that content presented in the form of theory or numerical exercises can give them logical concepts or a complete understanding of the subject. Therefore, at the center of the author's approach - information familiar to students from everyday life, which serves as a starting point for studying a physics course. Using this environment, we immerse students in context, with active participation in answering questions and formulating their own theories. At the same time, the teacher takes part as a moderator of the educational process.

Based on the application of the diagnostic complex, results were obtained at the control stage of the pedagogical experiment, the quantitative values of which, after mathematical processing, were presented as follows Fig. 1).

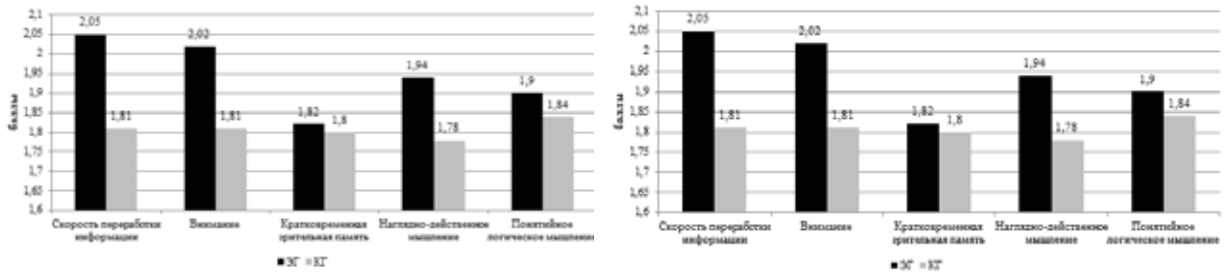

Fig.1. Results of the readiness study students to professional activities at the control stage of the pedagogical experiment

- at the component level «information and practical»

As can be seen from the presented empirical material, a sufficient level in terms of the indicator «information and practical» was demonstrated EG – 22.9%; KG – 78.44%, and low in KG – 21.6%. The optimal level was detected only in EG – 77.1%. Establishing statistical correspondence of significance parameters differences within the indicator under consideration were demonstrated by their presence between groups ($H=5.2684$; $p < 0.05$).

- at component «operational» level

Almost the same result was obtained for parameter «operational»: a sufficient level was recorded at EG – 22.9%; KG – 82.4%, low in KG – 17.6% students. The optimal level was detected only in EG – 77.1%. Establishing statistical correspondence of significance parameters differences within the indicator under consideration were demonstrated by their presence between groups ($H=4.0054$; $p < 0.05$).

- at component level «activity level»

From the data obtained during the pedagogical experiment and analysis of the results, it follows that students EG 11.4%; KG – 74.3%, sufficient level, and low level demonstrated in KG – 25.7% students. The optimal level was detected only in EG – 88.6%. Establishing statistical correspondence of significance parameters differences within the indicator under consideration were demonstrated by their presence between groups ($H=2.9259$; $p < 0.05$).

- at component level «evaluative»

They demonstrated a low level in KG – 25.7%, sufficient – at EG – 18.6%; KG – 74.3% students. The optimal level has only been identified in EG – 81.4%. Establishing statistical correspondence of significance parameters differences within the indicator under consideration were demonstrated by their presence between groups ($H=4.0074$; $p < 0.05$).

When organizing a pedagogical experiment, results were obtained that allowed us to draw a number of conclusions indicating the reliability and significance of the superiority in the required values of EG participants over CG. The positive changes presented in Figure 1 in the participants included in the EG, through graphs, clearly indicate the high efficiency of the organization of the educational process in general and classes in particular that we proposed, creating conditions for the formation of a foundation for improving the quality of the implemented pedagogical process.

Conclusions.

Our priority goal of the study was to find ways to resolve pedagogical conflict to improve the quality of the teaching process as part of the professional training of students – future physics teachers. The traditional teaching approach of following a curriculum with an introduced order of consideration of the previous topic,

presenting theory, and introducing formulas with possible laboratory work in subsequent classes is not as successful with most students. Therefore, we wanted to attract their attention by focusing on the topic they were directly mastering. In addition, we needed to help them better understand the logical concepts of physical processes so that they could easily navigate physical theories and concepts.

The main feature of our approach is the transfer of simple situations from real life to the context of physics without theoretical training in formulas, laws and definitions at the initial stage of the training process. Immersing students in a friend they're on Wednesday we create an adaptive environment that allows us to involve students in research activities with independent search for answers to the questions posed.

Thus, physics does not move away from them, but, on the contrary, becomes closer in everyday life. Students are directly involved in all stages of the development of logical physical concepts that prepare them to know theoretical formulations, laws and formulas Some classes include practical demonstrations conducted by the teacher together with students, where they directly participate in the discussion and spontaneously develop the logical concepts necessary for better mastery of all program material in the discipline «Physics».

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