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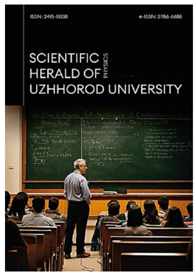

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Didactic conditions for improving demonstration experiments in physics in pedagogical universities

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Abstract

Relevance. The relevance of the research is conditioned upon the problems of improving the methodological foundations of teaching physics in the format of a visual experiment for the sustainable development of the educational process in a pedagogical higher educational institution.

Purpose. The purpose of the study is to develop a model for conducting demonstration experiments on the subject of physics using computer technology in pedagogical universities.

Methodology. The leading method to investigate this problem is testing developed by M.I. Lukyanova and N.V. Kalinina's "Methodology for studying the motivation of students' learning".

Results. For more successful assimilation and understanding of practical material within the subject of physics, a model for organising practical experiments considering environmental orientation was developed. It includes a demonstration of a multi-level process with didactic conditions, such as starting from the final version in its practical application of a physical phenomenon or a set of mechanisms. The process gradually deepens knowledge, beginning from the mechanical work of the object made to a detailed examination of each chain of its operations. This is accompanied by explanations at the level of physical formulas and regularities.

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Conclusions. The study showed that the developed model enhances learning experiences in physics. It emphasizes practical experiments visible through computer simulations, fostering intellectual development and environmental conservation awareness. This model enhances both the educational process and practical applications in physics, benefiting teachers, physicists, and educators alike.

Keywords: physics; experiment demonstration; methodology; visibility of the educational process; education.

Introduction

Teaching in the field of physics is currently undergoing changes in the basis. These changes emphasize highlighting the visibility of the application of physical phenomena, patterns and chains with the level of their reproduction in the sphere of practical life. These changes focus on the development of the well-being of social life within the framework of the development of an actual and important ecological culture in modern society [1]. Such a discipline as physics is endowed with a large level of experiments, which are mandatory in the learning process. They allow understanding the discipline at a deep level, thus making physical experiments one of the methods of teaching the subject, which will allow understanding and realising it [2].

During the observation of experimental physical actions, an experiment takes place, which at the mental level forms students' semantic, theoretical, and practical importance of the subject. This also forms students' ideas about scientific experiment and methods of its implementation, which increases thinking abilities and creates conditions for increasing students' intellectual inclinations and creative abilities [3]. Educational conditions within the framework of health saving do not allow many experiments in physics to be shown as part of the educational process in the classroom for many reasons related to safety and technical equipment. Such conditions often cannot be recreated at the level of health saving and adapted economy.

Therefore, at this stage, it is worth considering the possibility of using new innovative tools that will allow recreating and visualising all kinds of experiments within physics for its in-depth study and understanding. It is important to remember that the need based on the situation in the world speaks of the need to study all subjects within the framework of environmental conservation, which also applies to the study of physics [4]. Considering that the field of physics has a very extensive sphere of influence on the world, people's lives and the surrounding world, it is worth rethinking at a very deep level the application of knowledge of physics to clarify its impact on the well-being and ecology of the population and life in general. Therefore, it is crucial to remember that any scientific discoveries and knowledge taught should be aimed at improving everyone's life [5].

It is worth remembering about the systematic observation by the students of the experiments demonstrated to them, which form their ideas about this science, subject, and the field of the practical application of knowledge in the field under consideration. This situation fosters the development of mental engagement in the discipline and lays the professional groundwork that students will carry into their future careers, including in pedagogy where they bear significant responsibility for cultivating ecological awareness. It emphasizes the application of physics knowledge, ensuring that highly qualified specialists grasp the importance and intricacies of physical phenomena and their impact on human life and the environment, contributing to the restoration and enhancement of life overall [6].

In addition, the use in the educational process of visualisation of physical experiments' demonstrations, experiments using modern technologies increases motivation and interest in the educational process and the study of the discipline of physics. Thus, it dictates the need to use various innovative technologies in the above context to improve the educational process and create opportunities for a more informative and interesting study of the experimental part of physics within the framework of environmental safety [7].

Materials and Methods

This study was conducted using the diagnostic testing method developed by M.I. Lukyanova and N.V. Kalinina's "Methodology for studying the motivation of teaching students". This model allows determining motivation, interest in studying physics, identifies ways to apply the knowledge gained in the field of the subject from motivating factors based on the presence of mental activity in the field of the subject, considering students' formed internal motivation. The data obtained are essential for refining the educational approach with a focus on personalized learning strategies. This approach considers the application of experiments in the classroom while prioritizing student health and environmental conservation criteria. It integrates visual, semantic, motivational, and practical elements derived from experimental work into the educational process, enhancing its effectiveness and relevance. This will create a model of personal perception of this discipline and its theoretical and practical application in students' future lives.

This test has a number of questions that represent the beginning of sentences, and their endings are presented as a choice for answers among which the subject can choose a suitable option for himself, which shows his attitude to the proposed situation. Thus, this approach helps assess how external factors influence students' personalities and their responses to these influences. It uses taught knowledge to evaluate students' personal qualities, identifying areas for improvement through information presented in various forms during the learning process. This contributes to enhancing the educational environment's responsibility in shaping motivational characteristics among students exposed to diverse knowledge presentations. This, in turn, due to personal life, both present and future, including teaching activities within the professional environment, will affect the people, the world around them, and life in general, as a result of their household, personal, and professional activities.

After giving the answers, the test results were calculated. When calculating the data, ready-made keys were used that allowed determining the level of motivation present to study physics as part of its identification, such as a very high level of motivation, high, average, reduced, and low level. When calculating the overall results of the study, the standard method of mathematical calculation and graphical representation of the results was used. The pedagogical experiment was conducted based on Abai Kazakh National Pedagogical University. Diagnostic testing was conducted among 87 students of 2-4 courses of the university, aged from 19 to 27 years.

This problem was investigated in three stages, and at the first stage, a theoretical analysis of scientific, research, methodological literature on the problem under consideration was carried out as part of modelling for conducting demonstration experiments in physics using computer technologies with didactic conditions. Thus, the problem, purpose, research methods, and an active work plan were determined. At the second stage, students were tested and this experimental work was carried out with the analysis of the results and the formulation of conclusions. At the third stage, the conclusions were clarified and the results were systematised.

Results and Discussion

With a systematic approach, the data obtained during testing were analysed, which allowed identifying features that affect the motivation to study the lesson. This allowed to determine didactic conditions and work out a more detailed overview of the features of personal perception of information within teaching and considering the interest of cognitive function to strengthen during the development of a model. This model presents experiments in physics using computers at the time of deepening the personal orientation of the educational process in the classroom at the university to create conditions for stimulating motivational and cognitive function, considering students' individual requests [8]. This form of presenting knowledge while improving the personal approach allows students to perceive the material submitted to them with interest, which is realised based on the volume of completeness of the information and its gradual assimilation with the students' active involvement in classes.

Students show interest in cognition and manifestation of themselves at the mental level of reproduction according to the model of future professional activity, where the scope of application of the knowledge that was taught to them during classes, both theoretical and practical, will be identified [9]. The discipline of physics has in its structure an extensive part of experiments and knowledge of this area, considering deep personal perception, and allows students to acquire practical skills of the subject with its application in practice. This structure has the need to initially train students in such a way that they would form an environmentally-oriented view on the application of knowledge in the field of physics, which will allow them to apply it at a high level in the future and consider the preservation of ecology, and well-being for society and nature [10; 11].

In addition, to acquire an experimental share during the demonstration of experiments in physics, in which the student begins to realise examples of its application at the experimental level, it will create conditions for expanding their independence in actions within the discipline. It also will teach them to analyse the causal relationship, which will strengthen and create a complete picture of the application of physical laws and knowledge when presenting information from the created model for its application to practice with further gradual deepening into physical interactions that allow this model to exist at the practical level. It is also important to remember that the created model must bear an image corresponding to modern categories and requirements from the conservation of ecology, health [12-14].

Thus, comprehensively considering the above components covers the organization of forming a model for conducting demonstration experiments in physics using computer technology in pedagogical universities. This approach takes into account didactic conditions and methodological features aimed at successfully developing students' personalities with a personal orientation towards high motivation to study the subject and acquire practical skills in this area. The effectiveness of this approach is reflected in the functioning of the study based on the developed experimental model [15].

The obtained result of the research in the form of a developed model for conducting demonstration experiments in physics was introduced into the educational process in several stages. It included the determination of personal characteristics that affect motivation for studying the subject, which was reflected during a detailed analysis of testing data. It also included pedagogical observation and complete statistical processing of the data obtained during the analysis of the results. The next stage was the development and implementation of a model for demonstrating experiments in physics that use new, innovative possibilities of computer technology for its subsequent and successful implementation in the field of practical education, including in pedagogical universities.

The study covered 87 students. As the results of the study have shown, the subject of physics itself is of controversial interest to them, given that most do not understand how they can use their knowledge in practice since, including future teachers. It is difficult to perceive the importance of teaching this subject to their future students without understanding its use from the standpoint of environmental conservation. Although despite this, they consider the subject itself important in the educational system, but its presentation does not seem interesting and integral to them. In its practical part, as a cognitive moment of visualisation of experiments, their perception is fragmentary and partial and it is difficult for them to associate it with practice [16-18].

Within the framework of the results obtained on the initial motivation for the subject, students attend practical classes in physics to familiarize themselves with its experimental aspects. Understanding these experiments is crucial as they form a foundational part of the subject and contribute significantly to the advancement of technical progress. This understanding is particularly important in the modern world, where environmental considerations play a crucial role. Then, as the results of the study have shown, the level of motivation was not initially formed among students with a high understanding. But it is worth noting again that the subject itself is of interest to them, which is a very important indicator in studying this problem since the psychological component in the context under consideration will be leading in the development of motivation.

In addition, missing parts for creating a figurative model of demonstration of experiments in physics will be considered in the future. This will create conditions for a more active manifestation of the subject of interest with its development at the correct level of application, and the creation of a model of the practical application of knowledge in the field of physics with environmental orientation. The manifestation of future activities in its successful development will improve the well-being of life in society, due to the implementation of these didactic conditions [19; 20]. This research was conducted with a focus on training future teachers, initially emphasizing the importance of developing a model for educating specialists in the pedagogical field. This approach aims to imbue future teachers with a detailed understanding that can help them shape similar perceptions among their students. This includes fostering awareness in practical application and environmental conservation, which holds substantial benefits for society at large. The data obtained from this research underscores its importance for practical education.

Thus, at this stage of reviewing the results of research, it can be said that initially motivation was formed in the majority of students at a low level. The results of the work showed that only 27.5% of students have motivation at a high level, which is dictated by their personal interest in the subject, which in fact is determined by their personal interest. However, the clarifications identified that they would like to know the level of application of knowledge in practice and the importance of those experiments they witness. The rest of the subjects had medium and low levels of motivation, which corresponds to the limits of 18.4% and 54%, respectively, and proves the importance of considering the problem for the development of the above model with these didactic conditions. The obtained indicators are shown in Figure 1.

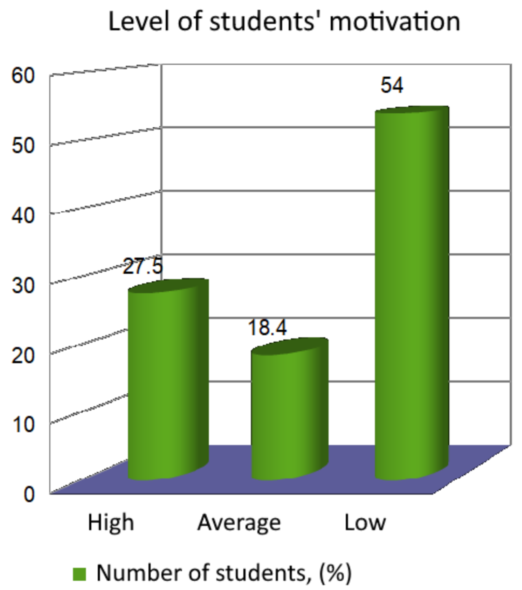

Figure 1. Distribution of students depending on their level of motivation to study physics

The analysis of the data allowed stating that the presentation of knowledge in physics should be methodically changed and the experiments shown should strengthen the motivation of students to study it. It is known that physics is demonstrated more in the course of an experiment for its practical understanding, and it must always be present in the course of education, this allows saying that physics is a practical science and its knowledge is applicable in human activity [21]. Observing the experiment, students learn about phenomena, they form basic physical concepts, and the science of physics begins to acquire a special meaning for them. Modern technologies now allow presenting what was previously possible only in laboratories with very long preparations, where even repeating the experiment was often difficult [22; 23].

Currently, there is a development of innovative computer technologies and it is possible to recreate all the visualising components of the experiment and show it in different sections and angles using many special programmes. It allows creating a general picture of the knowledge of the field of physics and creates conditions for students to realise this at a deep level of knowledge with the development of an internal model for the practical application of various experiments and their structures [24; 25]. Reasoning in this area, it is worth saying that this model teaches students to reflect and follow the direction they have created. This leads to their internal development against the background of increasing interest in the subject and increasing motivation to study it [26]. An important role in the above is played by visibility since people tend to remember what they see, and the created image of the experiment from general to detail allows the student to keep in mind the practical application of physics on its effective phenomenon, which has a special role in life providing many conditions for human life. In this case, it is important to review such details of experiments as the general objects already created for a prosperous living environment, against the background of its impact on the ecology, health, and well-being of society and nature [27-29].

Introduction to environmental education allows talking about the importance of this action, which is dictated by the conditions of the modern world and should be mandatory when considering methodological material for students to study it in the context of its impact on ecology and life. Types of demonstrations of experiments will have many facets but an important component in them will be the fact that they are all aimed at the benefit of the surrounding world and improving human life. Thus, using the elements and capabilities of the video series using computer technology, students will memorise objects as examples based which they will consider different experiments to study the laws of physics, as important information carriers for recreating a favourable environment for life in general. Detailed clarification of some facts will allow them to create models of their mental activity to improve these objects, as well as these didactic conditions allow them to strengthen the course of studying physics in general. Projects of its consideration for the development of students' independent activity on the issue of improving or developing similar to this eco-saving object based on physics, similar technical developments, which in the same context will help to strengthen this area under consideration [30; 31].

The demonstrated competent images of finished objects shape and establish meaningful examples, serving as a framework for solving cognitive tasks in their ongoing development. Through experiments, these models progress from general concepts to detailed illustrations, showcasing various laws of physics, interactions, and scientific principles. This approach enhances students' intelligence not just through theoretical chains demonstrated in practice, but also through tangible products of new technologies. These technologies are created to high environmental standards by physicists and effectively applied in practical life, thereby enhancing the quality of life for individuals [32-34]. Such knowledge will be of great importance in practical education at the level of knowledge of the phenomenon of natural factors while maintaining their high level of ecology, as well as practical skills and abilities.

From this standpoint, experiments within the educational process contribute significantly to achieving the overarching goal of education: fostering the development of individuals with robust value systems. This includes cultivating a conscientious approach to nature and health, while also enhancing personal qualities such as observational skills, the ability to discern and compare data and facts, analytical thinking, drawing conclusions, and constructing coherent chains of understanding from general concepts to specific details. All this is carried out based on many principles of teaching activity, and in particular such as consciousness, visibility, cognitive activity. This in turn leads to increased independence in additional study of the material and the creation of a model of their future professional and other activities within the framework of a value-based eco-saving system of reproduction of their ideological and thought processes. These are the first step in production activities and will further affect everyone's lives [35; 36].

Thus, reasoning in a given format with the categories described above and considering all the details of the study, an organisation model was developed with certain didactic conditions for demonstrating an experiment in physics for students in higher educational institutions in pedagogical orientation. This will allow creating conditions for the development of value orientations for caring for the lives of surrounding people and nature, including value-motivational, visual-practical, cognitive-informational, and modelling of creative ecological-cognitive professional activity based on which future specialists will have a level of ecological culture. This will allow the future specialist to form in the pedagogical field, as a person carrying a high culture of aesthetic perception of the world and life in general for future favourable interaction within both personal and professional activities aimed at the development of the well-being of society.

Thus, the criteria, main positions, and parameters were determined, which allowed creating a model for organising the demonstration of physics experiments for students of higher educational institutions, based on which teachers themselves should have a formed model based on ecological culture. This will allow them to show, tell, and explain the elements of their chosen environmental-saving objects at the methodological level and so carry a motivational value orientation for students on a practical environmental-saving approach to the study of physical knowledge. This is the basis of all technical and engineering developments, which is permissible against the background of the above didactic conditions.

After development, this model was introduced into the research base for its approbation, where its functional positive area was identified in increasing motivation at the loss of its value perception as environmental conservation, as well as to strengthen the development of interest with practical awareness to improve the sphere of life activity of physics. Thus, during the study's evaluation phase, data revealed dynamic trends based on results from repeated diagnostic tests of students exposed to this model. The approach involved demonstrating physics experiments with environmental considerations, illustrating a multi-tiered process that begins with presenting the final practical application of a physical phenomenon or set of mechanisms. This process then progressively delves deeper, starting from the mechanical workings of the object created, and meticulously examining each stage with explanations at the level of physical formulas and principles.

This led to an increase in the effectiveness of the educational learning process in practice and showed an improvement in the trend of understanding the importance of restoring and preserving ecology. This approach underscored the importance of building life, considering a careful, preserved attitude to the natural life of the surrounding world, against the background of a considerable increase in motivation to study physics and strengthening practical and theoretical interest in it. The obtained data of repeated testing allowed determining that the level of identified motivation among students at its high manifestation increased to 78%. Among the rest of the studied students, motivation was determined at an average level, which amounted to 22%, as shown in Figure 2.

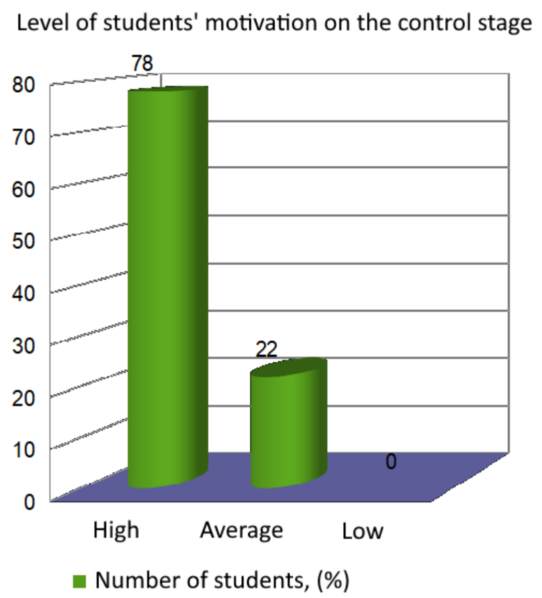

Figure 2. Distribution of students based on the dynamics of the study at the control stage of the experiment

In addition, pedagogical observation and survey identified that the majority of students were interested in possible practical activities within the framework of further development of ideas based on the similarity of ready-made objects shown during experiments. Those are based on knowledge of physical patterns and chains of phenomena, knowledge and factors built to improve life with a careful attitude to nature based on ecological culture. This demonstrates the importance and effectiveness of the study of physics as a science and discipline with the application of its knowledge in practice with successful implementation at a creative level in life and future professional activity.

In this study, its correctness was ensured since the characteristics, parameters of the test, and the developed aspects of the model for demonstrating physical experiments within the framework of physics were comparable in the study correctly. The analysis of its results allowed determining that the developed model allows successfully improving the educational process in higher educational institutions with a pedagogical orientation.

Currently, education should have a number of criteria that are important to consider when developing new methodological and educational programmes, and one of its conditions are factors for strengthening motivation that have value concepts at logical and ideological levels [37]. In addition, an important stage in improving successful education is the analysis of already existing methods and knowledge within the subject of physics in all its fields of study. This includes a large and mandatory area of its application in experiments to identify their impact on ecology and ecological balance in the world, and therewith it is necessary to proceed from the attitude to the norm, ideal health in general, ecology, and leave only those data that correspond to this high level [38-40]. It is necessary to study scientific and practical achievements at the level of ecological orientation, and when finding such environmentally-oriented technologies, it is necessary to study them and introduce them into the field of practical education for their study and use as ready-made objects based on which experiments in physics will be clearly demonstrated.

For example, there is a model of an apparatus for creating freshly squeezed juice, in which one or more oranges are placed depending on the required volume of obtaining fresh juice and a cup into which juice from these oranges will be poured. It is produced automatically by this apparatus from the peel of the same oranges. A similar existing technology based on many physical patterns and phenomena, which will be studied in layers and in detail during the demonstration and telling of this process visually at the physical level of knowledge. This experiment based on a ready-made model of environmental conservation, which it carries at its core, will be highlighted as an object for study and a model for imitation. Further developments within the framework of educational research and projects forming a model of mental activity in the aggregate, both knowledge of physics and its in-depth study, and environmental conservation. These efforts include introducing technical developments into the life of the population and having a large coefficient of benefit from their use, as in this case, obtaining freshly squeezed juice that is beneficial to human health.

All of the above will create conditions for creating a high interest in the study of physics at the level of development of high value motivation, while creating conditions for the restoration of nature and ensuring the prosperous life of society. Therefore, the developed model for organizing physics experiments leverages innovative technologies while prioritizing environmental considerations throughout the process, from initial design to the demonstration of the final object. These didactic conditions aim to foster an environment conducive to cultivating ecological awareness among students and sustaining a high level of motivation to study physics.

The developed model of conducting experiments at the virtual level within physics has proved to be at a high level and can be used in practice to form value motivation. It also can be used to study physics and acquire practical skills in this specialisation during the educational process at the level of practical education in pedagogical universities.

Conclusions

Central to the educational system is the student's personal interest in studying a subject and their intrinsic motivation, which guides them in shaping their thoughts and identifying areas for exploration. This is facilitated through methodological aspects and didactic conditions that leverage the capabilities of modern computer and innovative technologies. These technologies enable the recreation and reproduction of rare, complex, and finished objects, thereby enhancing mental engagement in physics. They also contribute to the development of students' internal motivation, promoting a personality-oriented approach in education that emphasizes the visibility of experiments through computer technology. This will also create conditions for intellectual development within the framework of environmental conservation.

Based on these didactic conditions, a model has been developed for organizing practical experiments with a focus on environmental conservation. This model involves demonstrating a multifunctional and multi-level process starting from a fully functional version of a practical object actively used in application. The approach includes a layered and detailed study of its structure and operation based on physical phenomena and a series of mechanisms. This process begins with an examination of the mechanical functioning of the object and proceeds to analyze each stage of its operation, accompanied by explanations using physical formulas and principles. The experimental data enriches this understanding, fostering deep knowledge of physics at an active, visual level. This model allows organising the knowledge of physics at the visualisation level with an understanding of its practical application in the environment of ecological culture and with the development of practical knowledge and skills in the field of physical science. This will considerably improve the educational process and bring practical significance to the educational system and the well-being of society.

The materials of this paper are useful for teachers, physicists, methodologists, and other workers in the field of education, and can be applied in practice, which will contribute to solving important problems in the field of education.

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Conflict of Interest
Not applicable.

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Дидактичні умови вдосконалення демонстраційних дослідів з фізики в педагогічних університетах

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Анотація

Актуальність. Актуальність дослідження зумовлена проблемами удосконалення методичних засад навчання фізики у форматі наочного експерименту для сталого розвитку навчального процесу в педагогічному вищому навчальному закладі.

Мета. Мета дослідження – розробка моделі проведення демонстраційних експериментів з предмету фізика з використанням комп'ютерних технологій у педагогічних університетах.

Методологія. Провідним методом дослідження цієї проблеми є тестування, розроблене М.І. Лук'яновою та Н.В. Калініною "Методика вивчення мотивації учіння студентів".

Результати. Для більш успішного засвоєння та розуміння практичного матеріалу предмета фізика розроблено модель організації практичних дослідів з урахуванням екологічної спрямованості. Вона включає демонстрацію багаторівневого процесу з дидактичними умовами, наприклад, починаючи з остаточної версії в її практичному застосуванні фізичного явища або набору механізмів. Процес поступово поглиблює знання, починаючи від механічної роботи зробленого об'єкта до детального вивчення кожного ланцюжка його операцій. Це супроводжується поясненнями на рівні фізичних формул і закономірностей.

Висновки. Дослідження показало, що розроблена модель покращує навчальний досвід з фізики. Вона підкріплена практичними експериментами, видимими через комп'ютерне моделювання, сприяючи інтелектуальному розвитку та обізнаності про збереження навколишнього середовища. Ця модель покращує як навчальний процес, так і практичне застосування фізики, приносячи користь як учителям і фізикам.

Ключові слова: фізика; демонстрація досліду; методологія; наочність навчального процесу; освіта.