навичок цілеспрямованої уваги, зосередженості, самостійності мислення, допитливості, розвиває уяву, підвищує впевненість учнів у собі, їх мотивацію, формує звички до групової та командної роботи, покращує ставлення учнів до математики та її вивчення. Використання стратегічних математичних ігор створює можливість розвивати в учнів аргументацію та логічні навички під час аналізу стратегії гри та пошуку виграшної стратегії. Вміле використання відповідних дидактичних ігор призводить до успішної реалізації ідей інклюзивного навчання.

Наш педагогічний досвід показує, що студенти люблять навчатися через гру і мотивовані до активної участі в заняттях, в які включені елементи гри.

Також помічено, що на уроках з іграми розвиваються мовленнєво-комунікативні вміння учнів, їх уміння аргументувати, навички уваги, зосередженості, самостійності мислення, розвиваються допитливість, розвивається уява та логічне мислення, самостійність учнів, підвищується впевненість і формуються навички групової та командної роботи.

І, як ми добре знаємо, деякі з цих умінь є ключовими компетенціями, які мають розвиватися в освіті. Уміла організація та виконання ефективних ігрових дій призводить до підвищення інтересу та мотивації учнів, є одним із найуспішніших шляхів досягнення цілей навчання не лише з математики.

Ключові слова: *ігри, дидактичні ігри, ділові ігри, навчання, компетентнісний підхід, навчання математики, освітній процес.*

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TESTING AS A METHOD OF MONITORING EDUCATIONAL ACHIEVEMENTS OF PHYSICS STUDENTS

Today, test technologies can be considered as an effective and standardized mechanism for diagnosing students' educational achievements, which optimally fits into the organizational process of educational classes. Tests make it possible to qualitatively measure the level of students' knowledge at each stage of their learning. At the same time, the necessary accuracy and objectivity of the inspection is ensured.

The purpose of the article is to investigate the peculiarities of testing as a method of monitoring the educational achievements of students in physics and to summarize one's own experience of its use. The hypothesis of our research can be formulated as follows: the correct, reasonable and effective use of test control of knowledge during physics education enriches the educational process and prepares students for future life exams

The article shows the essence of test technologies and their use in the educational process, substantiates the organizational and didactic conditions for their implementation in the study of physics. A complete system of test tasks in physics has been developed and put into practice, which contributes to increasing the objectivity of diagnosing the quality of students' knowledge

and competencies. We believe that the correct, reasonable and effective use of knowledge test control during physics education enriches the educational process and prepares students for future life exams.

We see further research in the implementation of test forms in the current educational process, in independent work and in a new generation of textbooks and manuals. Such large-scale use of the wide pedagogical possibilities of test forms allows us to achieve new results in improving the quality of education. With the transition to distance or blended learning, testing has become the main form of monitoring students' knowledge.

Key words: *tests, testing, students, physics, educational process, control of educational achievements.*

Formulation of the problem. The modern needs of society require a transition to a new, more flexible education strategy. In this regard, the question of improving the control of knowledge, abilities and skills of future specialists at all stages of their training in institutions of higher education is urgent. Control should be objective and provide full information about the real achievements of students' educational activities [1] and comprehensive and understandable for students in terms of content and purpose [2]. As experience shows, most often the assessment and control of students' educational achievements is carried out through testing. In the practice of modern educational institutions, tests have become one of the main means of obtaining pedagogical information. In addition, it should be noted that in modern conditions on the labor market, specialists who have a high level of qualification in a certain field are competitive. Verification of this level at the first stage of employment in most cases also takes place as a test. This method increases the objectivity of the candidate's assessment and allows the principle of equal opportunities to be implemented. Of course, the effective use of tests is possible only when the tests are used as a supplement to the interview conducted with a candidate for a certain position.

Analysis of current research. The analysis of the scientific and pedagogical literature proves that the issue of test control arouses interest and determines the significant interest of scientists and practitioners. Studies are devoted to the issue of test control in physics in educational institutions by D. Bodnenka, L. Varchenko, S. Velichka, P. Atamanchuk, V. Vlasenko, V. Sfimenka, V. Hrytsenko, V. Grishina, O. Ivanytskoho, Zh. Mozolyuk and others.

Analysis of research on this topic shows the importance and necessity of using test control at various stages, forms and levels of physics education.

In the article by Sadovska T.A. "Testing as a means of monitoring students' knowledge" [3] examines the advantages of testing over other methods of monitoring knowledge, such as traditional control, oral surveys, etc. It is noted that testing allows to assess students' knowledge in a short period of time, ensures objectivity of results and stimulates independent work of students.

In the article by Shulga V.I. "Testing as a means of monitoring students' educational achievements" [4] describes the methodology of building tests, their evaluation and use in the process of teaching students in physics. In the recommendations regarding the organization of student testing, which are given in the methodical recommendations of Vakaluk V.M. "Methodical recommendations on the organization of student testing" [5], the process of preparing, conducting and evaluating the test is described in detail.

In the article by Stepanov M.Yu. and Yakovenko V.M. "Testing as a method of controlling students' knowledge of physics" [6] emphasizes the importance of using testing to control students' knowledge of physics, in particular to check their understanding of fundamental concepts and laws of physics.

The introduction of test control of knowledge has become more relevant with the emergence of external independent assessment (EXA) in Ukraine. At the same time, there is a contradiction between the need to achieve guaranteed quality of specialist training, recorded in objective indicators, and the absence of an effective diagnostic system adequate to modern requirements for the results of the educational process; between the educational potential of test control and the ineffectiveness of its use in the educational process.

The relevance of the research problem and its insufficient development in the scientific and pedagogical literature determined the choice of the topic of the work.

The purpose of the article: to investigate the peculiarities of testing as a method of monitoring the educational achievements of students in physics and to summarize one's own experience of its use.

The hypothesis of our research can be formulated as follows: the correct, reasonable and effective use of test control of knowledge during physics education enriches the educational process and prepares students for future life exams.

Presenting main material. In accordance with the increase in the level of university education, there is an important need to develop effective methods of monitoring students' educational achievements. One of the most common methods of monitoring educational achievements is testing. Testing is considered one of the most effective ways to assess students' knowledge of various subjects, particularly physics.

The main purpose of testing is to assess students' knowledge of physics, as well as to help the teacher identify students' shortcomings and mistakes. Testing allows teachers to assess students' mastery of certain topics and skills. In addition, testing can help students navigate how well they have mastered the material and what specific topics they need to study more.

Testing can be done in various forms, such as test tasks, written tests, open questions and others. Universities usually use test papers that contain questions on different physics topics. These tasks contain different types of questions such as multiple choice, fill in the blanks, sequencing and others.

The advantages of testing are that it allows you to assess the knowledge of many students at the same time, and also ensures the accuracy of knowledge assessment. Testing is also an objective method, since the assessment depends on the correspondence of the answer to the correct answer, and not on the personal opinion of the teacher or the influence of the student.

In addition, testing allows the teacher to identify the shortcomings and mistakes of students. If students massively answer a specific question incorrectly, it gives the teacher an opportunity to understand that the topic needs additional explanations and clarifications. Also, the use of tests allows you to make an assessment regardless of what external factors may affect the student's ability to study, such as illnesses or personal problems.

The disadvantages of testing are that they can be provided only with the knowledge that could be applied in the testing questions. For example, the test may not reflect practical knowledge that may be important to researchers, engineers, and other physics professionals. In addition, testing may not cover all aspects of knowledge required of students.

So, testing is an effective method of monitoring students' educational achievements in physics. It allows teachers to assess the level of knowledge of students, identify shortcomings and mistakes of students and make an objective assessment regardless of external factors. In addition, the use of testing can help students navigate which specific topics they need to study more. However, the disadvantages of testing are that they may be limited only to those knowledge that could be reflected in the test, and may not take into account practical knowledge and may not sufficiently cover all aspects of knowledge required of students.

Therefore, to obtain a more complete map of the educational achievements of students in physics, teachers can use not only testing, but also other methods, such as practical tasks, laboratory work, experiments, discussions, etc. Combining different assessment methods can provide a more accurate and complete picture of students' knowledge and skills.

The educational process should be aimed at achieving the maximum quality of education and development of students. Testing can be an important element of monitoring the educational achievements of students in physics, but it should not be the only method of monitoring and evaluating knowledge. Using a variety of assessment methods, as well as giving students the opportunity to self-assess and dialogue with the teacher, can be useful to ensure the maximum effectiveness of learning and development of students in physics.

In addition, it is important to consider that testing should not be an end in itself but should only serve as a tool for evaluating the educational achievements of students. Teachers should set before themselves a specific goal that they want to achieve with the help of testing, as well as clearly formulate assessment criteria that will reflect the real knowledge and skills of students.

In addition, it is important that the test is properly prepared and organized. Teachers must be sure that the tests meet the requirements of the curriculum and reflect the required level of knowledge and skills. It is also important that the testing is fair and objective. Various measures can be used for this, such as controlling the time of the test, using different versions of the tests for different groups of students, as well as using a system of checking results with the help of two teachers.

Therefore, testing can be a useful method of monitoring student achievement in physics if it is used in conjunction with other assessment methods and considers all aspects of the knowledge and skills required of students. Teachers must properly prepare tests, organize their conduct and ensure fair and objective assessment of results. Only then can testing serve as a tool to ensure the maximum quality of learning and development of physics students.

In the process of learning, the teacher carries out purposeful management of students' cognitive activity. One of the important links of this process is the diagnosis of the quality of education, which acts as a check of student achievements at all its stages. The use of test technologies can be considered as an effective and standardized diagnostic mechanism that optimally fits into the organizational process of educational classes. Tests make it possible to qualitatively measure the level of knowledge of students at each stage of learning. At the same time, the necessary accuracy and objectivity of the inspection is ensured. Tests as a measurement tool are used in most countries of the world. Testology as a theory and practice of testing has existed for more than 120 years. During this time, sufficient experience in the use of tests has been accumulated [7].

As you know, a test (from the English test-test) is a standardized task, based on the results of which a conclusion is drawn about the knowledge, skills and abilities of the person being tested. The test task acts as a unit of the test, its constituent element. The content of the test consists of instructions and several (or many) tasks.

Before creating or applying tests in practice, it is necessary to decide what level of knowledge acquisition we will check.

The first level is recognition, distinction. Students must re-identify the perceived object, highlight it and name it. The basics of task performance – perception, memory. The type of test used is for recognition.

The second level is reproduction. It is necessary to reproduce previously learned information (definitions, formulas, description of the device, the procedure for performing practical actions), to solve a typical problem according to the previously presented plan. The type of test used is reproductive.

The third level is the solution of atypical problems, the solution of which must be found by oneself. Its basis is mental, productive activity.

The first and second levels are executive, they are based on reproductive activity and are carried out according to specific prescriptions. The third level is related to mental and creative activity.

During the educational process, testing performs the following functions:

1. The controlling function consists in identifying the state of knowledge and skills of students, the level of their mental development, in studying the degree of assimilation of techniques of cognitive activity, skills of rational educational activity.

2. The educational function of control consists in improving knowledge and skills, their systematization. In the process of checking, students repeat and consolidate the studied material. They not only reproduce the previously learned, but also apply knowledge and skills in a new situation.

3. The diagnostic function consists in obtaining information about errors, shortcomings and gaps in the knowledge and skills of students, as well as the reasons that give rise to them; students' difficulties in mastering the educational material, about the number and nature of errors.

4. The developmental function of control consists in stimulating the cognitive activity of students, the development of their creative abilities.

5. The indicative function consists in obtaining information on how well the individual student and the group have mastered and studied the educational material. Control helps students get to know themselves better, evaluate their knowledge and capabilities.

6. The educational function of control is to educate students in a responsible attitude to learning, discipline, accuracy, and honesty.

In the educational process, the functions themselves are manifested to varying degrees and in various combinations. Implementation of selected functions in practice makes control more effective, and the process itself becomes more effective.

Tests, compared to other methods of pedagogical assessment, have many advantages, including:

- the ability to check the results of educational achievements from many topics and sections of the program;
- objectively assess the level of assimilation of educational material;
- create equal testing conditions for all test participants;
- standardize and automate the procedure for checking results;
- cover many students with testing.

Certain principles must be followed when developing tests:

- Significance – inclusion in the test of only those elements that can be attributed to the most important, key in the general system of knowledge being tested.
- Interrelationship of content and form – a real pedagogical test can be characterized as the result of the interaction of the content of the task with the most appropriate form. Therefore, there are different types of tests.
- Scientific reliability – each task of the test is based, as a rule, on a fact, theorem, norm, law or on a method tested in practice.
- Completeness and enough tasks – the number of tasks in a traditional test is usually at least thirty. Correspondence of the content of the test to the level of the modern state of science. Complexity and balance of the content of the test (the final test is not based on the content of one topic).
- Systematic content – formulation of the content of test tasks that meets the requirements of the system.
- Variability of content – many variants of tasks of the same test, which are approximately equal in complexity, have similar indicators of variation in test scores.
- Increasing complexity – each element of the content of education in the process of learning and control has some degree of complexity averaged for students.

The following didactic requirements are put forward for test control:

- tests must be valid, i.e. measure exactly the indicator of knowledge or skills that is needed;
- unambiguous, that is, everyone who reads them must understand the condition in the same way;
- simple, that is, each task should contain one question;
- authentic, i.e. to correspond to scientific ideas from the curriculum and contain only the terms and expressions studied in the program;
- be performed based on the studied material.

The structural component of the pedagogical test is: a test task – a task in a test form, intended for execution, to which, in addition to the content, the requirements of the test form are presented and a standard – a sample of complete and correct execution of an action, which serves to compare the achieved level with the planned one.

Depending on which feature is the basis of the test classification, test tasks can be distinguished:

1. By goals: with learning and controlling elements.
2. According to the nature of the necessary actions: the task of reproducing knowledge, analyzing the signs of concepts, performing certain actions (calculation, comparison, logical conclusion, etc.).
3. According to the nature of the answers: open or closed.
4. According to the place engaged in the educational process – initial level of training, current or final control.
5. By level of learning: tests of the 1st level for recognition, recognition and discrimination; level II tests – reproducing information about the object from memory; III-rd level, requiring solving typical tasks; level IV – creative application of acquired knowledge.
6. By type: verbal, numerical, symbolic, visually spatial (diagrams, tables, graphs, drawings, etc.).
7. According to the structure of the answer: with the answer "yes"/"no", at the end of the opinion, with the choice of the correct answer, for comparison or juxtaposition, for the explanation of concepts, for the quantitative ratio of facts and others.
8. By means: blank, objective (constructive), with the use of technical means, practical (in the form of laboratory work).
9. According to the level of standardization of control: standardized or non-standardized.
10. According to the principle of selecting the content of the test for a specific group of students: adaptive or non-adaptive.
11. According to the design of the control program: independent of each other or tests with gradual complication.
12. According to the nature of control: individual or mass (frontal).
13. According to the functions of verification: ascertaining, diagnosing and prognostic.

Depending on the purpose and task of testing, different types of tests can be used, such as written tests, oral tests, tests with open questions, multiple-choice tests, and others. Each of these types has its advantages and disadvantages, so it is important to choose the type of test that best suits the purpose and tasks of the control.

One of the most common types of tests are multiple choice tests. These tests have several advantages, including speed and ease of testing, the ability to create more complex tasks using knowledge from different areas of physics, and the ability to ensure standardization of assessment between different students. However, they also have certain disadvantages, such as the possibility of taking the test randomly without subject knowledge, the possibility of answering questions using the method of eliminating multiple choice answers, and the limitation that they may not allow students to demonstrate their skills and understanding of more complex questions.

All these aspects must be considered when preparing tests. It is also important to use tests not only to control the educational achievements of students, but also for their development. With the right approach, tests can serve as a means of teaching and motivating students to develop their knowledge and skills in physics.

Recommendations on the form of submission of text or graphic test tasks [8]:

- test tasks of the same form are accompanied by one instruction for their execution (when the form is changed, the instruction changes);
- the text of the instructions should differ from the main text (font, color) and be separated from the test tasks with a colon;
- tasks are numbered with Arabic numerals, the numbering of tasks of different forms is continuous;
- the interrogative part of the task is formulated in an affirmative form concisely, clearly, without double interpretation and is highlighted in capital letters or in a certain color;
- the question part of test tasks and possible answers are not separated by any sign;
- answer elements of part of the test task have separate indexing;
- the answers are placed symmetrically under the question part or next to it;

– if the answer involves a certain calculation procedure, then the latter should be simple, without the need to use complex technical means.
– the form of submission of test tasks does not change within the block of tasks intended for testing.

The simplest test tasks of a closed form according to the principle of constructing an answer are alternative test tasks [9].

Alternative test tasks provide for the presence of two answer options, in particular "yes – no", "correct – incorrect". They are used to pre-check the correctness of the choice or decide based on the content of the task without revealing its essence.

Example. Choose the number of the correct answer.

Avogadro's number determines the number of molecules in 1 kg of substance?

1. Yes.
2. No.

If it is necessary to check the ability to correctly reproduce the acquired knowledge, it is advisable to use test tasks with multiple choices, in which from three to five possible answer options are provided. Only one of the proposed options is correct. When composing such test tasks, the difficulty lies in the selection of answer options, which should be quite similar to the correct ones.

Such test tasks are used, as a rule, in the form of an imaginary model of actions, an imaginary simulator, etc. The person being tested must insert the serial numbers of the components of actions placed in a free order.

Closed-form test tasks offer to choose one correct answer from several proposed ones.

In such test tasks, the answers must be placed in a certain order. In addition, it is desirable to use as few of their varieties as possible when creating test tasks.

Example. Choose the number of the correct answer.

A body was thrown horizontally from a tower with a height of h = 300 m with an initial speed of 20 m/s. At what height above the Earth's surface will the body be after 2 seconds of flight? Neglect air resistance [10]

1. 150 m;
2. 260 m;
3. 205.6 m;
4. 280.4 m;
5. 240.4 m.

Open-ended test tasks involve free answers from those being tested. They do not contain suggested answer options and are used to reveal knowledge of terms, meanings, and concepts presented in the educational material. By content, this is a statement with an unknown variable.

Example. For the first half of the journey, the car moved at a speed of 90 km/h, the second – at a speed of 20 m/s. Find the average road speed of the car over the entire journey.

To create tests, you need to choose an environment. It can be: blank testing, which is completed on paper; ready-made software environment; The Internet is an environment.

Each of these environments has its advantages and disadvantages, but it is necessary to use them appropriately for certain types of knowledge control.

Form manipulation (closed or open) is a necessary but not sufficient condition for creating full-fledged tests.

The content of one block of tests can include both tasks of one form (monoform tasks) and tasks that include tests of different forms (polyform).

The peculiarity of monoform tests is that one type of instruction is sufficient for their execution. This makes the task clearer, helping to reduce the time it takes to complete it. However, this type of task is quite monotonous and it is not recommended to use it often in this form. It is advisable to use tests of this type to consolidate knowledge, as well as to check the quality of learning the material.

The use of polyform tests significantly increases their variety and allows for a more objective assessment of knowledge. Tasks of this type allow you to use them to check the quality

of assimilation of the material of large sections, topics, blocks, which are of great importance for the acquisition of stable knowledge.

When creating polyform test tasks, it is recommended to start with the simplest forms containing the least number of essential operations, such as a recognition test task, and include the most complex tasks towards the middle or end of the test. Each type of such a test must be accompanied by appropriate instructions for its execution.

It is also important to consider that testing should be only one of the means of monitoring educational achievements, and not the only one. Along with tests, other control methods can be used, such as writing homework, laboratory work, projects, etc.

It is also important to pay attention to the use of tests as a means of student development. Instead of just testing knowledge, you can create tasks that allow students to demonstrate their skills and understanding of physics, as well as develop their critical thinking and analytical skills.

In our practice of teaching students, especially recently, we use test technologies at various stages of the educational process. So, for example, at the beginning of a practical lesson, students are offered a test check of the theoretical material, which significantly saves time and allows you to get information about preparation for the lesson in a short time. To conduct summaries on a certain topic, students are offered tests that cover both theoretical material and testing practical skills in solving problems. One of the forms of admission to laboratory work and their protection is testing. It is also one of the types of examination control.

Considering the person-oriented approach in education, it is advisable to use test technologies for organizing independent work. Students are offered, as an independent homework, to pass tests on the topic by a certain algorithm.

Here is an example of an algorithm for students to create a test task with a choice of answers:

Choose the topic of the test task.

Come up with a question or find an interesting short piece of information and ask a question about it. Write it down.

Give a series of answers (one is true, the others are plausible but false to choose from). Encode them, put a serial number or letter next to each – A, B, V.G.

Write down the topic, tests and code of the correct answer, indicate the surname of the compiler.

Such tasks contribute to the identification and development of individual abilities of students.

The role of test control has grown significantly in conditions of widespread use of distance education.

Today, there are many different systems (software products and online services) for creating tests and conducting testing. In particular, MyTest, INDIGO, Hot Potatoes, MultiTester System, Knowing, ADSoft Tester, eTest, AnsTester, EasyQuizzy, Google Forms, Microsoft Forms, Moodle platforms, iSpring Suite, Vseovsita, Na Urok. We have positive experience of using the mentioned software products and online services in cooperation with learning management systems Moodle, Microsoft Teams, Google Classroom.

The 21st century puts forward three main requirements for test technology – it is adaptability, quality and efficiency. The adaptability of technologies implies the priority of the personality of students and the need to create such technologies that are able to respond to the individual differences of the subjects, adjusting the level of difficulty of the tasks depending on the success of the answers to the previous tasks. This requirement is implemented by creating a large number of tasks of increasing complexity. The quality of the technology is mainly related to the reliability and validity of the test results. The effectiveness of technologies implies a reduction in the cost/results ratio.

But, despite the advantages of test control of knowledge, it is necessary to mention its disadvantages:

- test results can be affected by side circumstances: an incorrect answer can be explained not only by failure to learn the course, but also by incorrect reading or misunderstanding of the

task, incorrect crossing out of a letter (with correct understanding) due to fatigue, nervousness, personal style of presentation of the content of the task;

- tests reveal the result, not the progress of work. Despite the fact that the effectiveness of knowledge is judged primarily by its results, it is important for the teacher to know how the student reached this solution. Perhaps he reasoned correctly and wrote the answer incorrectly, or accidentally answered correctly;
- educational tests simplify the task facing the student, do not always allow to reveal the ability for independent logical thinking, random choice of answers or exclusion method is also possible.

Therefore, it should be recognized that tests cannot cover all aspects of students' performance. Only together with other forms of control can tests be used successfully. The monitoring system in the learning process ensures regular monitoring of the quality of knowledge and skill acquisition in the learning process, provides the teacher with objective and operational information about the level of students' learning of mandatory educational material. The testing technology should be designed in such a way that it is possible to measure not only the presence, but also the depth of knowledge acquisition.

Conclusions and prospects of further scientific investigations. Test technologies occupy a prominent place in the process of diagnosing the quality of education of physics students in higher education institutions. We have shown the essence of test technologies and their use in the educational process, substantiated the organizational and didactic conditions for their implementation in the study of physics. A comprehensive system of test tasks and technologies has been developed and put into practice, which contributes to increasing the objectivity of diagnosing the quality of students' knowledge and competencies. In the educational process, tasks in test form are used in large quantities. They are used not only to control the educational achievements of students, but also in the current educational process for the effective organization of independent work. Thus, a new situation has arisen that changes the perception of the use of test forms. The combination of tasks in a test form with already known new educational technologies gave birth to another educational technology based on the theory of pedagogical measurements. This was facilitated by the selection of tasks in the test form as a separate concept. We see further research in the implementation of test forms in the current educational process, in independent work and in a new generation of textbooks and manuals. Such large-scale use of the wide pedagogical possibilities of test forms allows us to achieve new results in improving the quality of education. With the transition to distance or blended learning, testing has become the main form of monitoring students' knowledge.

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Салтикова А. І., Салтиков Д. І., Каленик М. В., Шкурдода Ю. О. Тестування як метод контролю навчальних досягнень студентів з фізики.

Анотація. *Тестові технології, на сьогодні, можна розглядати як результативний і стандартизований механізм діагностики навчальних досягнень студентів, який оптимально вписується в організаційний процес навчальних занять. Тести дозволяють якісно вимірювати рівень знань студентів на кожному етапі їх засвоєння. При цьому забезпечується необхідна точність і об'єктивність перевірки.*

Метою статті є дослідити особливості тестування як методу контролю навчальних досягнень студентів з фізики та узагальнити власний досвід його використання. Гіпотезу нашого дослідження можна сформулювати так: правильне, обґрунтоване та ефективне використання тестового контролю знань під час навчання фізики збагачує освітній процес і готує студентів до майбутніх життєвих іспитів.

У статті показано сутність тестових технологій та їх використання в освітньому процесі, обґрунтовано організаційно-дидактичні умови їх реалізації при вивченні фізики. Розроблено і впроваджено в практику цілісну систему тестових завдань з фізики, що сприяє підвищенню об'єктивності діагностики якості знань і компетентностей студентів. Вважаємо, що правильне, розумне та ефективне використання тестового контролю знань під час навчання фізики збагачує навчальний процес, готує студентів до майбутніх життєвих іспитів.

Подальші пошуки вбачаємо у впровадженні тестових технологій у поточний освітній процес, у самостійну роботу та в новому поколінні підручників і посібників. Таке масштабне використання широких педагогічних можливостей тестових технологій дозволяє досягти нових результатів у підвищенні якості освіти. З переходом на дистанційне або змішане навчання основною формою контролю знань студентів стало тестування.

***Ключові слова**: тести, тестування, студенти, фізика, освітній процес, контроль навчальних досягнень.*

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РОЗРОБЛЕННЯ УЧНЯМИ МОДЕЛЕЙ ФІЗИЧНИХ ЯВИЩ ЯК ОДИН З ШЛЯХІВ РЕАЛІЗАЦІЇ STEAM-ПІДХОДУ В ОСВІТІ

Впровадження підходу STEAM у шкільну освіту є одним із шляхів підвищення мотивації учнів до вивчення природничо-математичних дисциплін, а також дотримання принципів науковості, зв'язку навчання з життям, діяльністю. У статті обґрунтовано застосування одного із шляхів реалізації підходу STEAM до навчання студентів, а саме створення комп'ютерних моделей фізичних явищ на заняттях гуртка «Інформатика».

У статті обґрунтовується вибір мови програмування C#, враховуючи відносну простоту та популярність цієї мови програмування. Об'єктами роботи студентів є комп'ютерні моделі таких фізичних явищ: електролізу, експерименту з визначення коефіцієнта тертя, математичного маятника, а також динамічна бібліотека функцій для обчислення основних фізичних величин. Складні проекти доцільно створювати кількома учнями. У той час як одні студенти розроблятимуть динамічні бібліотеки та налагоджуватимуть їх, інші розроблятимуть інтерфейс програмного засобу. Завдяки такому підходу стає можливим створювати програмне забезпечення, яке буде важливим і яке можна буде використовувати для вирішення важливих практичних завдань. Надалі планується розробити та апробувати методику організації спільної роботи студентів над програмними засобами та динамічними бібліотеками, які використовуватимуться для вирішення важливих завдань.

На основі аналізу результатів написання і захисту науково-дослідних вихованцями гуртка можна зробити такі висновки: створення учнями комп'ютерних моделей фізичних явищ сприяє їх зануренню у відповідну проблематику (фізика: досліджуване явище, закон, процес; алгебра: перетворення формул; геометрія: декартова система координат, тригонометричні функції, співвідношення сторін у прямокутному трикутнику); для одного учня створення повнофункціонального програмного засобу часто є важким. Спрощення програмного засобу веде до зменшення його цінності; якщо це навчальна модель фізичного досліду, то учні потребують пояснень керівника гуртка щодо того, які дані є вхідними і як правильно перевірити розрахунки; створення будь-якої комп'ютерної програми, яка матиме практичну цінність, вимагає від учня поглиблення його знань у певній галузі (наприклад, в криптографії і теорії чисел). Тому створення таких програм являє собою цінність і для самого учня; у процесі розроблення прикладних програм, які вирішують важливі практичні завдання, учні досягають як об'єктивних результатів (створення програми, яка має практичну користь), так і суб'єктивних (набувають компетентностей, які у подальшому будуть корисні; поглиблюють знання в певних галузях людської діяльності; розвивають уміння планувати свою діяльність).

***Ключові слова:** STEAM, освіта, програмування, проект, гурток, Мала академія наук.*