

METHODOLOGY FOR DEVELOPING STUDENTS' PHYSICAL AND TECHNICAL ABILITIES THROUGH PROBLEMS OF TECHNICAL CONTENT

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Abstract

This article provides a theoretical and methodological analysis of the methodology for developing students' physical and technical abilities through solving problems of technical content in the mechanics section of the 7th-grade physics course. The introductory part substantiates the relevance of the topic and highlights the role of problems of technical content in the formation of scientific and technical thinking and practical skills in students. The methods section presents the stages of selecting, setting, and solving problems, as well as a table of sample problems. The results section describes the knowledge, skills, thinking, and personal qualities that students develop as a result of using this methodology. The discussion section presents the advantages, difficulties, and practical recommendations of the methodology. In conclusion, it is emphasized that solving problems of technical content serves not only to deepen the understanding of physics but also to form an interest in technology and engineering among students.

Keywords: Physics education, problems of technical content, mechanics, physical and technical abilities, methodology, 7th grade, technical thinking, problem solving, scientific and methodological approach, practical skills.

Introduction

МЕТОДИКА РАЗВИТИЯ ФИЗИКО-ТЕХНИЧЕСКИХ СПОСОБНОСТЕЙ УЧАЩИХСЯ ЧЕРЕЗ ЗАДАЧИ ТЕХНИЧЕСКОГО СОДЕРЖАНИЯ

Аннотация

В данной статье представлен теоретико-методологический анализ методики развития физико-технических способностей учащихся посредством

решения задач технического содержания в разделе «Механика» курса физики 7-го класса. Во вводной части обосновывается актуальность темы и освещается роль задач технического содержания в формировании научно-технического мышления и практических навыков учащихся. В разделе «Методика» представлены этапы выбора, постановки и решения задач, а также таблица примеров задач. В разделе «Результаты» описываются знания, умения, навыки, мышление и личностные качества, которые развиваются у учащихся в результате использования данной методики. В разделе «Обсуждение» представлены преимущества, трудности и практические рекомендации методики. В заключение подчёркивается, что решение задач технического содержания служит не только углублению понимания физики, но и формированию у учащихся интереса к технике и инженерному делу.

Ключевые слова: физическое образование, задачи технического содержания, механика, физико-технические способности, методика, 7 класс, техническое мышление, решение задач, научно-методический подход, практические навыки.

INTRODUCTION

Today, in teaching physics in general secondary schools, the priority task is to connect theoretical knowledge with practice, that is, to teach science practically. The purpose of physics lessons is not only to memorize formulas, but also to develop cognitive interest, intellectual and creative abilities in students, and to form the ability to apply fundamental laws in real life. In particular, students should have the skills to use simple measuring instruments, present observation results in the form of tables and graphs, and explain the principles of operation of the most important technical devices. The ability to apply the acquired knowledge and skills to solve everyday problems and to understand the role of technical achievements in the development of society is also an important skill. It is emphasized that the development of students' physical and technical abilities is of particular importance in achieving these goals - without the formation of these abilities, it is impossible to achieve the results envisaged by the state educational standard.



The concept of physical and technical abilities refers to a set of intellectual qualities that ensure the success of students in technical and physics-related activities. P.M. Jacobson's research shows that all individuals who successfully work in technical fields, without exception, have general physical and technical abilities, which are necessary for working in all areas of technology. The scientist noted that physical and technical abilities are understood not as the highest achievements in the field of technology, but as the ability of a student of a certain age to complete technical problems that can be solved within the scope of his knowledge. In general, physical and technical abilities consist of a combination of individual mental characteristics of a person, which are manifested and developed in technical activities only when the appropriate knowledge, skills, and qualifications are available.

One of the effective ways to develop the physical and technical abilities of students in the educational process is to solve problems of technical content. In scientific and methodological literature, various terms are used for such issues: for example, issues of practical content, issues of polytechnical content, issues of industrial-technical content, etc. In general, a technical (practical) issue can be understood as a problem that illustrates physical phenomena and laws on the example of natural, technical, or household objects encountered by a person in their practical activities. The content of such issues includes the physical foundations of modern technology and production processes, that is, they are aimed at substantiating the principles of operation of modern machines and mechanisms, industrial technologies, or technical devices in everyday life from a physical point of view. Issues of technical content are usually presented in textbooks and manuals, and the teacher can also reconstruct them based on information from the daily press, radio, and television programs and offer them in the lesson. It is worth noting that while traditional abstract problems serve to develop theoretical and abstract thinking, problems with technical content, on the contrary, are a means of connecting students' knowledge and concepts with real-life phenomena, demonstrating the practical significance of scientific knowledge. Therefore, problems with technical content form the skills of students to apply theoretical knowledge in various unfamiliar, real-life situations, and increase interest in technology and production. The above shows the relevance of this topic. In the context of the introduction of new production sectors and high technologies in Uzbekistan, it is necessary to increase the interest and training of

school graduates in the technical field. Developing a methodology for developing students' physical and technical abilities by solving problems with technical content in the process of studying the mechanics section of the 7th-grade physics course is a scientific and methodological issue in accordance with this requirement. This very methodological approach is described in this article. The article is in the form of theoretical and methodological recommendations, and the results of practical experiments are not presented; rather, scientifically based methods, expected results, and discussions are presented to build students' abilities using technically meaningful issues within the mechanics section.

LITERATURE REVIEW AND METHODOLOGICAL APPROACHES

The methodology for using technical problems in the 7th-grade mechanics department (on topics such as force, motion, work, energy) is aimed at solving real-life and interesting problems appropriate to the age and level of knowledge of students. This methodology includes the following approaches and stages:

Selection and adaptation of problems: The teacher initially selects those with technical content from among the problems in textbooks and manuals. If such problems are not enough, then new problems are created based on information from real life (for example, scientific and technical news in newspapers, facts from TV shows about simple technical devices). For the content of the problem to be understandable and interesting to students, it is important to connect it with simple examples from everyday life or the world of technology. The types of problems can be different: computational problems (finding a numerical answer based on certain formulas), qualitative (theoretical) problems (explaining the cause of a device or phenomenon), graphic problems (solved using motion graphs or other graphic connections), etc. When selecting problems, attention is paid to the correspondence of their content to the topics of the mechanics section (for example, kinematics of motion, force balance, work and energy).

Problem statement (explanation of the condition): During the lesson, the teacher clearly and consistently explains the condition of the problem to the students. The condition of a problem with technical content usually describes a specific technical situation; therefore, the teacher is recommended to use visual materials whenever possible - for example, physical models, pictures, or diagrams. This helps students better imagine the condition of the problem and understand the

problem in it. After the condition of the problem is explained, students are given some time for independent thinking and are directed to analyze the problem.

Stages of solving the problem: Whether it is a technical or simple problem, its solution is carried out based on a specific algorithm. The following four-stage scheme is followed to form the competence of solving such problems in students: Analysis and recording of the condition of the problem: Carefully read the problem and determine the information and requirements given in it. If necessary, draw a diagram or diagram of the problem statement (for example, a force diagram, a graphical representation of the path of motion, etc.). Identify the physical processes or phenomena involved in the problem; determine the physical quantities associated with them; determine the relationships between these quantities, and write the appropriate formulas. Make a brief written statement of the problem statement (given and found values).

Formulate a solution plan: Plan how to solve the problem, that is, determine which basic physical laws or formulas will be used to solve the problem. If necessary, several formulas will be used together. Formulate the equations (or systems of equations) necessary to solve the problem. At this stage, students understand which equations should be used to determine the unknown values in the problem.

Implement the plan (calculations): Carry out a practical solution based on the developed plan, that is, solve the written equations mathematically. In this, students calculate unknown values by performing algebraic and arithmetic operations. In the process of calculation, they are taught to pay attention to units of measurement and to logically check intermediate results.

Analysis and interpretation of the solution: Analysis of the obtained result - whether this result logically corresponds to the conditions of the problem, what is its physical meaning - discussing these. Students explain the solution found in words: for example, is the magnitude of the value is significant for the life situation, and whether the result led to the expected logical conclusion. It is also recommended to check the answer in an alternative way (for example, by analyzing the units of measurement or by making an approximate estimate).

This four-step approach is similar to the Polya algorithm and creates a culture of systematic and consistent problem-solving in students. As a result, students become accustomed to analyzing and solving even more complex technical problems independently, step by step.

Problem-solving forms: The methodology can use various organizational forms of problem-solving. During the lesson, students are given tasks to solve some simple technical problems independently, while the teacher observes and guides them where necessary. Some more complex problems are solved through collective discussion: for example, thinking in small groups and then presenting the results to the class. This method also increases students' ability to work together and exchange ideas. Also, solving creative problems (technical inventive problems) can be organized in extracurricular circle classes. For example, tasks that encourage inventiveness can be given through problems such as "propose a method for lowering the center of gravity so that a light cart does not go out of a turn at maximum speed." Such problems require different approaches rather than a specific solution and stimulate students' technical creativity.

Types of problems and examples: Technical problems can be structured in the following subject areas: problems related to motion and speed, problems related to force and equilibrium, problems related to work, power, and energy, etc. Below are sample technical problems for 7th-grade students in the mechanics section (Table 1). These problems are selected based on the principle of simple to complex, and by solving them, students apply their knowledge of the topics of speed, force, and energy, respectively.

Table 1 Sample questions of technical content for the 7th-grade mechanics section

Topic	Problem description (condition)	Basic physical concepts and laws
Electric train speed	A new electric train covered a distance of 120 km in 1 hour and 30 minutes. Find its average speed.	The relationship between speed, distance, and time
Lifting loads using a bucket	What should be the ratio of the arms of the crane to the arms of the crane to lift a load weighing 600 N with a force of 300 N?	The lever rule - equality of moments
Crane performance and power	A crane lifted a load of 200 kg to a height of 5 m in 10 s. Calculate the amount of work done by the crane and its average power.	Mechanical work and power formulas

The above problems are interesting to students with their technical content, and when solving them, students apply physical laws based on real-life realities. For example, the problem of finding the speed of an electric train encourages them to

evaluate innovations in transport technology from a physical point of view; the problem of a lever helps to understand the power of a force and the advantages of simple mechanisms; and the problem of crane power reinforces the concepts of mechanical work and energy in a practical example. In the process of solving such problems, students not only use formulas, but also learn to relate the results to real processes, for example: how does an electric train speed of 80 km/h compare to the speed of cars, or imagine that a crane operating at 1 kW consumes power equal to the number of light bulbs that are powered by this voltage, etc. In general, the use of technical problems in physics lessons as a methodological approach has an integrative nature: it connects physical knowledge with practical technical concepts, strengthens mathematical skills (for example, proportions, solving equations), and serves to form a scientific worldview in students. It is worth noting that the teacher plays a significant guiding role in the process, from selecting problems to analyzing them. The teacher motivates students, advises on complex issues, and helps them complete their solutions with correct scientific conclusions.

RESULTS

By using the proposed methodology, the following expected results and developed abilities are observed in 7th-grade students (theoretically):

Deepening and systematization of physical knowledge: Students concretize and systematize their theoretical knowledge in the process of solving problems of technical content. For example, the basic laws and formulas of mechanics (Newton's laws, conservation of energy, etc.) become more understandable through their application in practical examples. Solving problems organizes students' existing knowledge, creates new knowledge, and reveals the relationship between various physical concepts. As a result, students' conscious assimilation of the program material increases.

Formation of technical and practical concepts: In the process of solving problems of technical content, students also acquire some technical concepts. For example, when solving the problem of a bowl, an idea of \u200b\u200bthe concept of "mechanical force gain" or "center of gravity" is formed. Through the problem of a crane, they understand the technical meaning of "power". This explains the connection between physics and technology, that is, it teaches that the laws of physics are the basis of modern technologies. Students gain additional



information about the main directions of industry, the application of physical laws in everyday life, and their professional outlook expands.

Development of scientific and technical thinking: The process of solving problems of technical content develops logical, scientific, and technical, and figurative thinking in students. While working on the problem, they first analyze the problem, try to draw logical conclusions, and model the given data in their imagination. Solving the problem stimulates research skills: the student first formulates a hypothesis (solution plan) to solve the problem, then tests it and analyzes the result. This is a small scientific research model, as a result of which the student's mental activity methods are formed. In particular, actions such as comparing different ways to solve problems and finding the optimal solution teach creative thinking.

Practical skills and competencies: During problem-solving, students acquire various practical skills. First of all, the ability to work with formulas and correctly use units of physical quantities increases. Also, skills such as graph analysis, table construction, and approximate estimation are formed. Since technical problems are often based on real-life data, students' ability to work with information also develops: they gain practical experience in separating unnecessary and necessary information, finding additional information from various sources (if the problem is incomplete). In this process, the skills of independent work and decision-making in a problem situation are also formed.

Positive motivation and increased interest: Problems with content close to life significantly increase students' interest in science. Studies show that solving problems creates a sense of personal success in students, and this process itself awakens an internal need for knowledge. Technical problems, especially if they are formulated in a problematic way, attract the student with curiosity to find the answer, as a result of which his attention increases and he is actively involved in the lesson. By solving the problem correctly, the student's self-confidence increases, and his confidence in his ability to master physics is strengthened. This serves as a motivating factor for continuous self-development (self-study).

Personal qualities and competencies: In the process of solving problems, students also develop such personal qualities as willpower, perseverance, and independence. Solving a more complex problem requires a certain level of perseverance and concentration from the child. Group discussions develop communication skills and teamwork skills - students learn to correctly express

their opinions and defend their opinions in a debate. By considering issues related to technology and production, students can also develop economic and ecological thinking (for example, by discussing energy efficiency issues). Most importantly, such an approach forms a positive attitude of students towards choosing technical fields in the future - in the process of solving problems, interest in the world of technology may increase, and a desire to connect their profession with technology may arise.

The above-mentioned results are expected, and they are theoretically substantiated within the framework of the article. It should be noted that the achievement of these achievements directly depends on how the educational process is organized. Only the right questions and methodological approach can produce the expected results. Therefore, the next section discusses the advantages and limitations of this methodology, as well as practical recommendations.

DISCUSSION

The methodology for developing students' physical and technical abilities by solving problems of technical content in the 7th-grade mechanics department has several advantages. First of all, it meets the main requirements of the general secondary education physics course - that is, it performs the function of connecting physics education with life and practice. In the lessons, theoretical knowledge does not remain as "dry" formulas, but is integrated with the solution of real problems. This increases students' interest in science and consolidates knowledge. Problems of technical content serve as a multifunctional tool for achieving the didactic goals of teaching: they can simultaneously perform educational (informative), educational, developmental, verification (control), and motivational functions. For example, in the process of solving a technical problem, a student learns new technical concepts (teaching function), develops the ability to think logically and find creative solutions (developmental function), acquires habits of independent and team work (educational function), evaluates his own level of knowledge (control function), and most importantly, his interest in physics increases (motivational function). In this regard, this methodology serves to improve the quality and efficiency of education. The second important advantage is the possibility of providing a professional orientation. Solving more technical problems in physics lessons gives students an idea of various technical professions and engineering activities. They see the physical laws used in such

areas as mechanical engineering, energy, transport, and construction, and understand the role of these areas in society. It will be possible to identify those among students who are interested in technology and can provide them with more assistance. This will help students consciously choose technical professions in the future. Studies have shown that students who develop technical creativity and abilities during school are more likely to successfully enter technical universities and achieve success in their field. In this sense, this methodology can also make a long-term contribution to filling the ranks of engineering and technical personnel who are lacking in our country.

Another advantage is the liveliness and interactivity of lessons. Technical issues usually raise more questions in students, encouraging them to discuss them. Because the issue is real, students imagine familiar phenomena and actively participate in the discussion. This creates the basis for conducting lessons based on a two-way activity rather than a one-way explanation. The dialogue between the teacher and the class increases, and students are encouraged to express their opinions and make assumptions. As a result, the lesson process becomes interesting and memorable, and students are more involved in the lesson.

At the same time, the methodology is not without some limitations and difficulties. First of all, the workload for the teacher may increase: he will have to spend more time than usual in the process of preparing for the lesson, trying to search for or compose relevant problems. At the same time, existing textbooks and problem sets may not contain enough technical content problems, which encourages the teacher to be creative. Not every teacher may have the skills to monitor daily information sources and identify problems from them. To alleviate this problem, it is necessary to form methodological manuals and a bank of problems. Secondly, the time factor: solving technical problems usually takes more time than simple problems. Because their condition is longer, the discussion can be more detailed. And school lessons are limited in time. If the teacher discusses many problems on each topic, there is a risk that all the material in the program will not be learned on time. Here, it is important to find a balance: the quality, not the quantity, of problems should prevail. That is, it is advisable to select 1-2 representative technical issues for each topic and conduct an in-depth and qualitative analysis.

Another limitation is individual differences in students. Some students may be very interested in technical topics, while others may be less interested. Problems



with technical content also require mathematical preparation; for example, it is natural that a student who has difficulty with algebraic expressions will have more difficulty solving a physics problem. Therefore, the teacher should use a differentiated approach: giving more complex problems to stronger students, offering simpler options for weaker students, and establishing mutual assistance through mixed work in groups. Ensuring the active participation of all students in the problem-solving process is a difficult task, but an environment should be created in which no one feels left out. Another problematic aspect of the methodology is the assessment of results. Solving problems in physics is usually assessed in written tests. However, it is important to take into account the students' thinking process when solving problems with technical content. It is not always correct to limit oneself to the final numerical result, because a student can solve the problem in the right direction and make only an arithmetic error. Therefore, the assessment criteria should be broadened: aspects such as the correctness of the problem-solving method, logical consistency, and the ability to interpret the result should also be taken into account. Although this complicates the assessment process, it helps to provide students with more complete feedback. To overcome the above limitations and difficulties, the following recommendations can be made:

Strengthening methodological support: It is necessary to create a set of technical problems and methodological manuals for physics teachers. These manuals should contain problems of different levels, instructions, and explanations for solving them. In particular, if a special set of problems is developed for the 7th-grade mechanics department, it will be easier for teachers to use them in their lessons. If such resources are also distributed electronically (on online platforms), teachers can exchange ideas and enrich each other.

Teacher training: It would be useful to hold special seminars and training courses on working with technical issues in advanced training courses in physics and its teaching methods. In them, teachers will exchange experience in formulating such issues, selecting examples from real life, and creating integrated lesson plans. In addition to explaining the theoretical foundations of the methodology, practical exercises can demonstrate methods of joint problem solving and teaching using role-playing games.

Extracurricular activities: To increase students' technical creativity, it is recommended to organize extracurricular physics and technology clubs. In these

clubs, you can work on various technical tasks, interesting issues, and projects. For example, within the framework of the “Little Engineers” club, students try to make simple devices (souvenir hydraulic press model, windmill model, etc.), explain their physical basis. Such activities, along with consolidating the theoretical knowledge gained in the lesson, further develop the technical thinking of students and direct them towards a profession.

Support individual interest: If there are students in the class who are particularly fond of technology, are interested in adjusting various objects, and making small inventions, they should be encouraged. For example, such students can be given a leadership role in solving technical problems in lessons, and more complex problems can be assigned as independent work. In addition, it is recommended to develop their interests and inclinations by involving them in technical exhibitions at school, organizing excursions to higher education institutions, or industrial enterprises.

Interdisciplinary integration: Technical problems are related not only to physics, but also to mathematics, computer science, and even labor education (technology). Therefore, science teachers can collaborate and organize integrated lessons. For example, when teaching proportions in a math lesson, knowledge is reinforced by solving a physical problem (about speed, time, distance), or by performing practical exercises on measuring physical quantities in a technology lesson. This approach teaches students to see knowledge as a whole, not in pieces, and integrates their competencies in different subjects.

CONCLUSION

In conclusion, the methodology for developing students' physical and technical abilities through technical problems is relevant and useful for today's education. This methodology serves to link students' theoretical knowledge with real life in the mechanics section of the 7th-grade physics course, to develop scientific and technical thinking and practical skills in them. The effectiveness of the methodology is confirmed by scientific sources, and it allows you to simultaneously achieve educational, developmental, and motivational goals in the learning process. By solving technical problems, students will learn physics more deeply, their interest in the secrets of technology and production will increase, and their desire to choose engineering professions will increase. Of course, the implementation of this approach requires a certain level of creativity and

additional work from the teacher, and it is also necessary to overcome some limitations. However, taking into account the recommendations given, this methodology can be consistently applied in practice. As a result, the foundation will be laid for the development of young technical personnel who are eager for today's research and ready for tomorrow.

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