

DEVELOPMENT OF MODERN POLYTECHNIC EDUCATION AT PHYSICS CLASSES

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Abstract: This article considers one of the aspects of the improvement of studying physics at secondary schools, i.e. the problem of polytechnic education in the new environment. It also considers problems of teaching physics at secondary schools according to tasks of polytechnic education in the context of innovative technologies. On the basis of the scientific and pedagogical analysis of the theory and practice of polytechnic education at general secondary schools, the paper shows the need to enhance the polytechnic training of students when studying physics.

Keywords: scientific and technical progress, innovative development, modern production, polytechnic training, physics, technology, methodical complex, career guidance.

1 Introduction

At present, secondary schools are faced with the task of training students to have knowledge corresponding to the latest achievements of scientific and technological progress. In the context of industrial and innovative development, a school should give not only a certain amount of knowledge but also teach future specialists to think creatively, independently improve, update and develop their knowledge. Our analysis showed that there are still many unresolved and unexplained issues related to the formation of polytechnic knowledge and skills in teaching the basics of science in secondary schools. Nevertheless, the problem in question should find a new scientific rationale and the practical solution given the tasks of the reform of secondary and vocational schools. (1-2) In this regard, it is necessary to further improve the polytechnic education that implies the theoretical and practical mastery of general scientific fundamentals of modern industry and technology as its most important component. In the framework of teaching physics, the most important problems are the outdated method of implementing the polytechnic principle and the low level of formation of the students' polytechnic skills and abilities.

When studying physics, the possibilities of implementing the polytechnic principle are not fully realized; educational and skill levels remain insufficient.

In the authors' opinion, the following issues are unresolved in this area:

1. Content and principles of selection of applied material reflecting the physical foundations of the modern industry.
2. Development of a complex of didactic tools that contribute to the formation of polytechnic knowledge and skills in the process of studying physics in a secondary school.

Thus, this problem becomes the central task of improving secondary schools, given the prospects for accelerating socio-economic, scientific and technological progress. The urgency of this problem is caused by integrative processes in secondary education and cardinal changes in modern material production (3-4)

1.1 Purpose and Objectives of the Research

The problem, therefore, is as follows: polytechnic education must be viewed as an integral part of lifelong education that has its own comprehensive subject of study and a specific contribution to the development and mentoring of students. Polytechnic education has its structural components and successive stages. (5-7)

The purpose of the work is to develop a new didactic system of polytechnic education of students in the process of teaching physics in a secondary school.

In accordance with the purpose of the research, its objectives are as follows:

1. To identify the main trends in the development of polytechnic education at physics classes in secondary schools on the basis of the achievements of domestic and foreign pedagogy.
2. To determine the basic requirements of modern industry as well as scientific and technological progress to the content of polytechnic training of schoolchildren in the process of studying physics.
3. To develop a model of the system of polytechnic education of students in the process of teaching physics in general secondary schools.

The research is based on the following hypothesis: if the developed didactic system for studying physics in secondary schools, including the content, methods, and means of polytechnic education, ensures effective learning of polytechnic material and corresponds to the level of polytechnic training and vocational guidance, then the task of teaching physics in secondary schools will be successfully solved and will promote comprehensive students' development.

2 Materials and Methods

This paper examines one of the aspects of improving the study of physics in secondary schools, i.e. the problem of polytechnic education in the new environment. Modern scientific and technical progress requires the training of highly qualified personnel. The starting point in the training of such personnel is a secondary school, the tasks of which for the current stage are defined as follows: to give each student a deep knowledge of the fundamentals of science, to establish a close relationship of training with productive work, to improve the preparedness of young people for work in material production and for a sound choice of profession. In this connection, the tasks of the development of polytechnic education in the process of teaching physics in the context of modern industry become particularly relevant. (6,8) Knowledge of the polytechnic foundations of modern, intensively developing industry will not only help young people quickly master a particular specialty but also make it professionally demanded and mobile. Polytechnic education is considered here as a process and result of the assimilation of systematized knowledge related to the general scientific foundations of modern industry, the formation of the skills and abilities necessary to handle typical (accessible) means of labor common in various industries. The ultimate goal of such an education is the development of personality traits that allow to freely navigate the entire system of public production. (9-10)

Certain aspects of polytechnic education were studied by scientists in different periods of the development of pedagogical science. Problems of polytechnic education were and remain one of the main problems in pedagogical science and secondary school practice. Physicists-methodologists L.I. Reznikov, V.G. Razumovsky, A.V. Usova, A.I. Bugayev, N.T. Glazunov, S.U. Goncharenko, B.M. Mirzakhmedov, Y.D. Schukin, and others devoted their research to these problems. They determined the content of the applied material of the physics course, they revealed the structure of polytechnic knowledge and methods of familiarizing students with the main branches of modern industry.

The value of physical knowledge, which forms the basis of scientific and technological progress, is only growing from year to year. They are in demand in various fields of human activity. In the device and the principle of operation of household appliances, industrial mechanisms, physical laws are used.

Polytechnic education and upbringing involve the study of the technological aspects of the modern scientific picture of the world, familiarity with the methods of obtaining and processing materials, energy, information, technical design of the environment. Students need to master the principles of modern production, master practical skills in the use of tools, machines, and mechanisms. The solution of the problem of maximal growth of a person's creative abilities is possible under the condition of strengthening polytechnic education, comprehensive development of students' abilities for subsequent successful work in various fields. Therefore, in a modern high-tech world and a developing information society, it is necessary to study physics, delving into the essence of phenomena and processes.

Currently, in the system of secondary education, there is some separation of theory from practice. The task of polytechnic education should be not only the study of the fundamentals of science but also polytechnic workshops, conducting experiments and laboratory work, practical exercises related to the elements of research, technical creativity. In physics lessons, schoolchild acquires skills to work with various instruments and equipment, learns to identify and fix their problems. Being engaged in the design and manufacture of existing models, students acquire not only practical skills in processing materials, designing, reading electrical circuits and drawings, but also are attached to research activities and scientific research.

The use of the principle of polytechnic education in the study of physics, mastering the general methods of activity implies the creative participation of schoolchildren in the implementation of successive stages of the teaching and research cycle and the transformation of knowledge into work. This type of activity includes the formulation of an idea, the search for and assimilation of the necessary applied knowledge as a means of realizing the results of the basic sciences, determining the methods of their application, and conducting the necessary research. Mastering the methods of research activity is usually attributed to the essential characteristics of a high level of education of modern youth. Therefore, it is necessary to form students' ability to research and create in the context of systematically attracting them from the school bench to various forms of research. It is this type of activity that directly contributes to the self-development of a person's creative powers and self-improvement.

The implementation of the principle of polytechnic education in the study of physics allows you to create conditions for the conscious professional self-determination of students in accordance with the abilities, inclinations, personality traits.

Modern education sets students in addition to learning goals and objectives, and the tasks of developing and formation of research skills. One of the methods of scientific research is modeling, in the process of which essential interrelations between elements of the system are identified and fixed.

Educational and research, design activities of students, as a specific scientific and methodological direction, has a long tradition. In modern conditions, when the issue of reducing the academic load is quite acute, the idea of research activity as a tool to improve the quality of education increases. For example, in the conditions of a gymnasium or lyceum, the main task of research activities may be the organization of specialized training on its basis, therefore it is necessary to develop courses of choice, allocate appropriate time for research projects, and organize a system of individual counseling and project protection. In institutions of additional education, excursion and expeditionary work may be effective. In any case, the tasks and forms of research should be consistent with the contingent of students, their age characteristics, the specifics of cognitive

motivation. Student research is one of the types of educational technology where the main is educational research. In this case, students are supposed to perform educational research tasks with a previously unknown solution, which are aimed at creating ideas about the object or phenomenon of the surrounding world, and are carried out under the guidance of, for example, a subject teacher.

Educational research is an educational process that is implemented on the basis of the technology of research activities, while simultaneously solving the tasks of polytechnic education. The main characteristics of it can be considered the selection in the educational material of the problem points, suggesting variability; hypothesis formulation; the collection of material, its comparison, and analysis, followed by the choice of one of the advanced versions as the true one. Participation in such creative activity forms a cognitive position when a person not only actively responds to changes in the world but also feels the need to seek and find the unknown before. The main result of the implementation of an educational and research project is to get an idea of a particular phenomenon, process, and technological cycle.

3 Results

The basis of the teaching of physics should be based on the polytechnic principle, which implies the polytechnic content of the educational and labor activities of schoolchildren and a set of didactic means aimed at theoretical assimilation and mastery of this content. (11-12)

The scientific novelty of the work is as follows:

1. The most important trends characterizing the development of polytechnic education in the process of studying physics in secondary school have been identified.
2. The conceptual foundations of improving the polytechnic education of students in the process of teaching physics in secondary schools are revealed.
3. The methodical system of polytechnic training of students at physics classes in secondary school has been developed.

The practical significance of the work lies in determining the content and system of polytechnic knowledge and skills when teaching physics in secondary school. It also lies in the development of a methodological complex related for modernizing polytechnic education and enhancing the polytechnic training of students in the process of studying the physical fundamentals of the main areas of scientific and technological progress.

The authors have attempted to build the structure of polytechnic training materials for physics in accordance with the main areas of scientific and technological progress. Such a system of communicating knowledge within the physics course ensures the observance of a stricter sequence when forming polytechnic knowledge and skills.

The authors considered how polytechnic training of schoolchildren is carried out in teaching physics using the example of the five main areas of scientific and technological progress (automation; energy; electronics and computing; creation of materials with the necessary technical properties; ecology).

As a result of the analysis, the authors systematized polytechnic training materials for physics in accordance with the main areas of the technological revolution. The authors developed the system of polytechnic training materials where they indicated not only the links between the sections of the course and the main areas of scientific and technical progress in the economy but also provided the applied material that can be used by teachers when studying a particular topic. Such systematization of applied physics issues determines the content of polytechnic training materials and enhances the professional orientation when studying this physics course in secondary school (2,12-13).

During the physics course, a teacher brings students to an understanding of some important technical and economic problems being solved for further scientific and technological progress based on the achievements of modern physics. On the assumption that the polytechnic education is the basis of the right career guidance for children, a teacher consolidates and expands the practical skills of students. For example, when studying molecular physics and electrodynamics, a teacher introduces schoolchildren to the physical problems of thermal power engineering and electrometallurgy, conducts a physical experiment based on some technological processes related to the properties of solid, liquid and gaseous bodies. (14-15)

When studying thermodynamics, children consider the principle of operation of heat engines and ways to enhance their efficiency. A teacher draws the attention of students to modern internal combustion engines, their difference from the previous ones and discusses with children the professions associated with them: driver, auto mechanic, engine manufacturer, etc. Then he/she talks about the construction of thermal power stations. He/she reports that they mainly use large units with a capacity of 500 and 800 thousand kW, which use high-quality steam. This enables higher efficiency and, consequently, leads to fuel economy and increased productivity. The use of such large units also provides savings in materials and funds for the construction of power plants. The attention of students is drawn to the professions associated with the installation and commissioning of units of thermal power plants, to the profession of people maintaining such stations. When studying the properties of liquids, the application of capillary phenomena in engineering, agriculture, and everyday life, the principle of the flotation process of enrichment of polymetallic and iron ores used by metallurgical plants, is considered. A teacher talks about the professions of ore enrichment specialist, a machinist of magnetic separators, flotation engineers, machinists of mills, crushers, and conveyors; introduces students to the production of iron concentrate, pellets, and sinter. (16)

When studying the properties of solids and plastic properties of metals, a teacher uses a local example of a metallurgical plant; explains to children what is the principle of the rolling of metals. A teacher not only tells students about the use of the deformation of metals in the industry but, at the same time, acquaints them with a certain range of professions engaged in the metallurgical industry. When considering the passage of electric current through different environments, a teacher explains to students the physical foundations of a number of technological processes (using electrolysis to produce aluminum and other non-ferrous metals, using electroplating technology and spark discharge for processing metals and cleaning gases in electrostatic precipitators; using arc discharge for welding metal parts). When studying the material, a teacher consults on the professions of people participating in these technological processes, draws the attention of students to the important role of electricians in all heavy and light industries, to different specializations depending on the nature of an industry.

Particular attention is paid to the study of devices that are electronic components of radio, automation and remote-control equipment (vacuum diode and triode, cathode-ray tube, photoresistor, semiconductor diode, and triode, etc.). (17) When studying the topic of magnetic properties of matter, a teacher focuses students' attention on the application of the magnetic properties of iron ore during its enrichment, talks about the essence of this technological process and about using the properties of ferromagnetic materials to create magnetic separators. After that, an excursion is held to an iron ore enrichment works, where students learn about the process of enrichment of iron ore and the range of professions of people employed in this industry.

In physics methodological literature, the approach to the problems of the content of polytechnic education changes substantially due to the increasing role of science in technological progress and the rise in the scientific level of compulsory school education. Previously, the basis of

polytechnic education in many disciplines, and in physics in particular, often consisted in the selection of technological examples that reveal the practical use of physical laws. Analysis of the results of the educational process showed that this approach is ineffective, it led and leads to a fragmentary knowledge of students, the insufficient formation of skills and abilities. In this regard, the methodology suggests that in order to successfully implement a polytechnic principle, the material included in the school physics course should cover the basic theories, laws, and concepts interpreted according to the modern level of development of physics and technology, enhanced role of theory and technology and simultaneous applied orientation of the course. (18-19)

The determination of the subject of polytechnic education, as well as of any other branch of the educational process, is, first of all, to clarify:

- a) the subject of study determined in turn by the object and nature of study;
- b) contribution to the education of an individual;
- c) content structure of a given branch;
- d) place of a given branch in the educational process.

Thus, the educational object of polytechnic education is technology; the subject of study is the general educational fundamentals of technology; the educational subject is the formation of personal pre-vocational traits in the field of transformative human technological activity.

Polytechnic education consists in the students' assimilation of the basic laws of the structure and functioning of technological systems, in the study of the fundamentals of technology, and also in the formation of polytechnic skills. In the process of polytechnic training, a contribution is made to the development of all aspects of the students' personality. In other words, polytechnic education is of cognitive, educational and developmental value. (19)

Polytechnic training, which implies the theoretical and practical mastery of the general scientific foundations and objects of modern technology, enriches the social relations of schoolchildren, the means of their activities and the norms of conscious behavior. This has a significant impact on the process of socialization of students. Such training helps young people to determine their place in social practice in accordance with their abilities, which cannot but have a positive effect on the formation of the personality as a whole. (20)

The key to the success and effectiveness of polytechnic education in the process of teaching physics is a systematic approach to it. We have developed a conceptual model of the pedagogical system of polytechnic education in the process of teaching physics in school, consisting of three subsystems:

- goals and objectives of polytechnic education in school;
- the mechanism for implementing the principle of polytechnic education in the course of physics
- the results of polytechnic education in the process of teaching physics.

The target component of the polytechnic education system is formed under the influence of the following factors such as the socio-economic needs of society, scientific and technological progress, and environmental conditions. The goal of polytechnic education is the formation of the comprehensive development of the student's personality and its preparation for work in the field of modern engineering in the process of teaching physics. (21) This main goal is achieved by solving the following main tasks such as the formation of knowledge about the scientific foundations of modern production; the formation of a system of polytechnical skills and practical mastering of the elements and objects of equipment and technology; development of creative abilities and technical thinking of schoolchildren; preparing students for work in the field of modern technology. In accordance with certain tasks, the content of polytechnic education is formed, which is implemented as an interrelated

activity of a teacher and a student. Moreover, the activity of the teacher, aimed at uncovering the physical foundations of modern production, involves guiding students' perception of polytechnic material considering the level of formation of skills and abilities, showing the practical application of the studied laws and theories in engineering. The student should not be a passive listener: his active cognitive-transformative, research and production, independent productive, exploratory, creative, research, labor activity are alleged.

The mechanism for implementing the principle of polytechnic education in the physics course includes:

- the study of the physical basis of the specific technical device;
- students' understanding of the technical principle underlying the design properties of the device;
- training in the ability to use specific technical devices that implement the studied physical and technical principle.

As a result of purposeful interrelated work of a teacher and a student, polytechnical knowledge and skills are formed based on the specified mechanism. The study showed that the use of specific methods and means of training, forms of organization of studies is ultimately predetermined by the goals and objectives of polytechnic education. Separate methods and means of instruction, forms of organization of studies are directed, as a rule, to the solution of one goal (task) of polytechnical training of students. Therefore, to solve the problem being studied as a whole, it is necessary to use a set of methods and means of training, forms of organization of studies.

Based on the analysis, we highlight the most significant features of the concept of polytechnic education:

- 1) the principle of the organization of training;
- 2) the principle of teaching;
- 3) the option of practical implementation of the idea of professional education;
- 4) education based on familiarity with the technique;
- 5) the principle of the formation of labor skills of students, etc.

In this regard, at the present stage of development of society, polytechnic education can be understood as education based on an acquaintance of students with the basics of modern production, teaching schoolchildren how to work with computers, as well as familiarizing them with the basics of mechanized and automated work.

As practice shows, the better polytechnic education is organized in school, the easier it is for students to choose the right path to the profession. Polytechnic education guarantees the professional interest of the younger generation is the basis of professional growth, and therefore significantly affects the social life of a person. (22) Thus, polytechnic education is the foundation of the professional training of the younger generation.

The requirement of modern production such as ensuring the maximum growth of human creative abilities implies the recognition as the leading function of polytechnic education the development of students' abilities necessary for their successful future work in various fields.

At the lessons of physics, biology, chemistry and other school disciplines, students can get acquainted with the scientific foundations of most industries, learn how the common technical devices work and how they are arranged. As practice shows, one of the tasks of polytechnic education is the formation and development of polytechnic skills (skills to work with devices, installations, etc.) in the course of a diverse physical experiment, laboratory work, and physical practice.

In physics classes, students acquire skills in working with various instruments and devices, learn how to adjust them, and identify deficiencies.

4 Conclusion

The developed methodology of polytechnic education at physics classes in secondary schools differs from the preceding ones by:

- the content of selected polytechnic material;
- consideration of individual technical objects and technological processes of modern industrial and agricultural production;
- consideration of the development of socio-economic and scientific-technical progress;
- the creation of a new methodical system for polytechnic training of schoolchildren;
- usage of the means and methods of active transformation of polytechnical knowledge in the process of their application in various situations.

Thus, the polytechnic education of students develops their conscious, creative approach to their activities in the field of engineering and technology, enriches the sphere of their social relations and provides the norms of conscious behavior, as well as a broad basis for the choice of a profession related to engineering. All this helps to determine their place in society in accordance with their abilities, which is a condition for the further formation of a comprehensively developed personality.

To date, several classification systems of polytechnic knowledge and skills have been defined in the scientific and pedagogical literature. But the complexity of the problem is mainly determined by the fact that many authors often use various specialized criteria as a classification basis. Considering the modern requirements for the school, the content and organization of labor polytechnic education, the further development of the content and methods of polytechnic education should, we believe, follow the path of identifying and studying the general fundamentals of modern production.

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