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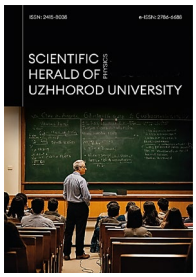

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Modernization of polytechnic physics education in the conditions of present-day production

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Abstract

Relevance. The paper reveals the prerequisites for the modernisation of the modern system of polytechnic education when teaching physics in secondary school at the present stage. The paper defines the principles of construction and the content of the modernised polytechnic material, on which the process of forming practical skills in physics is based in secondary school.

Purpose. The article reveals the pedagogical conditions that contribute to improving the effectiveness of polytechnic training and the choice of future professions related to technology, as well as the essence of the practical activity of a physics teacher in a modern school in the totality of its principles, forms and methods of working with students.

Methodology. The paper uses such research methods as the analysis of psychological and pedagogical, scientific and methodological, educational and methodical literature on the problem of polytechnic education; a systematic approach to the study of new equipment and production technologies; analysis of their work on the introduction of polytechnic materials developed by the authors into the educational process of secondary schools; conducting and processing the results of a pedagogical experiment; discussion of the results of research at methodological seminars, scientific and practical conferences.

Results. In the aspect of the main directions aimed at modernisation of polytechnic education, the analysis is given and recommendations are proposed for regular and extracurricular activities in physics, in particular, recommendations for lessons with applied material, as well as practical classes. This paper describes the introduction of modern means of

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quality control of education at all levels and stages of the polytechnic education system in the process of teaching physics in secondary school.

Conclusions. The article is of interest to scientists, practical teachers, as well as to everyone who takes part in the renewal of modern society. The article discusses the materials of the scientific project carried out at Kh. Dosmukhamedov Atyrau University.

Keywords: innovative approaches; teaching methods; secondary school students; field of technology; applied significance.

Introduction

The system of public education is systematically brought into line with the level of development of scientific and technological progress, with the requirements of life. Modern scientific and technological progress requires training highly qualified personnel in the Republic of Kazakhstan. Secondary school is the initial link in training such personnel, whose tasks are defined for the modern stage as to give each student a deep knowledge of the basics of sciences, establish a close connection between education and productive work, improve the preparation of young people for work in the field of material production, for a reasonable choice of profession. At the moment, an urgent task for school is to prepare students for life, work, introducing them to their future profession, along with providing a high level of general and polytechnic education. To this end, the content of education and teaching methods are being improved. Updating the content of education, increasing its scientific level is a significant contribution to polytechnic training. In solving these problems, physics occupies a leading place among the academic subjects of the natural science cycle. A significant part of modern technical achievements (new machines, mechanisms, installations, technological processes) is based on the success of physical science, in this regard, the role of physics significantly increase in the polytechnic training of schoolchildren.

An analysis of the polytechnic training of school graduates carried out within the framework of this study [1] showed that students often found it difficult to transfer polytechnic knowledge to various industrial situations, poorly use physical knowledge in explaining the essence of technology and technological processes. An analysis of teaching physics in secondary schools showed that the polytechnic and labour training of school graduates still did not meet modern requirements despite the increase in the general education and scientific level of the school course. According to the authors, this discrepancy is explained by a certain weakening of attention to polytechnic education and an underestimation in its implementation when studying the basics of sciences, in particular physics. When studying various sections of physics, it is necessary to show students the possibility of applying scientific knowledge. It is advisable to consider the connection of the physics course with polytechnic and labour training in three aspects: the formation of students' scientific worldview, mastering the basics of knowledge in physics, the formation of their creative attitude to work. Throughout the course of physics, students were introduced to various technical applications of physical laws and processes. There is no such field of technology where the achievements of physics would not be used, and students should know the applied meaning of each physical phenomenon known to them by the end of the physics course [1; 2].

The paper considers the principles of building a system of polytechnic knowledge and skills in the physics course to improve the quality of students' knowledge both when perceiving and studying and consolidating the material at various stages of a lesson. Thus, a physics lesson is to provide a high level of knowledge and purposeful education and development for each student. The relevance of the research is because the nature of the learning process should change to meet the public need for an increase in the scientific and technical level of readiness of students following the requirements of the implementation of the principle of polytechnism at the present stage, in particular, with the need to modernise polytechnic knowledge about the basics of production, using the main directions of technical progress for this. The purpose of the work is the modernisation of polytechnic education based on innovative technologies in the process of studying physics in modern secondary school. Following the goal, the research tasks are defined:

1. To determine the level of polytechnic training of students and the necessary steps to introduce new methodologies.

2. To identify a system of methodological techniques and tools that contribute to strengthening the polytechnic training of students in the process of studying the physical foundations of the main directions of scientific and technological progress, as well as to qualitatively and, if possible, quantitatively assess their impact on students' knowledge.

3. Experimentally test the effectiveness of the proposed methodology of polytechnic education in the process of teaching physics during experimental teaching in secondary school.

Practical significance of the paper:

- determination of the content and system of modernised polytechnic education in the process of teaching physics in secondary schools;
- development of a modernised methodological system model of polytechnic education in teaching the physical foundations of modern production;
- introduction of methodological guidelines for the modernisation of polytechnic training of students in teaching physics.

Mastering the system of knowledge about the scientific foundations of modern technology and production by schoolchildren is one of the main tasks of the polytechnic principle. This system contains general scientific, technical-industrial, socio-economic knowledge and corresponding skills. Some scientific works and articles concern the issues of the polytechnic principle of teaching

physics, for example, by A. I. Bugaev [3], V. G. Razumovsky [4], A. G. Glazunova [5], E. V. Korshaka [6], M. I. Shut [7] and other authors, and pay attention to the principle of polytechnism in the course of physics. In the works of Kazakh scientists A. E. Abylkasymova [8], E. A. Almukhametova [9], A. P. Seiteshova [10] reflect some issues of polytechnic training of students. Assessing the importance of polytechnic education, P. R. Atutov [2] notes that scientific, technical and social progress places high demands on the polytechnic training of young people in Kazakhstan. This is due to the tasks of educating a fully developed personality and preparing it for work in the field of modern technology. A. I. Bugayev [3] notes that polytechnic education acts both as one of the goals of training and as an important factor in improving the quality of knowledge in teaching physics. Polytechnic education contributes not only to professional mobility but also to the development of spiritual forces and abilities of students, the formation of their scientific worldview, moral ideals, creative attitude to work, etc.

Materials and Methods

The development and introduction of a scientifically based methodological system of teaching physics into the educational process, which is based on the polytechnic principle, reflecting the applied orientation of training, will lead to an increase in the quality of the polytechnic training of students, in particular, it will contribute to improving the level of practical training of students and the formation of their polytechnic skills. Following a certain goal, the content, means, methods and forms of polytechnic education, represent a single whole at each stage, links are established between the joint activities of teachers and students. The paper attempts to study in detail the ways and means of polytechnic knowledge and skills modernisation in the process of studying physics in the light of the requirements of the modern scientific and technological revolution [11; 12].

The analysis of methodological recommendations showed on the study of the most important areas of scientific and technological progress in physics lessons that they provided valuable material that could be used by the teacher when covering various topics for the purpose of polytechnic education of workers. In the methodology, the issue of the formation of polytechnic knowledge and skills is not highlighted with sufficient completeness. The methodological literature indicates that physics, being the basis of modern technology,will penetrate deeply into various fields of technology and production in its further development . Concretising this general position, the authors emphasise that the content of the physics course provides ample opportunities for students to familiarise themselves with the physical basics of the main branches of production.

Many researchers, authors of methodological manuals agree that the formation of polytechnic skills and abilities is primarily a methodological problem. Creative searches of methodologists, practical teachers and researchers are aimed at solving this problem, searching for new, optimal ways of forming skills and abilities. The main directions of solving the problem of polytechnic education are laid down in the radical improvement of the organization, content, methods and quality of polytechnic education, in the approval, both in theory and in practice, of a unified system of teaching and educating students. To this end, it is proposed to develop more widely and boldly and use more effectively a variety of ways, forms and methods of involving students in productive work at all levels of education [12; 13]. The paper uses the materials of the scientific project carried out at Kh. Dosmukhamedov Atyrau University.

The paper uses such research methods as the analysis of psychological and pedagogical, scientific and methodological, educational and methodical literature on the problem of polytechnic education; a systematic approach to the study of new equipment and production technologies; analysis of their work on the introduction of polytechnic materials developed by the authors into the educational process of secondary schools; conducting and processing the results of a pedagogical experiment; discussion of the results of research at methodological seminars, scientific and practical conferences. The methodological basis of the work consists of the provisions of modern science on the dialectical relationship of theory and practice in the development of personality, the theory of cognition, the theory of personality-oriented organization of the educational process, as well as the works of teachers, psychologists and methodologists on the problem of research. The scientific novelty of the work is that:

– the scientific and methodological foundations are determined of polytechnic education at the present stage in the study of physics in secondary school;

– the approximate modernisation of polytechnic education is proposed, the system of polytechnic knowledge and skills is developed and justified in the process of studying physics in secondary school;

– a methodological system was developed of polytechnic training of students in the study of electrodynamics and quantum physics in secondary school.

Results and Discussion

Giving a modern physics lesson is connected with the choice of teaching methods that meet the tasks of polytechnic education. The effectiveness of the lesson is maximum in cases when the teacher determines the tasks in direct correlation with the cognitive activity of students in the planning stages. During a physics lesson, students must switch from one type of activity to another (for example, taking notes of a lecture and working with a textbook, watching a video and participating in a conversation, solving problems). In the educational process, it is necessary to introduce teaching methods that activate the mental activity of schoolchildren, develop creative abilities, skills and skills of independent acquisition of new knowledge. First of all, it is necessary to include solutions to quantitative and qualitative problems. This method is a way of transmitting information by the teacher and assimilating it by students, a way of organising the cognitive activity of students, ensuring the mastery of knowledge, methods and techniques.

For the polytechnic orientation, tasks with industrial and technical content are of great importance; these are tasks that reflect the general principles of the design and operation of various installations and machines, individual

branches of industrial production. Taking into account the modern requirements for school, the content and organisation of polytechnic education, the further development of the content and methodology of polytechnic education should include, according to the authors, highlighting and studying the general foundations of modern production. As the research and the conducted experimental work have shown, in the process of teaching physics, a set of didactic tools should be used, including generalized schemes for studying polytechnic material in the physics course; intersubject connections in the sections “Quantum Physics", "Electrodynamics"; various educational tasks of a polytechnic nature; a system of polytechnic knowledge and skills in the sections of the physics course in secondary school. So, the analysis of educational papers, methodological manuals and recommendations showed that the issues of polytechnic education modernisation are not sufficiently reflected in pedagogical research and methodological recommendations concerning physics in secondary school [14-17]. Thus, this problem becomes the central task of improving secondary schools, taking into account the prospects for accelerating socio-economic and scientific and technological progress.

The system of polytechnic education of schoolchildren has now mostly developed, but it should be improved, and first of all by strengthening the polytechnic and practical orientation of teaching all academic subjects. To date, some theoretical problems of polytechnic education have been developed, but at the same time, there are still unresolved issues that require special attention and research. Polytechnism in the process of studying the basics of electrodynamics and quantum physics is one of them, which is highlighted by the authors for research. The content and process of polytechnic education are being modernized under the influence of the scientific and technical revolution. The authors believe that it is very important to proceed from the prospects for the development of the scientific and technical revolution for the modernisation of polytechnic education and the ways of its implementation in the process of teaching physics.

The modern stage of scientific and technological revolution is distinguished, first, by the technology of processing natural materials supplemented by fundamentally new material technologies ¬at the molecular level, the laws of atomic and nuclear physics, quantum mechanics and relativistic mechanics, the laws of molecular genetics, optoelectronics, nanotechnology, informology etc., i.e., drawing on ideas, concepts, theories, and laws, primarily components of the quantum-field picture of the world [18; 19]. Second, if mechanical engineering was the main industry in the initial stage of the scientific and technical revolution, automated based on microelectronics and computer technology, now it is microelectronics and computer technology itself in all its varieties: computers, computer networks and systems, global international networks and other means of computer science, telematics and telenetics [20]. Third, the informatisation of society has dramatically increased, the computer science industry and new information technologies have appeared. Fourth, there was an integration of science and production, science has become a direct productive force, and in the information paradigm, it is now considered as a system of accumulation, storage and processing of information, its analysis with the development of norms and rules of selection; as a system of creating methods and methodologies for modelling [21-23]. Now science is considered as one of the communicative systems and models [1; 15].

In school, the effectiveness of polytechnic education courses is determined by the optimal applied material, classified according to its physical content. When studying electrodynamics, the content of the polytechnic material should be determined mainly by two directions of technical progress: production, transmission, and use of electricity in production automation [24; 25]. In this section, students get acquainted with the achievements in such areas of physics as new materials, for example, ferrites, superconductors, new methods of energy conversion, in particular, magnetohydrodynamic generators. In the course of the study, the following criteria were identified to select the applied material of the course “Electrodynamics”:

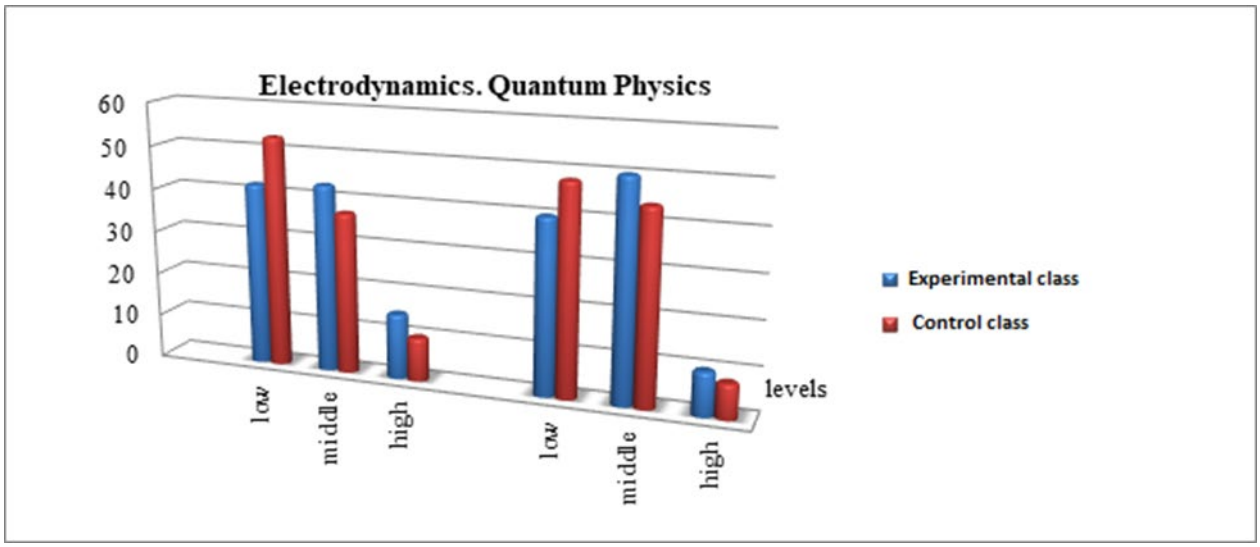
- reflection of the physical foundations of the most important areas of scientific and technological progress in the educational material, the most common and promising technologies, equipment and production;
- an organic combination of applied issues with the programme and theoretical material of the electrodynamics course;
- development of students' technical thinking.

The specified criteria for the selection of the material should be applied in a close relationship. This does not mean that the level of polytechnicity of the material meets all the requirements at the same time in the section “Electrodynamics”. It is necessary to search for the most optimal selection of polytechnic material. The implementation of the principles of polytechnism should be carried out throughout the study of the entire section. Based on these criteria, the applied material was selected for the course of electrodynamics and quantum physics. The section "Electrodynamics" is the theoretical foundation of such technical sciences as electrical engineering, radio engineering, and many sections of automation [26; 27]. The issues of electricity and magnetism are considered more from the polytechnic side, as applied in life and technology. In the course of electrodynamics, the issues of transmission and use of electricity are considered. A number of issues related to the loss of electricity in the wires can be calculated based on the knowledge of students on the topic “Laws of direct current”. Studying electrical phenomena, schoolchildren get acquainted with the wide introduction of electric energy into the economy and everyday life. Basically, the phenomena and laws are studied that make up the physical foundations of electrification. It is necessary to tell about the use of powerful beams for melting and cutting metals, the device of a cathode ray tube [28]. The study of superconductivity will introduce students to the application of this phenomenon in science and technology, it is necessary to highlight one of the problems of energy related to the use of superconductivity to prevent losses in electric power transmission lines [29-31]. When studying plasma, one can pay attention to the construction of the world's first pilot-industrial magnetohydrodynamic power plant with a capacity of 580 MW. Electric energy should

be obtained using plasma during the operation of a magneto hydrodynamic power plant [32].

Polytechnic training is carried out when studying all sections of the school physics course, among which the corresponding place is occupied by the section “Quantum Physics”. To ensure the polytechnic orientation of the study of physics in secondary school, it is important to bring the content of education in line with the level of development of modern science and technology. Therefore, the study of the section "Quantum Physics" should also provide for the disclosure of the latest achievements of science in this field to students, familiarizing them with the features of the wide practical application of these laws. Knowledge about technology, technology in production, where quantum laws are applied, forms a system of polytechnic knowledge in quantum physics in high school [33-35]. The school physics course, including the sections “Optics” and “Quantum Physics”, provides great opportunities in strengthening these sections with applied material no lower than the sections of mechanics, molecular physics, electrodynamics. In the section "Quantum Physics", the content and methods of studying the basics of using solar radiation energy and the nuclear industry are developed to varying degrees [12; 16; 36].

But, nevertheless, solar energy with its constant renewability and exceptional “purity” in use has begun to arouse more and more interest among people [37; 38]. Therefore, the paper offers material for familiarizing students with the principles of operation of a solar battery and a solar thermal power plant. Developed by the authors on the basis of research data (questionnaires, study of experience, conversations with students and teachers, etc.) and applied general criteria for assessing the levels of polytechnic education of students were experimentally tested in schools in the region. Based on the analysis of the results of the ascertaining experiment, the article concludes that the knowledge of students of a polytechnic nature requires the modernisation of polytechnic education in accordance with the modern development of production and economy (Figure 1). The levels of polytechnic training of students in the process of studying physics are presented in the form of Figure 1.



During the training experiment, the recommended method was tested in the process of studying the sections "Electrodynamics", "Quantum Physics". The evaluation of the results of experimental training was carried out based on a quantitative and qualitative analysis of the results of students' tests. During the experimental training, the influence of the polytechnic orientation of the study of “Electrodynamics” and “Quantum Physics” was checked on the quality of students ' knowledge and skills. The reliability of the obtained results was checked by calculating the criterion χ^2 /Chi-square/. As a null hypothesis, the authors suggested that the experimental method of knowledge formation contributes to a better assimilation of the polytechnic material of the physics course, that is, students of experimental classes have a higher level of knowledge and skills formation than students of control classes [1; 17]. Let us check the null hypothesis H_0: $P_i = P_{2i}$ for all 3 categories /i.e. $P_{Ii} = P_{2i}$ $P_{I2} = P_2$ $P_{I3} = P_{23}$/. Where P_{Ii} is the probability of completing the tasks by students of experimental classes in the i category; P_{2i} is the probability of completing the tasks by students of control classes in the i category. Alternative hypothesis H_0: $P_i = P_{2i}$ for at least one of the three categories. The value of the statistical criterion was calculated using the formula 1 for each element of knowledge.

$$T_{obs.} = \frac{I}{n_I \cdot n_2} \sum_{i-I}^{c} \frac{(n_I \cdot Q_{2i} - n_2 Q_{Ii})^2}{Q_{Ii} + Q_{2i}} \qquad (1)$$

We will analyыe the results of tests that check the depth and strength of assimilation of selected topics in electrodynamics and quantum physics.

Topic 1. Electrical capacity. Condensers

The polytechnic awareness was checked by the control questions:

1. What is the phenomenon of electrostatic induction?
2. Define the electrical capacity. Print the formula of the electric capacity of a flat capacitor.
3. What is the principle of operation of the capacitor?
4. The plates of a flat air-charged capacitor are attracted with power F. Will this power change if the

dielectric plates are inserted into the air gap between the capacitor plates?

5. Tell us about the use of capacitors in engineering.

6. When a battery, consisting of 20 identical capacitors connected in parallel, was discharged, 10 J of heat was released. The capacity of each capacitor is 4 uF. Determine to what potential difference the capacitors were charged.

Table 1 shows the results of the test on this topic.

Table 1. The level of students' knowledge and skills in the experimental and control classes on Electrical Capacity. Condensers

Sample type	Levels		
	high	average	low
Sample (e) n_1=810	Q_{11}=273	Q_{12}=408	Q_{13}=129
Sample (k) n_2=795	Q_{21}=111	Q_{22}=318	Q_{23}=366

$$T_{obs.}=\frac{1}{810\cdot795}\left[\frac{(810\cdot111-795\cdot273)^2}{273+111}+\frac{(810\cdot318-795\cdot408)^2}{408+318}+\frac{(810\cdot366-795\cdot129)^2}{366+129}\right]=192.85. \quad (2)$$

The inequality is fulfilled:

$$T_{obs.}>>T_{crit.}\ |192.851>>5.911|, \quad (3)$$

that is, the null hypothesis is rejected and an alternative one is accepted: the students of the experimental classes coped with the proposed tests, which is determined by the positive impact on the depth and strength of mastering the polytechnic material on the chosen topic.

Topic 2. Magnetic field and electromagnetic induction

1. Discover the physical meaning of the phenomenon of electromagnetic induction.

2. Explain the effect of the magnetic field on a current-carrying conductor, on a current-carrying frame, the magnetic interaction of currents.

3. How does an electromagnetic relay work? What is the difference between an electrodynamic relay and a magnetoelectric one?

4. A car frame and wheel axles make a closed loop circuit. Is a current induced in it when the car moves?

5. Explain the principle of operation of measuring devices of a magnetoelectric system.

6. Tell us about the use of electromagnetic induction in engineering (a generator with a rotating inductor, an induction furnace).

Table 2 shows the distribution of grades of students in the experimental and control classes for answers to the above test.

Table 2. Levels of students' knowledge and skills in the experimental and control classes on the topic “Magnetic field and electromagnetic induction”

Sample type	Levels		
	high	average	low
Sample (e) n_1=795	Q_{11}=214	Q_{12}=467	Q_{13}=114
Sample (k) n_2=784	Q_{21}=86	Q_{22}=352	Q_{23}=346

$$T_{obs.}=\frac{1}{795\cdot784}\left[\frac{(795\cdot86-784\cdot214)^2}{86+214}+\frac{(795\cdot352-784\cdot467)^2}{352+467}+\frac{(795\cdot346-784\cdot114)^2}{114+346}\right]=187.714. \quad (4)$$

$$T_{obs.}>>T_{crit.}\ (187.714>>5.991). \quad (5)$$

Hypothesis H_0 is rejected, that is, an alternative hypothesis is valid. This means that the proposed methodological system of polytechnic training of students contributes to improving their knowledge of electromagnetic induction, the magnetic properties of substances used in modern technology.

Topic 3. Electric current in semiconductors

1. List the main properties of semiconductors. What is the role of diffusion in the operation of semiconductors?

2. Draw a diagram of a vacuum diode and explain how it works.

3. Explain how you can experimentally find the characteristic of a vacuum diode.

4. How does a resistance thermometer work and what is the principle of operation?

5. Draw a diagram of a photo relay and explain its operation.

6. What is a thermistor? What are thermistors used for?

The results of the test are shown in Table 3.

Table 3. Levels of students' knowledge and skills in the experimental and control classes on the topic "Electric current in semiconductors”

Sample type	Levels		
	high	average	low
Sample (e) n_1=908	Q_{11}=283	Q_{12}=535	Q_{13}=90
Sample (k) n_2=890	Q_{21}=133	Q_{22}=418	Q_{23}=339

$$T_{obs.}=\frac{1}{908\cdot890}\left[\frac{(908\cdot133-890\cdot283)^2}{283+133}+\frac{(908\cdot418-890\cdot535)^2}{418+535}+\frac{(908\cdot339-890\cdot90)^2}{90+339}\right]=212.822. \quad 6$$

$$T_{obs.}>>T_{crit.}\ (212.822>>5.991). \quad (7)$$

It can be seen from the inequality that the hypothesis is correct. This gives reason to believe that the students in the experimental classes have better mastered the polytechnic material on this topic, their knowledge has become more solid and deep.

Topic 4. Electromagnetic waves

1. What are the main properties and characteristics of electromagnetic waves?

2. Using the scale of electromagnetic waves, describe the types of electromagnetic radiation.

3. Name the sources of X-ray radiation. List the properties and applications of X-ray radiation.

4. Draw a block diagram of a TV transmitter and explain its operation.

5. What is the principle of radar? What properties of electromagnetic waves are used in this case?

6. Draw a diagram of a device for amplitude modulation. Explain the action of each element of this scheme. What elements can be used to obtain undamped high-frequency vibrations?

Table 4 shows the distribution of students in the experimental and control classes by the quality of knowledge.

Table 4. Levels of students' knowledge and skills in the experimental and control classes on the topic "Electromagnetic waves"

Sample type	Levels		
	high	average	low
Sample (e) n_1=856	Q_{11}=257	Q_{12}=479	Q_{13}=120
Sample (k) n_2=807	Q_{21}=105	Q_{22}=339	Q_{23}=363

$$T_{obs.}=\frac{1}{856\cdot807}\left[\frac{(856\cdot105-807\cdot257)^2}{105+257}+\frac{(856\cdot339-807\cdot479)^2}{339+479}-\frac{(856\cdot363-807\cdot120)^2}{120+363}\right]=208.782. \quad (8)$$

Because

$$T_{obs.}>>T_{crit.}\ (208.782>>5.991), \quad (9)$$

then the null hypothesis is rejected and an alternative one is applied. This confirms the advantage of the proposed content and methodology of polytechnic education on the tested topic of the course of electrodynamics, that is, a sufficient number of correct answers of students of the experimental classes.

Topic 5. Photoelectric effect and its application in engineering

1. List and explain the main laws of the photoelectric effect. Draw a diagram of an experiment, which allows you to establish the laws of the photoelectric effect.

2. Draw one of the possible schemes of an automatic machine containing a photocell, using which it would be possible to turn off (turn on) an electric drive when the photocell is illuminated.

3. Draw a graph of the dependence of a photocurrent on the voltage between the electrodes of a vacuum tube. What is the value of the delay voltage and what does it depend on?

4. What is induced radiation? Discover the physical meaning of the concept of "induced radiation".

5. What is the general operation scheme of a laser? What modes does it work in? What are the main directions in the use of lasers?

6. Calculate the wavelength of the light that illuminates a metal surface, if the photoelectrons have a kinetic energy of 4.5*10-20 J. The work of the electron output from the metal is 7.5*10-18 J.

Below is the level of students' polytechnic knowledge and skills in the process of studying quantum physics in secondary schools (Table 5).

Table 5 Level of students' polytechnic knowledge and skills on the topic "Photoelectric effect and its application in technology"

Sample type	Levels		
	high	average	low
Sample (e) n_1=924	Q_{11}=259	Q_{12}=582	Q_{13}=83
Sample (k) n_2=916	Q_{21}=110	Q_{22}=467	Q_{23}=339

$$T_{obs.}=\frac{1}{924\cdot916}\left[\frac{(924\cdot110-916\cdot259)^2}{110+259}+\frac{(924\cdot467-916\cdot582)^2}{467+582}+\frac{(924\cdot339-916\cdot83)^2}{339+83}\right]=228.061. \quad (10)$$

$$T_{obs.}>>T_{crit.}\ (228.061>>5.991). \quad (11)$$

It can be seen from the inequality that the hypothesis is correct. The obtained data indicate that the level of polytechnic knowledge and skills in the experimental classes is higher than in the control ones [15; 18; 39]. This gives grounds to assert that the high quality of students' knowledge in the experimental classes contributes to an increase in the level of knowledge and skills when considering the laws of the photoelectric effect. We present the data of static processing of the results obtained in the control and experimental classes (Figure 2).

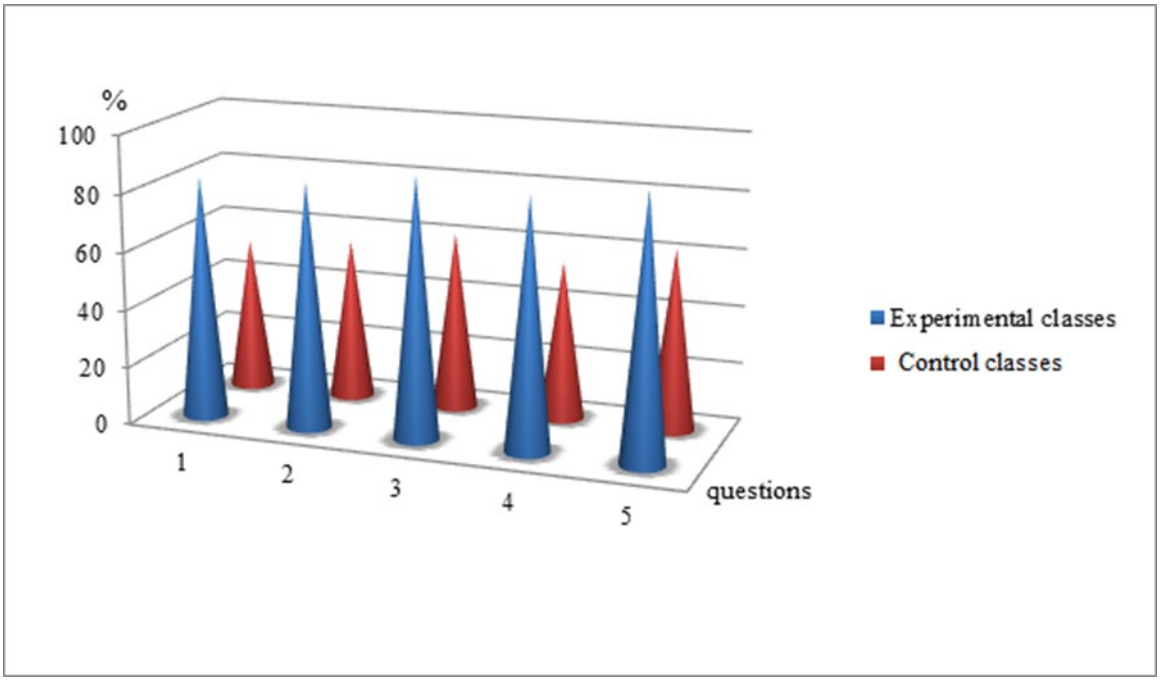


Figure 2. Indicators of mastering the polytechnic material on selected topics of the physics course in the experimental and control classes

As can be seen from Figure 2, the students of the experimental class most successfully mastered the polytechnic material on the use of the photoelectric effect (91%), semiconductors (90%), and 63% and 60% in the control classes, respectively. Students know the properties of electromagnetic waves (86% in the experimental and 55% in the control classes), can explain the phenomenon of electromagnetic induction and its application in engineering (85% in the experimental and 56% in the control classes). The data from Figure 2 show that the levels of polytechnic training of students are higher in the experimental classes than those of the control classes. This is because the proposed modernised polytechnic material of the courses of electrodynamics and quantum physics turned out to be accessible to the understanding of students and is assimilated by them at a high level.

Conclusions

1. The content is determined for strengthening the polytechnic orientation of teaching physics following the requirements of modern production.

2. The modernised polytechnic education of students develops a conscious, creative approach to their activities in the field of technology and technology, enriches the sphere of their social relations and provides norms of conscious behaviour, as well as a broad basis for choosing a profession related to technology.

3. The pedagogical possibilities of the physics course in the polytechnic education of schoolchildren will be most effective when the nature of tasks for schoolchildren is systematic and has different directions, and the stages of mastering technical knowledge and skills by students are observed.

4. The methodological recommendations developed by the authors to study physical and technical materials based on the modernisation of education contribute to improving the level of polytechnic training of schoolchildren.

Based on the answers of the students, it was found that they can apply knowledge to explain the physical foundations of creating new materials with specified properties, electric power, microelectronics and production automation. The students acquired the skills of describing physical phenomena and patterns in modern technology, performing tests and solving problems of polytechnic content. The students of the control classes did not fully answer the questions posed, they could not reveal the technical application of physical phenomena and laws. The explanation of the physical foundations of important areas of scientific and technological progress caused special difficulties for students of control classes. The proposed modernised polytechnic material of the courses of electrodynamics and quantum physics turned out to be accessible to the understanding of students and is assimilated by them at a high level. This study was conducted on the example of electrodynamics and quantum physics, but, according to the authors, the method of modernisation of polytechnic education in the physics course developed by the authors can be applied to solving the issues of polytechnic training of students both in other sections of physics and in any subject of the natural-mathematical cycle.

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Conflict of Interest

None.

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Модернізація політехнічної фізичної освіти в умовах сучасного виробництва

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Анотація

Актуальність. У статті розкриваються передумови модернізації сучасної системи політехнічної освіти при навчанні фізики в середній школі на сучасному етапі. Визначено принципи побудови та зміст модернізованого політехнічного матеріалу, на якому базується процес формування практичних умінь і навичок з фізики в середній школі.

Мета. Розкрити педагогічні умови, що сприяють підвищенню ефективності політехнічної підготовки та вибору майбутніх професій, пов'язаних з технікою, а також сутність практичної діяльності вчителя фізики в сучасній школі в сукупності її принципів, форм і методів роботи з учнями.

Методологія. У роботі використано такі методи дослідження, як аналіз психолого-педагогічної, науково-методичної, навчально-методичної літератури з проблеми політехнічної освіти; системний підхід до вивчення нової техніки і технологій виробництва; аналіз роботи з впровадження розроблених авторами політехнічних матеріалів у навчальний процес загальноосвітніх шкіл; проведення та обробка результатів педагогічного експерименту; обговорення результатів дослідження на методичних семінарах, науково-практичних конференціях.

Результати. В аспекті основних напрямів модернізації політехнічної освіти проаналізовано та запропоновано рекомендації щодо проведення урочної та позаурочної роботи з фізики, зокрема, рекомендації щодо проведення уроків з прикладним матеріалом, а також практичних занять. Описано впровадження сучасних засобів контролю якості освіти на всіх рівнях і етапах системи політехнічної освіти в процес навчання фізики в середній школі.

Висновки. Стаття становить інтерес для науковців, вчителів-практиків, а також для всіх, хто бере участь в оновленні сучасного суспільства. У статті розглядаються матеріали наукового проекту, виконаного в ХНУ імені Тараса Шевченка. Досмухамедова в Атирауському університеті.

Ключові слова: інноваційні підходи; методи навчання; учні середньої школи; технологічна галузь; прикладне значення.