CONTENT OF PROFESSIONALLY ORIENTED TRAINING IN COURSE OF PHYSICS FOR STUDENTS OF AGRICULTURAL ENGINEERING SPECIALTIES

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Abstract. The technology of professionally oriented education requires fundamental changes in the organization, content and methods of the educational process. This is, first of all, the transfer of emphasis of theoretical training to theoretical and applied, professionally oriented training. On the scientific and methodological level, the relevance of this investigation is determined by the need to design the process of forming professional competence and to identify didactic conditions that contribute to its efficient implementation. The purpose of this study is the problem of forming professional competence of the future engineers in the process of teaching a physics course. As a result of the investigation the efficiency of the proposed methodology for the formation of professional competence of the future agricultural engineers was scientifically substantiated and experimentally verified. A comparative analysis of the results of the study in the reference and the experimental group showed that the quantitative indicators and qualitative characteristics of the levels of formation of the components of the readiness of the future agricultural engineer to implement professionally oriented training in the experimental groups increased significantly compared to the reference group. In the experimental groups the number of students with a low level of knowledge decreased by 48% and increased with an average of ≈ 29% and sufficient by 18.5%. The positive dynamics of the level of knowledge revealed as a result of experimental verification gives reason to assert the efficiency of the proposed organizational and pedagogical conditions of this methodology for the implementation of professionally oriented education in the course of physics.

Keywords: competence, physics, professional orientation, agricultural engineer.

Introduction

One of the central trends in the didactic system of higher education is the problem how professional orientation of education is solved at pedagogical educational institutions. The Covid-19 pandemic has become one of the most significant events, affecting the largest number of countries around the world at the same time. Governments have imposed school closures and lockdowns of cities and other areas to prevent the spread of the virus. Students were required to learn through online platforms, designed to improve lifelong learning [1]. At higher educational institutions of Ukraine this problem is also developing, especially in the recent years. The task of higher education in all European countries, and especially in Ukraine, is persistent demanded for radical improvement in the professional training of specialists with higher agrarian and technical education. The specificity of education at higher agrarian and technical educational institutions lies in the fact that, in addition to the natural science disciplines, cycles of professional and practical training disciplines are studied, so the learning process should be carried out on the basis of interdisciplinary links between the natural science disciplines and the general technical and professional disciplines, without which knowledge and skills are impossible.

In this regard, the place of physical science as a direct production force of society, which directly or through a number of intermediate links affects all branches of material production, and primarily the development of such sectors as agriculture and energy, is becoming more and more significant. The scientific and technological progress implies raising the technical level of production through the development and improvement of agricultural tools, technological processes, control systems, based on the use of the achievements of science and, above all, physics.

The problem of the methodology of studying physics is given great attention in the studies of psychologists, didacts, methodologists (S.L. Rubinshtein, N.O. Menchinskaya, K.O. Slavskaya, Z.I. Kalmikova, E.O. Fleshner, V.A. Krutetsky , E.M. Kabanova-Meller, L.M. Landa, G.S. Kostyuk).

Scientific works on the specifics of implementation of professional training in the educational process are published by such researchers as E. Ari, F. Vatansever, A. Uzun, S. Loucks-Horsley, K. E. Stiles, S. Mundry, N. Love, P. Hewson, H. Mizell, M. Mulder, S. Sandhu, T. Afifi, F. Amara and others.

Many works deal with the professional orientation of the young people. For example, N. Miloradova and E. Savina [2] study the problem of professional orientation of an individuality; in particular, formation of the impact of conditions and factors upon the professional personality of the future builder

and architect. Hui Li [3], and Ricardo Rodrigues, et al. [2] draw attention to the relationship between professional orientation and personal effectiveness.

Professional orientation are tendencies and models of behaviour that express a person's desire to pursue or apply oneself to a certain profession; and together these orientations influence the decision-making process regarding the choice of a profession [5]. Valerie A. Johnson et al. [6] note a characteristic motivational process that links interests with behavioural results; therefore, the students, who are interested in the profession, showed better academic performance. Thus, professional orientation is considered as one of the decisive factors that determine a person's choice. In addition, it is perceived as an indicator of the degree of democracy and freedom of the individual that depends on his or her professional career and, ultimately, on his or her future [7; 8]. As a result of the important role played by the university environment, the higher education institutions should provide programs, aimed at shaping students' professional orientation and developing their administrative skills [9; 10].

There are many investigations that deal with the relationship between the career orientation and the specifics of learning, such as multiple intelligences, personality traits, academic achievements, academic specialization, creative abilities, and cognitive style in samples of the high school students and students [11-17]. Analysis of the source base of the study made it possible to identify the contradictions that appear between the modern requirements of the state regulatory documents of Ukraine in the field of higher education to the quality of training of the agricultural engineers and the real state; between the high scientific and methodological potential of the physical science and its use in the system of training agricultural engineers, lack of clear methodological recommendations regarding the ways and methods of implementing professionally oriented teaching of physics to the students of the corresponding profile.

In this regard, the problem of better training of the future agroengineers is becoming relevant, requiring clarification of the content, and improvement of the quality of teaching physics, ensuring its professional and practical orientation, the use of such methods and teaching aids that contribute to firm assimilation of knowledge, formation of skills, and intellectual development of the personality.

Material and methods

The basis of the study is theoretical (comparative analysis of scientific, methodological and pedagogical literature) and empirical (observation, analysis and generalization of pedagogical learning experience) methods. Professional orientation is the main criterion for professional training, and it is the main indicator of the efficiency of functioning of the pedagogical system, the main condition for productive training of a specialist. In scientific research, professional orientation of the students is understood as "an integral dynamic property of a personality that characterizes the conscious attitude of a given person to the chosen profession and affects the preparation for professional activity" [16; 17]. The framework around which you need to form a system of engineering knowledge is the future profession. Under the conditions of higher agrarian and technical education one of the main tasks is to establish links between the professional-technical and general education. The organic combination of general and professional education constitutes a reliable foundation for the implementation of the principle of professional orientation. First, to solve this problem, it is necessary to conduct a detailed analysis of the relationship between the course of physics and the main general technical and professional disciplines. First of all, this will make it possible to determine what physical knowledge, skills and abilities will be required in the further study of professional disciplines, and secondly, it will most skilfully use the examples of agricultural content in the physics classes, related to the future professional activities of the students.

Analysis of the curricula and content of the academic disciplines made it possible to reveal the links between teaching the students in physics and their professional training. Fig. 1 shows the relationship between physics and the disciplines of the natural science cycle, general technical and disciplines of professional and practical training. Therefore, in our opinion, for the future engineer it is important not so much to get acquainted with various physical processes and phenomena in a descriptive way but to master the hierarchy of scientific concepts, ideas, laws, theories that allow them to be effectively used in specific professional situations.

Taking into account the peculiarities of training engineers in different areas, the content of the physics course may be considered as follows:

1. Consideration in the lecture course of examples that are related to the objects and technologies of future professional activity;
2. The choice of problems of a physical workshop, taking into account algorithms for unleashing specific problems, both from different sections of physics, and applied problems of a future specialty [18];
3. Laboratory work both on instruments, traditional for a physics course, and on professional ones.

To build the content of the lecture material, one should be guided by the following algorithm:

1. Select agricultural objects and technological processes with which the future specialist will have to work.
2. Select those technological operations and agricultural processes for which the laws of physics are used (ploughs, harrows, cultivators, a seeder moves rectilinearly and progressively across the field; oscillatory movements are made by fan blades, gear wheels, pulleys, wheels, a drum, augers, etc.).
3. Select professionally directed material in such a way that it clearly highlights the laws of physics, that is, to most fully reveal the possibilities of applying a particular law or phenomenon.
4. Select professionally directed material, not allowing it to obscure the material of the physics course, but be an auxiliary link for explaining the laws and phenomena; that is, the applied material must be closely related to physical theories.

For example, when studying the topic "Kinematics", when using professional objects related to the future professional activities, it is advisable to show that, when solving engineering problems, it is necessary to determine a mechanical system (for example, a combine, a tool, fasteners). It should also be emphasized that in agriculture determination of the trajectory of the movement is an important scientific-research, calculatory-design and calculatory-practical issue. Select objects and show where linear and angular speeds are taken into account (during the movement of the drums, sorting and other grain cleaning machines, etc.), associate this movement with a coordinate system.

In the lecture course, in addition to the presentation of the educational material, the student is oriented in the main directions of his future professional activity; they create setting to design the laws of physics for the tasks that are associated with the future professional activity. At the same time in some cases, the students are shown ways and means how to solve such problems; in other cases, they pose a problem, the solution of which is found in the process of independent work. The tasks for independent work are formed as complex tasks on professional objects, in which different physical problems and theories interact in professional objects, defining a physical but at the same time agricultural theory and technology.

The theoretical presentation of the material can be illustrated not only by abstract schemes, but also by technical ones; for example, the movement of not just a material point in a straight line, but a point that is located on a part of the revolving drum of some device of an agricultural machine [18].

The cutting drum of the KDU-2 "Ukrainka" crusher makes 600 min^{-1}, and the crushing drum – 2920 min^{-1}. How many times do their angular velocities differ?

For lectures it is advisable to offer, for example, such tasks that will be dealt with in practical and individual classes with the students:

1. Explain why in the first gear the crankshaft of the tractor engine makes the highest number of revolutions (the engine is fully loaded), while the tractor speed is the lowest.
2. The tractor moves uniformly and straight across the field. Are all the parts of the tractor moving by inertia?
3. Why the grain with high humidity, poured into the pile, can be heated up to 50ºC.
4. Why do ploughing and harrowing reduce the thermal conductivity and heat capacity of the soil?
5. Why does the car pump heat up when it pumps air into the tires?
6. It is known that elongated grains are electrified more than shortened or spherical ones, and a grain mixture, placed in the electric field, is oriented along the field lines of force. Explain these phenomena.

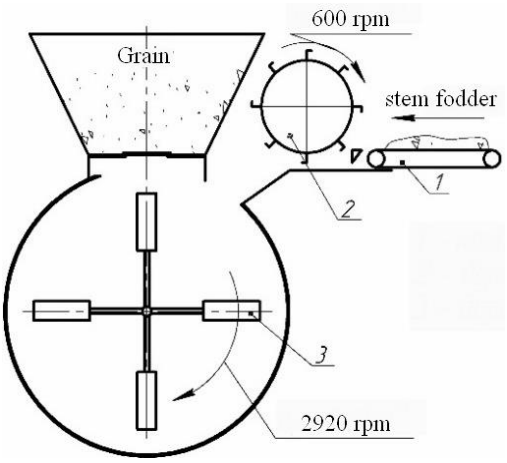

Fig. 1. **Crusher KDU-2 "Ukrainka":** 1 – conveyor; 2 – cutting drum; 3 – crushing drum

Physics is a natural science; therefore, one of the conditions for successful formation of physical concepts and theories is a system of rationally selected and skilfully delivered educational experiment.

The main task of a physical workshop in a higher agrarian and technical educational institution is to apply the acquired knowledge and methods of conducting an experiment in scientific and technical practice. In our opinion, for this, the students should learn to predict, put forward hypotheses, conduct experiments to test them, generalize and evaluate research results [16]. Part of the work of the laboratory workshop we perform according to the traditional scheme, part - using computer simulation. The combination of a traditional workshop with a computer one was fruitful. We have developed a technique for combining the traditional workshop with a computer one, which made it possible to expand significantly the limits of knowledge. For example, while explaining the structure and principle of operation of the internal combustion engine, the students were given a task to decompose the applied efforts into components in the piston engine. This work is carried out using the animation below (Fig. 2).

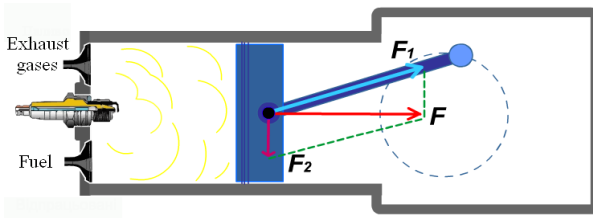

Fig. 2. **Demonstration of the decomposition of forces in a piston engine**

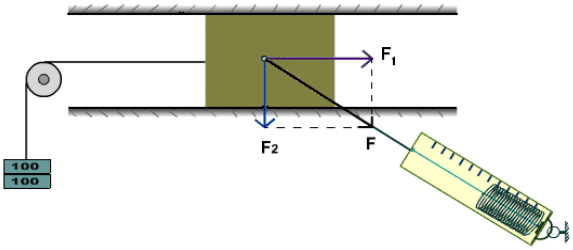

Fig. 3. **Demonstration of the forces that act upon the slider**

An analogue of this task in a traditional laboratory workshop is a self-made model of a slider that moves in horizontal directions with the least friction (Fig. 3).

So a clearly and correctly organized laboratory workshop becomes a reliable tool during the study of physics; helps overcome the gap between the theory and practice, demonstrates the link between physics and technology; promotes the development of logical thinking; allows to consolidate, expand and deepen the system of variable knowledge and increase the efficiency of the formation of physical knowledge and professional skills of a future specialist.

Results and discussion

To substantiate the efficiency of the introduced professionally oriented training in the course of physics for training the future agricultural engineers, analysis of its results was carried out using statistical methods. The main objective of the experiment was implementation of the experimental research into the teaching practice. This made it possible to form experimental and reference groups of students. 110 students, teachers of technical disciplines and physics took part in the experimental work.

In addition, the experimental research work was performed in the following order: the initial level the of first-year students was clarified in specialty 208 "Agroengineering" (Fig. 4).

When determining the level of students' knowledge, low, average, sufficient and high levels of success were used. When receiving a low grade, the student could only reproduce the material of the discipline at the initial stage. The average level of success was monitored where students could not only reproduce the material of the discipline, but also understood its meaning. A sufficient level was obtained by students who could apply the acquired knowledge when studying other disciplines. The decisive criterion for the efficiency of the proposed methodological support should be considered the learning results that show the impact of knowledge, gained in the study of physics on the level of the professional disciplines "Mechanical and technological properties of agricultural materials", "Agricultural machines", "Hydraulics and water supply", and other professional disciplines, the development of creative, analytical thinking among the future specialists (Fig. 5).

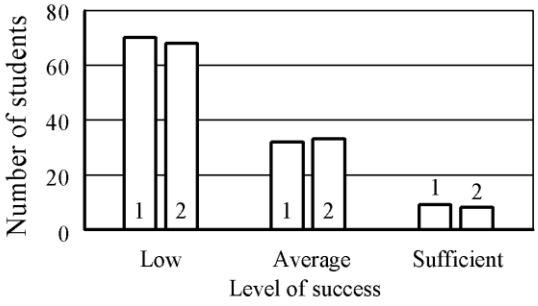

Fig. 4. **Results of the students' performance at the beginning of the experiment:** 1 – control group; 2 – experimental group

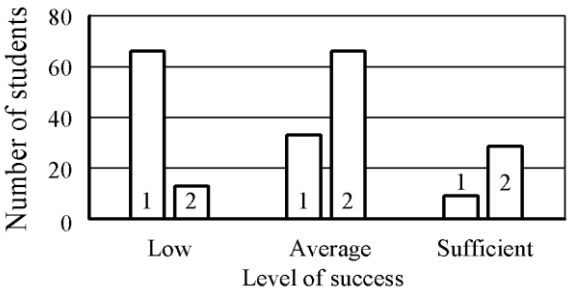

Fig. 5. **Results of the students' performance at the end of the experiment:** 1 – control group; 2 – experimental group

A multi-stage test of the knowledge and skills of the applicants for higher education throughout the entire period of the research made it possible to obtain objective data on the acquisition of the educational material, based on professionally oriented training (Fig. 5). The level of the integrated knowledge in technical disciplines and physics, the ability to apply it in practical activities allowed identification of the reasons that affect the quality of assimilation of the professionally oriented disciplines and physics.

Conclusions

A comparative analysis of the results of the investigation in the reference and the experimental group after the completion of the pedagogical experiment showed that the quantitative indicators and qualitative characteristics of readiness to use professionally oriented training in the experimental groups increased significantly compared to the reference ones. In the experimental groups the number of students with the low level decreased from 62.3% to 11.9%, and it increased with the average level - from 30.3% to 61.5%, and the sufficient level of readiness from 8.1% to 26.6%. The positive dynamics (attitude) of the future agroengineer towards professionally oriented training revealed as a result of experimental testing gives grounds to assert the efficiency of the proposed organizational and pedagogical conditions.

Based on the obtained results, we arrived at the following conclusions:

- most applicants for higher education do not see the interrelation between physics, general technical disciplines and disciplines of professional and practical training;
- the content of lectures and practical classes includes abstract material, and the laboratory work is not different from the work performed, for example, at a pedagogical university.

The reasons for this situation are the traditional system of teaching physics in agrarian-technical educational institutions, which does not sufficiently contribute to the implementation of the professional orientation of education; it does not allow a significant impact upon the professional development of applicants for higher education.

Author contributions

All the authors have contributed equally to creation of this article.

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