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Research Results
Резултати от научни изследвания

MODERNIZATION OF THE CONTENT OF THE LECTURE COURSE IN PHYSICS FOR TRAINING FUTURE AGRICULTURAL ENGINEERS

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Abstract. The article analyzes the theoretical provisions that form the basis of the concept of teaching physics to students of agricultural and technical educational institutions during lectures. The integrative connections of the fundamental and professional orientation of teaching physics to the students of the agro-technical educational institution during the lectures are established and the tested method of their carrying out is described. The basic methods of realization of professional orientation of teaching physics on lecture forms of employment of students of agrarian-technical educational institutions are opened. The basic ways of increase of professional knowledge of students at studying of a course of physics are defined. It is proved that the use of professionally oriented material contributes to the formation of a system of physical knowledge of students, as well as the acquisition of various practical skills and abilities. The introduction of professional competence in the educational process stimulates cognitive interest in the study of physics as a science, allows better learning of other disciplines of the natural science cycle, develop their cognitive and creative abilities, influence the formation of stable motives for acquiring knowledge in special disciplines.

Keywords: training; physics; lecture; fundamentality; professional orientation

1. Formulation of the problem

The content and organization of higher education has always been the subject of lively debate. In recent years, interest in this has increased even more due to the crisis in society, resulting in a clear weakening of young people's interest in higher

education. In order to remedy the current situation, it is necessary to radically restructure the entire education system in the country: to move to more democratic forms of government, to form a continuous education system, significantly strengthen professional training, develop new forms of education. Modern scientific and information space is developing quite rapidly, which, in turn, requires from the modern agro-specialist such knowledge, skills and abilities, which are the result of a combination of many components – basic (basic) disciplines with exclusively professional, as well as – using them in non-standard situations when working on specialty.

In higher education, lectures are one of the leading forms of organization of the educational process. The lecture largely determines the general directions and ways of forming the knowledge of future professionals. At different stages of development of higher education, the attitude to the lecture forms of organization of educational classes was different. Some teachers, given the low cognitive activity of students during lectures, believe that they have lost their relevance and significance.

The logically constructed course of lectures gives a basis of scientific thinking, shows historical formation of the scientific truth, introduces with new scientific methods of research. All this is a guarantee that the future specialist will become a creative person. The lecture largely determines the ways of conducting all types and forms of learning and therefore can be attributed to the original highway of the learning process (Zbaravska et al. 2019).

2. Analysis of recent research and publications

The results of scientific research, which are devoted to general issues of personal readiness for educational activities in physics, are presented in the works of A.I. Arkhipova, G.F. Bushka, B.S. Kolupaeva, V.F. Zabolotnogo, V.M. Zimina, E.V. Luchika, O.M. Meleshina, I.K. Zotova, Y.A. Pasichnik, P.I. Samoilenko, A.M. Sohor, V.I. Sumskiy, M.I. Schut and others. Scientific achievements on the specifics of professional training have been studied by researchers such as M. Mulder, T. Hyland, J. Raven, G. Ryle, D. Kaittani, C. Lyall, A. Bruce, J. Tait, L. Meagher, X. Cheng and others. In particular, J. Raven considers competence as a specific ability necessary to effectively perform a certain action in a particular subject area, including specialized knowledge, specific subject skills, ways of thinking, as well as an understanding of responsibility for their actions (Raven 2020). M. Mulder studies the concept and practice of vocational and practical training, including related research traditions and educational positions (Zbaravska et al. 2019).

Although the subject of scientific research is quite broad, but the problem of studying physics by students of agricultural engineering remains little studied. Based on the obtained results, we came to the following conclusions:

– most students do not see a close relationship between physics, general technical disciplines and disciplines of professional and practical training;

– the content of lectures and practical classes sometimes contains abstract material, and laboratory work differs little from the work performed, for example, in a pedagogical university.

The reasons for this state are insufficiently formed professional orientation of the physics program (taking into account the direction of training). The traditional system of teaching physics in an agricultural and technical educational institution did not sufficiently contribute to the realization of the professional orientation of education, did not allow to significantly influence the professional development of students. As a result, many students are not clearly aware of the purpose of studying physics. While studying physics, they do not acquire enough basic knowledge of physics and the ability to apply them to perform tasks related to future professional activities (Zbaravska 2016, pp. 135 – 141).

3. The aim of the study

Modernization of methods of conducting physics lectures for students of agricultural engineering faculties and technical universities, which will allow them to most effectively achieve not only basic knowledge, but also more closely link them with general technical disciplines and disciplines of professional and practical training.

4. Research methods

We used the following research methods: theoretical analysis of philosophical, psychological and pedagogical literature on the research topic in order to select and comprehend the actual material; analysis of concepts, theories and methods aimed at identifying ways to solve the research problem as close as possible to the future professional activity of students.

5. Main material of the research and its discussion

In the introductory professional-oriented lecture the teacher explains to students the functions of the physics course, theoretical and practical significance of physical knowledge in the future professional activity of an agricultural engineer, acquaints with the logic of engineering tasks, and substantiates the role and place of physical knowledge.

Then we offer some questions and problems that require the application of physical knowledge in agricultural areas. For example, according to studies presented in (Zbaravska 2010):

1. Is it possible to determine the composition and condition of the soil (heavy, wet or dry, etc.) from the window of a moving tractor?

2. What are the physical methods for determining the moisture content of bulk material (grain)?

3. Where is the laser used in agriculture?

The lecturer accompanies the explanation of the questions with a demonstration of drawings that show the technical application of physical knowledge.

For students, it was important to know what professional skills and personality traits a future agricultural engineer should have, and what role the physics course plays in this (Zbaravska et al. 2019, pp. 645 – 657). Therefore, the purpose of the introductory lecture we saw in creating a professional and motivational situation for first-year students who began to study physics. From a methodological point of view, this question, of course, deserves attention, because the formation of learning motivation is the solution of issues of personal education; if it is not controlled, the motives may lose their meaning.

Cognitive interest in knowledge, caused by the professional orientation of learning, was formed throughout the period of studying physics. Therefore, we created a professional and motivational situation not only during the introductory lecture, but also at the beginning of the study of each topic. The system of lectures was built on the basis of the maximum approximation of the general provisions of physical theories to the future professional activity of the specialist (Zbaravska et al. 2019). Referring to the statement of S. M. Arkhangelsky "lecture in high school – it is not just a translation of a textbook or other literary sources, it is a personal scientific and pedagogical work of the teacher" (Arkhangelsky 1974), we resorted to a problem-professional explanation of demonstrations for lectures.

Consider the content of the lecture "Friction force", which highlights the invariant and variable parts to test students' mastery of lecture material, which is built in accordance with physical theories and taking into account the future profession of students and their future activities in agriculture.

Friction is one of the types of interaction of bodies. It occurs when two bodies collide. Friction, like all other types of interaction, is subject to Newton's third law: if a force of friction acts on one of the bodies, then the same modulus, but directed in the opposite direction, acts on the other body. Agricultural machines have many parts, assemblies and mechanisms, the movement or action of which is caused by friction (clutches between the engine crankshaft and gearbox, conveyors, combine blades, etc.).

The phenomenon of friction underlies the action of some grain cleaning machines, such as oatmeal picker, "snake", linen slide. In agricultural practice, the difference between the values of the coefficient of friction in the grains of cereals is based on the distribution of the mixture of these grains into the main components. A mixture of grains, such as oats and millet, is gradually poured out of the hopper on a moving endless belt, which is placed at an angle to the horizon. The angle of the tape is selected so that the oat grains are held on it by friction and captured upwards, and millet grains, the coefficient of friction of which with the tape material is less than oat grains, slide down the tape.

As a result, grains of oats and millet will fall on different sides of the "belt separator" (Fig. 1).

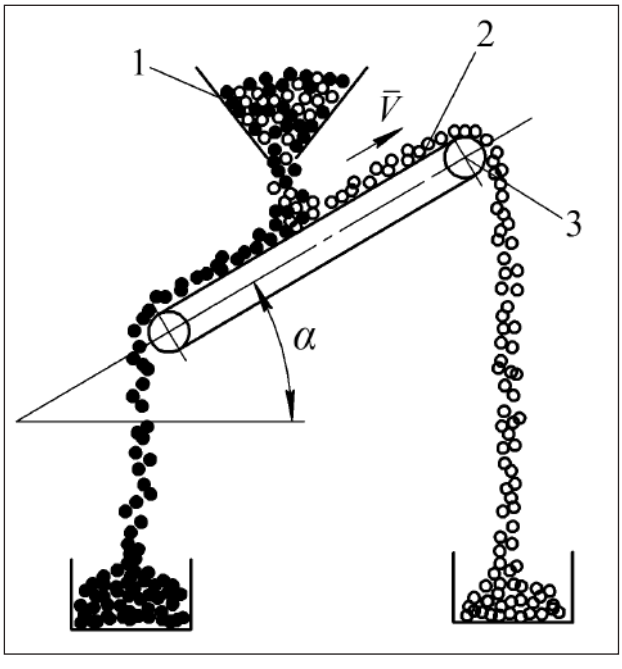

Figure 1. Scheme of the principle of operation of a belt separator:
1 – bunker; 2 – belt; 3 – shaft

The working process in such machines is as follows: the seeds buried in the bucket fall through the feed hole on a moving endless inclined canvas. The seeds of cultivated plants (clover, flax, etc.) have a smooth surface, and various weeds – hard. Therefore, the seeds of cultivated plants (at the appropriate angle α of the canvas) roll down, and the seeds of weeds and various impurities move up. The force of friction changes the direction of reaction of soil particles to the working bodies of tillage implements. The action of a knife, ploughshare, harrow tooth, and many other parts of agricultural machines is similar to the action of a wedge, so we will consider the action of a wedge on the soil. If a flat wedge would move on the ground without friction, its pressure P on soil particles M would be directed along the normal (Fig. 2, a). The frictional force F, directed along the surface of the wedge against the motion of the particle. The equality of the two forces, directed at an angle to each other, will be the force R, which does not coincide with the normal (Fig. 2, b). This force will be the pressure of the wedge on the ground.

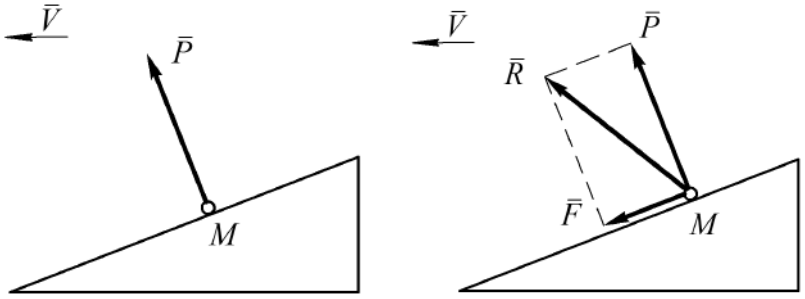

Figure 2. Influence of friction force on the action of agricultural mechanisms in the soil

In conventional harrows the teeth are set vertically, in some harrows you can adjust the angle of the tooth in the ground, which allows the harrow to work at different depths. If the entry angle is sharp, there is a force F_2, which is directed downward. If the angle is blunt, there is a force that pushes the teeth up (Fig. 3).

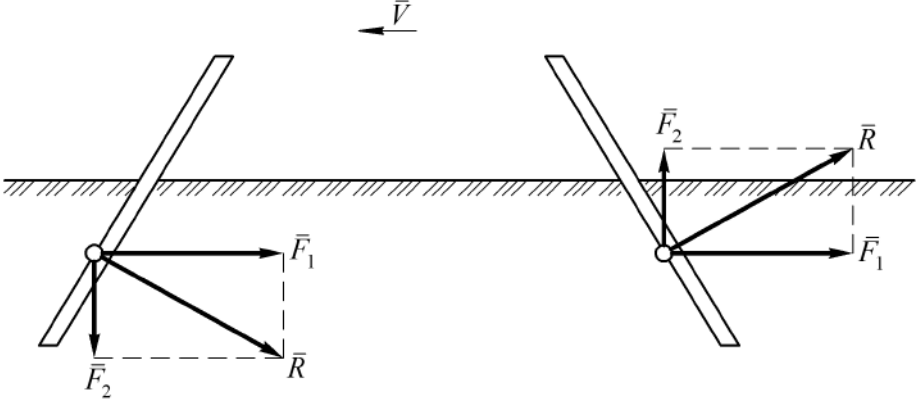

Figure 3. Decomposition of force on the harrow tooth

During the motion of a solid body in a liquid or gas there is a force of viscous friction. The force of viscous friction is much less than the force of dry friction. It is also directed in the direction opposite to the relative velocity of the body. Under conditions of viscous friction there is no friction at rest.

The force of viscous friction depends considerably on the velocity of the body: at sufficiently small velocities $F_{tr} \sim v$, if the velocities are large, $F_{tr} \sim v^2$. The coefficients of proportionality in these relations depend on the shape of the

body. Where friction has a detrimental effect, it is reduced by placing a viscous liquid (lubricant) between the rubbing surfaces. Another way to reduce friction is to replace sliding by rolling: the use of wheels, rollers, ball and roller bearings. Friction forces also occur during body rolling. However, the rolling friction forces are usually quite small. These forces are neglected in solving simple problems. The value of the coefficient of rolling friction is ten times less than the value of the sliding coefficient. ***The rolling friction force is inversely proportional to the radius of the rolling body. Therefore, in vehicles that are used for driving on unpaved roads, the wheels have a large radius. The rolling friction force*** $F_{tr.k}$ is calculated by the formula:

$$F_{tr.k} = \eta \frac{F_H}{R},$$

where F_H – the force of normal pressure; R – the radius of the rolling body; η – coefficient of friction, which depends on the properties of the materials of the tangential surfaces.

Friction is inherent in all mechanisms, but in some cases it contributes to the efficient operation of the machine, in others – is harmful.

Methods of reducing friction: to reduce friction and traction that occur during the movement of agricultural machinery, use the same methods of reducing friction as in other machines, lubrication, replacement of sliding friction by rolling friction, the use of polymeric materials with low coefficient of friction:

1. Lubrication of rubbing surfaces reduces friction energy use by a factor of 2 to 5 as compared to what is necessary in the case of friction of non-lubricated bodies. Lubricants not only reduce friction, but are also a means of cooling the rubbing surfaces as an insulator against moisture entering the rubbing parts, which is especially important for roller and ball bearings.

2. Replacement of sliding friction by rolling friction. Significant amount of friction is achieved in the running gear of the machine between the axle and the wheel hub. Here, the reduction of friction is achieved by lubricating the axles of the wheels, as well as the use of ball and roller bearings. On two ball bearings the shaft of a threshing drum which rotates with a frequency of 1000 min^{-1} is established; in rolling bearings shafts of fans of grain cleaning machines, axes of wheels of combines, tractors, disk knives rotate. Replacing plain bearings with rolling bearings can significantly increase the working speeds of agricultural machinery, their productivity and efficiency.

3. Along with the lubrication and use of rolling bearings, special attention is paid to such methods of reducing friction as grinding and cleaning of dust and dirt from friction surfaces. For example, to reduce friction on the ground, the working surfaces of the plow and the plow shelf, cultivator legs, seed drill coulters should be carefully sanded. During the assembly and repair of agricultural machinery, the

friction parts are thoroughly cleaned of paint, dust and dirt. It should be noted that the rubbing parts in new agricultural machines are partially made of plastics. For example, some parts for seeders are made of kapron. To reduce the friction of the ploughshare and the plough flange on the ground, their surfaces are covered with a tape of fluoroplastic. In this way, it is possible to plow at a much higher speed.

Up to now we have been talking about the detrimental value of friction in machines. At the same time, in many machines friction is used as a useful phenomenon. To increase friction in agricultural machines is used when it is necessary to overcome the slip of drive belts or to prevent slipping and sliding of the drive wheels of machines. Passing slip on pulleys can be reduced by using rosin to rub the transmission belts. In some machines, in order to reduce friction, for example in grain cleaning slides, the «working» surface is toughened. The widely used belt transmission is based on friction between the belt and the smooth surfaces of the pulleys. It is important to have a high value of the coefficient of friction between the metal and leather or rubber. Insufficient friction force causes harmful slippage of the belt, which changes the speed of the transmitted movement. To ensure sufficient friction, the tension of the belts (the density of their fit) and the surface properties of the pulley and belt are important. It is also important that the belt covers the rim of the pulley in a fairly large arc; in case of insufficient girth there is a slip; the girth of the pulley belt is sometimes increased by auxiliary tension rollers.

Directly under the influence of friction the irreversible conversion of all kinds of energy into heat takes place. Due to friction, motion occurs and transport stops.

Thus, the study of basic concepts and provisions of the physical foundations of dynamics, illustrated by examples of objects related to the future professional activity of the student, as the experiment shows, has contributed to improving the level of professional training of agricultural engineers.

With this presentation of educational material, students realized that the study of physical laws and principles that describe mechanical motion, will allow them to later calculate the physical parameters of components, parts, devices. This approach created motivation for the use of these movements in the implementation of construction and technological development of devices and technological agricultural processes, which undoubtedly stimulated students to creative knowledge of the laws and principles of mechanics. Further expansion of the acquired knowledge and their more complex engineering and practical application took place during the study of courses “Details of machines”, “Hydraulics and water supply”, “Machinery and equipment in the agro-industrial complex” and other professional disciplines.

To further study the professional approach in agricultural and technical higher education, we have developed a questionnaire to determine the attitude of students to the study of physics (Table 1).

Table 1. Questionnaires and interviews on students' attitudes to the study of physics

1. Are you interested in a physics course in terms of future profession?	No
	Partly interested
	Yes, it is the theoretical basis of the profession
2. Do you consider physical concepts in professional objects?	No
	Partly interested
	Yes, exactly where?
3. Do you single out the laws and phenomena of the physics course in professional objects (combine, plow, car, conveyor)?	No
	Partly interested
	Yes, exactly where?

The answers to the questions about the attitude of students to the study of physics in terms of future profession are generally distributed as shown in table. 2.

Table 2. Students' attitude to the study of physics from the point of view future profession

Question	Answer options, %			
	No	Partly interested	Yes, exactly where?	Did not answer
Are you interested in a physics course in terms of future specialization?	10	65	18	7
Do you consider physical concepts in professional objects?	15	61	13	11
Do you single out the laws and phenomena of the physics course in professional objects and processes?	17	58	11	14

Most of the answers indicate an intuitive understanding of the need for a physics course for the future profession, but a specific idea of the place of physics in future professional activities has from 10 to 18% of students. Answers to the question: "Where exactly are the laws and phenomena of the physics course used?" indicate that most students can not apply knowledge of physics to professional situations and do not see physical phenomena in agricultural processes.

One of the reasons for this state of affairs, students and teachers who participated in the survey and interview, see in the fact that the physics course is quite abstract, problem collections and laboratory workshops do not sufficiently reflect the specifics of the future agricultural engineer. 41 teachers of engineering and technical faculties of Lviv National Agrarian University and Podolsk State Agrarian and Technical

University took part in the survey. Teachers' answers to the questionnaire are given in table. 3.

Table 3. Questionnaire of teachers

1. Do you take into account the specifics of the future profession of students?	
Account	7 %
I take it into account sometimes	25 %
Not taken into account	68 %
2. How do you feel about the idea of implementing the principle of professional orientation of teaching physics?	
Positively	82 %
Negatively	13 %
I do not pay attention	5 %
3. What is the essence of the principle of professional orientation of teaching physics?	
Have no idea	33 %
4. Do you use the principle of professional orientation in your practice?	
I use often	7 %
I use occasionally	25 %
I do not use	68 %
5. Why do you rarely use the principle of professional orientation of education in your work?	
I consider it inexpedient	6.7 %
Due to limited study time	37.2 %
Due to insufficient training in the methods of teaching physics	45 %
Due to poor student training	11.1 %
6. Does the principle of professional orientation of education contribute to the formation of knowledge and skills in future professional activities?	
Contributes	87.2 %
Not conducive	17 %
I do not know	5.8 %

In spite of the fact that 87.2 % of teachers are positive to the idea of synthesizing theoretical and professionally oriented knowledge in physics teaching, the question of their use remains open. Teachers, in addition, believe that it is necessary to develop their own programs, collections and laboratory practical works, reflecting the principle of professional orientation of teaching.

6. Conclusions

On the basis of the conducted research there is a provision about the necessity of providing a professionally directed course of physics, which would be based on

the wide use of the principle of professional orientation, integration of new and classical teaching tools, innovative teaching technologies. It is the compliance with the specified requirements that ensures successful activity of the future specialist in agrarian and technical branch.

The Higher Agrarian School has a wide front of work to reform all aspects of its activities. It will take time, effort and perseverance. Here it is appropriate to recall the words of the ancient Chinese philosopher Kuan Tzu, who lived in 551 – 449 BC: "If you make plans for the year – sow grain, if for ten years – plant a tree, if for a hundred years – teach children. If you ever sow grain, you will reap one harvest; if you teach people, you will reap a hundred harvests". We need hundreds of harvests in all countries and for hundreds of years. This requires individuals who are highly educated, competent, and understand the complex inner world of a young person. And such students should be trained at the agro-engineering faculties of agricultural universities.

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