METHODOLOGICAL ASPECTS OF TRAINING FUTURE AGROENGINEERS

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Abstract. The purpose of this study is to reveal the methodological aspects of teaching the disciplines that are basic in the system of training an engineer for modern agricultural production, in particular during the lecture sessions. The paper presents the basic requirements for the modern teacher who teaches special disciplines, training an engineer in the field of agricultural mechanisation. Emphasis is placed on theoretical aspects, as well on the results of the acquisition and generalisation of practical experience in pedagogy in order to raise the efficiency of mastering the material by the students during the lectures. Attention is centred on the topical problem how to develop the professional activity of the teacher. Analysis is made of all the stages of consecutive development of the pedagogical activity: highly professional understanding of the subject, pedagogical professionalism, and pedagogical innovation in training the future engineers in the field of agricultural mechanisation. The results of the study will allow a conclusion that the effect of the lecture on technical disciplines depends on the logical lines selected by the teacher (inductive, deductive, traditions; during the transfer of power; from the basic part; during the technological or physiological process). The pedagogical skills of a teacher at a higher agricultural educational institution are based not only on a high professional level, but also on his overall culture. Pedagogical activity must be learned, one must purposefully acquire the positive teaching experience, constantly replenish the stock of knowledge with contemporary psychological and pedagogical ideas.

Keywords: training, transmission of knowledge, methods and means of teaching, lecture.

Introduction

The development of any science, including the pedagogical one, involves continuously increasing activity of the research work, expansion of the range of issues under consideration, widening of the international exchange of the obtained information, etc.

The wide range of the scientific research works in the field of professional training undoubtedly has a significant impact upon the theory and practice of the educational processes at agricultural universities in most countries of the world. The lecture, among the other forms of education at the university, occupied and continues to occupy a special place, since the centuries-old experience shows that it is the lecture that continues to be the main form of the knowledge transfer. Therefore, further research raises an issue how to improve the forms and methods of teaching by means of lectures in various areas of professional development (including agroengineering).

In his work "Man as a subject of education" (1868) the great pedagogue Konstantin Ushinsky defines pedagogy in artistic dimensions „Neither politics, medicine, nor pedagogy can be regarded as sciences in this strict sense, but only as arts, the purpose of which is not to study what exists independently of the human will. Science merely studies what exists or has existed but art is striving to create what is not yet". He convinces, „Pedagogy is not a science but art – most of all, the most complicated, the highest and the most necessary of all the arts" [1]. At the same time pedagogy has an objectively subjective character, and the content and result of this process completely depend on the personality of the teacher, his ability to organise productive pedagogical interaction.

It is the teacher, who is the central figure in the educational process of a higher educational establishment, who independently sets the goals of education, selects the means of its activities, educates, and develops the students' interest in science, in the future profession. It should be remarked that the efficiency of the teachers' professional activities regarding their ability to provide quality training in order to attract the young people to the designing and creative activities under the dynamic conditions of contemporary production is one of the most acute problems of the modern higher school, including the agrarian one. Practice proves that pedagogical innovations (transition to a credit-modular organisation of the educational process, the personality developmental technologies, objective methods for the evaluation of the students' academic achievements, distant learning, etc.) do not yet give the desired results exactly because of the poor readiness of the teachers themselves to implement

them. The reason is obvious: now the pedagogical activity of the teacher of a higher educational establishment does not correspond to the level that could meet the present-time requirements.

It should be emphasised that the problem of the development of the teacher's pedagogical activity is now very relevant both for the theory and for the practice of higher education, especially for the professional development. The pedagogical skills are based on high professional standards of the pedagogue, his overall culture and pedagogical experience [2]. In Latvia and the Czech Republic, the problems of training future agro-engineers and teaching technical disciplines were investigated by Vitnere A., Baltsite R., Briede B., Novotny J. et al. [3-5]. The researchers have developed a method for the control of the formation process of the educational-and-cognitive activity of agricultural students by applying a system of the organisation methods and forms of education, aimed at step-by-step formation of the students' educational and cognitive activity. The authors note that during the teaching of the course it is necessary to take into account the peculiarities of studying agricultural machines, which are determined by agrotechnical requirements for their work, the specificity of the working process, aggregation, etc., and the new material must be precisely connected with the previously acquired technical knowledge. The researchers have also developed a methodology for conducting lectures of a problem-developing character, teaching games, test control in the classroom on the subject "Agricultural Machines". When studying engineering disciplines it is proposed to apply actively problem-based learning, gaming activities (pedagogical games), various production-and-technological situations, etc. With an aim to fix the new knowledge in the students' memory on the basis of a joint work of the figurative and the conceptual-logical spheres of thinking, it is proposed to use the fundamental integrative concept (a design assignment), which is logically associated with the new lecture material [6].

In the dissertation research by E. Dzhedzhuly [7] a methodology is proposed for graphic training of the engineering students at higher educational establishments based on information and communication technologies, computer graphics and computer simulation. For this purpose computer-based visualisation lectures have been developed using image slides combined by means of hyperlinks with integration of graphic objects into a web page. A thorough research in training the future engineers is in the work of N. Bryukhanova, in which there is developed a concept of designing a system of pedagogical training of the future engineers-teachers. Among the other important issues justified by the author is a pedagogical training technology of the engineering-and-pedagogical personnel: motivational, reporting (description and prescription, complexes of situations, assignments and exercises, a model of professional activity), activity (reproductive, problem-developing, heuristic, developing), controlling (step-by-step, deferred, prognostic, cognitive), organisational (frontal, directionally differentiated, individualised). According to this researcher, sufficiently efficient for training engineers-teachers are such technologies as the complex- situational and the model technologies to which she refers a lecture [2]. The study is devoted to the formation of technical abilities of the future agricultural engineers during the academic course "Agricultural Machines". In particular, the author notes that during the teaching of the course it is necessary to take into account the peculiarities of studying agricultural machines, which are determined by agrotechnical requirements for their work, the specificity of the working process, aggregation, etc., and the new material must be precisely connected with the previously acquired technical knowledge. The researcher has also developed a methodology for conducting lectures of a problem-developing character, teaching games, test control in the classroom on the subject "Agricultural Machines". The dissertation research by A. Zabolotny [8] is also of interest, which is devoted to the formation of didactic competence of the future teachers of higher agricultural educational establishments. By the way, the researcher has suggested implementation of a credit-modular technology of learning, context-based learning, problem-based learning, productive independent work through such forms of education as lecture-presentation, lecture-visualisation, a problem lecture, a seminar discussion, a business game, solving pedagogical problems, a training class, and the research work.

Materials and methods

The purpose of this research is to reveal the methodological aspects of teaching the disciplines that are basic in the training system of an engineer for up-to-date agricultural production, in particular, during the lecture course.

During this research modern methods of theoretical analysis were used that include synthesis of abstraction and generalisation, as well as the method of pedagogical observation. An important factor is to get feedback of the acquired material, which allows objective identification and evaluation of the students' understanding of the laws of physics and the processes occurring in structures, mechanisms of machines and their details, the ability of students at a modern professional level to freely operate with the obtained amount of theoretical knowledge, the ability to give a range of subjectively new proposals for the calculation and design of agricultural machinery, to perform independently a multivariate analysis of technical solutions, to substantiate theoretically the choice of a rational variant, and so on. According to the student's high-quality answers, the teacher has an opportunity to check the amount of knowledge that the student has gained in the discipline, to objectively and accurately assess the complex formation of the multicomponent structure of the engineer's creative thinking. The main methodological foundation for such experimental studies is a standardised test control, based on the use of modern information technologies that allow the use of a personal computer. This makes it possible to increase the frequency of control and its omnitude, to differentiate and individualise control over the educational and cognitive activity of the students, which has a positive impact upon the formation of their motivational sphere and professional and cognitive interests. There were also used well-known methodologies of developmental education.

When conducting such a study, the criteria, selected for the evaluation, were independence and subjective novelty of the proposed solutions, their number and level the of the student's intellectual activity (reproductive, transitional, creative). The final control of the formation of creative technical thinking, educational, cognitive and engineering skills of the future specialists in the field of agroengineering was carried out during the exams and defence of the academic term projects.

Results and discussion

In its development the pedagogical activity passes through certain stages. The first stage is professionalism. A graduate of the higher school who is trained for pedagogical activity has it. After that the teacher starts independent work at an educational establishment, where intense and purposeful process of his professional growth continues. The efficiency of this process depends on his motivation for self-learning and self-training, on the availability of an appropriate program, as well as systematic raising one's qualifications (seminars, courses, scientific and methodological conferences, and so on).

Gradually, the professional level of the teacher increases, he masters new pedagogical technologies, his psychological and pedagogical culture rises, his pedagogical abilities, personal qualities develop, his methodological arsenal is enriched. This is the second stage – the pedagogical proficiency – constant striving to creativity, research, discovery of new teaching tools and techniques.

The third stage of pedagogical proficiency is pedagogical innovation. The teacher-innovator introduces fundamentally new ideas into the educational process, he develops new methods and technologies. Since reaching of the highest level of pedagogical proficiency is a long and complex process, let us consider these stages by the example of training the future engineers in the field of agricultural mechanisation and agricultural engineering. Let us designate the characteristics of pedagogical skills, since it is the lecture activity that is an extremely important dominant among the other types of a teacher's activity at a higher educational establishment, including an agrarian one. We would remark that it is necessary to approach the structuring of the content of each lecture, in particular, any agricultural machine, quite carefully, mastering the educational material according to a certain structure. Need to clearly understand for what kind of work or technological operation the agricultural machine or equipment is designed. For example, a general-purpose plough performs the following operations in the course of its work: it cuts a layer of soil to a depth of 30 cm; it overturns and partially loosens the soil layer; it lays the undercut layer at the bottom of the furrow, and so on. Thus, knowing this, the student must clearly define the operations for which the plough can be used.

Not a less important structural element of the discussed educational material are the agrotechnical requirements for the operation of the machine. The point is that in the future agricultural engineer will have to be able to calculate the parameters of the machine performing certain agrotechnical operations. It is noteworthy to add that before the study of the design and the working process of the machine the students must be acquainted with the requirements that determine the quality of the work. We will add that this block of the educational material is taught by the teacher along with concrete examples and a

detailed analysis of the production situations, putting problematic questions. After that, the lecturer carefully explains the indicators according to which these machines and equipment are classified (grouped). Such knowledge is generalised, systemic, it requires from the person developed abstract thinking, a holistic and interconnected vision of phenomena and processes in their totality. In such an academic discipline as agricultural machinery, this knowledge is present in each new section and topic, where the individual objects are grouped into homogeneous classes on the basis of accepted indicators. In the future such knowledge will make it possible for the students to solve typical tasks of their professional activity. The study of the technical characteristics of the machine (the next element of the content) is built mainly on the basis of comparative knowledge. It should be noted that in agro-industrial production several similar machines and types of equipment may be used to perform particular operations, and a specialist needs to select the optimal set of machines for the specific production conditions. This is a fact that should be appropriately reflected in the author's methodology for selecting the training content. Because the students, having listened to the lectures, should receive the knowledge that is necessary in order to determine the efficiency of a machine performing certain operations, to make comparative evaluation of two or more machines that are close or identical by their destination. After that the students are offered training material about general devices of agricultural machines. Acquisition of this structural content element is intended to form in the students the knowledge about the elements (aggregates) of the machine, their purpose and functions. It would not be superfluous to say that the methodology of the Ukrainian innovator V. Shatalov also provides for the presentation of the previously mentioned educational material in large blocks, and in this case it overlaps with the given methodological approaches to the structuring of the content [9].

After acquaintance with the overall structure of an agricultural machine it is supposed to study the design of its individual parts (units, mechanisms, systems), the didactic dominant being aimed at the students' comprehension of the design peculiarities of the aggregates, units, and functions. The next structural element of the study of the agricultural machine is acquaintance with its working process. This block of educational information provides that, according to the results of its acquisition, the students should clearly name and describe in detail the operations that constitute the working (technological) process of the machine, its components and the order in which they are performed. The technological adjustment and regulation of the machine completes its study. It is planned that, having mastered this informative element, the students will acquire the knowledge, necessary to determine the performance parameters of the machine: checking the readiness of the machine to perform certain kinds of work, regulation of certain units and evaluation of the adjustment of machines and aggregates. It should be emphasised that the results of the lecture explanations depend on the logical line selected by the teacher. For example, when explaining the educational material on technical subjects, the following logical lines are distinguished: inductive; deductive, traductive; when discussing the power transmission (torque); from the basic part; along the course of the technological or physiological process. The choice of the logical line of explanation depends mostly on the contents of the educational material. Sometimes it happens that even several logical lines are suitable to explain a particular material. For instance, the inductive explanation line determines the course of the message from concrete concepts to a general concept. And, conversely, the deductive logical line directs the explanation from the general concept to its concrete manifestations. The traductive logical line is used in cases, when the teacher explains the new material in comparison with similar material that the students have already learned. The logical line along the power transmission (torque) provides for the order of explanation from the part of the object that receives the driving force, and then continues along its transmission line. For example, such an explanation is only possible to determine the overall efficiency coefficient of a machine, when it is necessary to demonstrate the consecutive loss of power in the units during the torque transmission from the engine to the driving shaft of the machine. This logical line is used to explain the structure and operation of the transmission mechanisms, gearboxes, combines, and so on. The logical line from the basic part is characterised by the fact that the explanation of the object begins from the part that is basic for it. For example, the device of the internal combustion engine begins with the study of the crankcase. Until the students have mastered the knowledge of this basic part, they will not be able to understand completely the structure and operation of the mechanisms and systems of the engine, and therefore it is advisable to prognosticate the reproductive level of their operation along this logical line. The logical line along the course of the technological process is conventionally applied in order to explain which processes perform the work

using a definite working substance. The structure of combine harvesters, dryers, feeding shops, workshops for the processing of agricultural products, grain-cleaning complexes, etc., is explained along this logical line. The logic of teaching the lecture material has its own specific features having impact upon the best acquisition of the educational information by the students. In particular, each specific question of the topic should be explained solely along a single logical line from the beginning to the end. After the exposition of a scientific issue it is obligatory to sum up and make generalisations. Such techniques have impact on the consolidation of knowledge in the students' memory, on the one hand, and, on the other hand, they help the students systematise information and build a precise synopsis. It is known that the final part of the lecture is of great importance for achieving the objectives of the lesson - the lecturer should concisely summarise the previously told material, motivating the students to further research during their independent academic work. Particularly successful is the formulation of topical scientific problems, which will serve for the future engineers of agricultural production as themes of their research work, in particular, for their master's studies. Let us dwell upon the basic components of the teacher's lecture. The style and way how the lecture is delivered should reflect the lecturer's cultural and professional level as a personality. The lecturer should always be tidy, sedate, moderate, attentive to others; he should be distinguished by deep wisdom, a vision of problems, a bright mind, developed mathematical thinking. It is these features that should create the distinctive style of teaching technical subjects. Naturally, each lecturer has exclusively individual features, personal traits that are difficult to generalise. And yet the outer form of the lecture must be subject to certain rules. For the lecturer the first rule should be deep awareness in the lecture material, as well as knowledge of the methodological ways of presenting the material depending on the specificity of the specialty that the future agro-engineers are mastering.

The results of the comparative study led to a conclusion about the significant advantages of the indicators of the students from the experimental groups over the students of the control ones [2, 8-10]. In particular, the academic achievements of these students, who were registered according to the results of the current and the final control (the course exam, the course project defence) were significantly higher compared with the training results of students from the control massive. During the exam the majority of students freely operated with the necessary technical terms, had thoroughly mastered the skills of calculation and design. A witness for changes in the development of the technical creative thinking of the students from the Agro-engineering Faculty is also the fact of participation of 26 % of students of experimental groups in the annual Olympiad, whereas from the control groups only 14 % of students felt a desire to take part in this competition.

According to the results of the conducted experimental studies, distribution graphs of the students from the experimental group E and two control groups K (1) and K (2) were built by the levels of their learning and cognitive activity, estimated in % (Fig. 1), the data about the indicated groups being obtained at the beginning of the experiments (Begin) and at the end of the experiment (End).

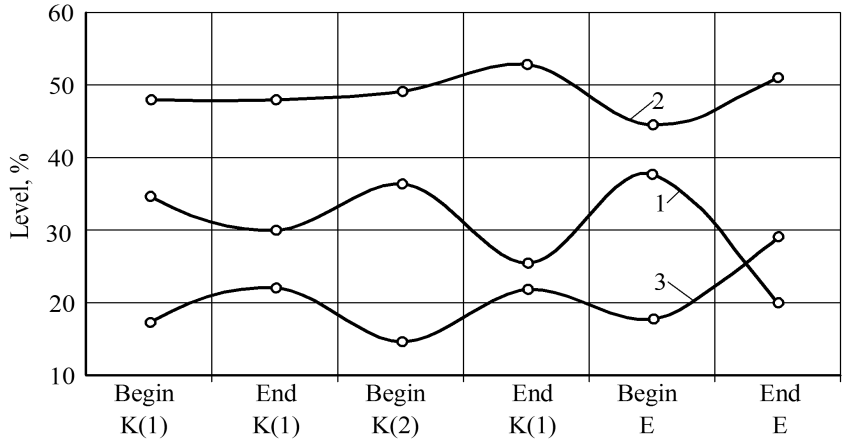

Fig. 1. **Distribution of students from experimental group (E) and two control groups K (1), K (2) according to levels of their educational and cognitive activity:** 1 – reproductive level; 2 –transitional level; 3 – creative level

Fig. 2-4 present graphical dependencies reflecting the dynamics of changes in the educational and cognitive activity of the students from these groups at the beginning of the experiment and at its end. In addition, Fig. 2 shows graphs of the dynamics of changes in the reproductive level of students' learning and cognitive activity, Fig. 3 depicts similar graphs for the transitional level and Fig. 4 – graphs showing the dynamics of changes in the creative level of the students' cognitive activity. Data are also given at the beginning of the experiment and at its end.

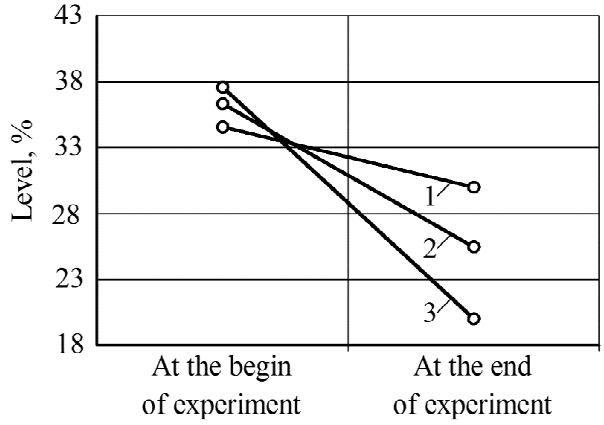

Fig. 2. **Changes in reproductive level of educational and cognitive activity of students at the Faculty of Agroengineering:** 1 – control group K (1); 2 – control group K (2); 3 – experimental group E

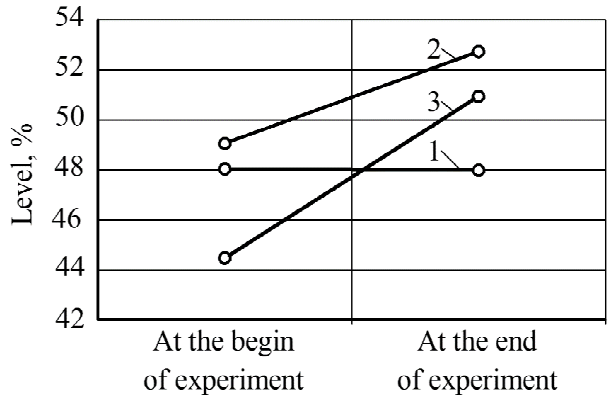

Fig. 3. **Changes in transitional level of educational and cognitive activity of students at the Faculty of Agroengineering:** 1 – control group K (1); 2 – control group K (2); 3 – experimental group E

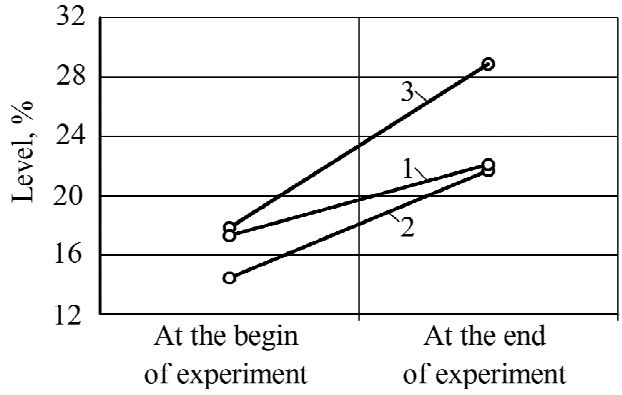

Fig. 4. **Changes in creative level of educational and cognitive activities of students at the Faculty of Agroengineering:** 1 – control group K (1); 2 – control group K (2); 3 – experimental group E

As it is obvious from the presented graphs, the efficiency of the applied methodology for the developmental education reflects the dynamics of changes in the levels of the created educational and cognitive activity of the students in studying the disciplines included into the course for training agroengineers. In the final experiment 29 % of the students from the experimental groups demonstrated a creative level of the educational and cognitive activity, whereas in the control groups there were 22 % of such students; 51 % of the students from the experimental groups and 48 % of the students from the control groups were referred to the transitional level. It was established that at the reproductive level there were 20 % of students from the experimental groups, and, correspondingly, 30 % of students from the control groups. Based on the theoretical studies, own observations and the studies of the practical experience of famous teachers [4-6], we arrive at a conclusion that among the leading skills of a teacher at the higher agricultural educational establishment should be the following skills:

- ability to see the pedagogical work as a whole, in the unity of its tasks, goals, methods, conditions, results, to understand the cause-and-effect relationships between them;
- use the knowledge of the modern pedagogical science, to identify and implement technologies contributing to efficient formation of instructive and cognitive activity of the students;
- control one's emotional state giving it a constructive, not a destructive character;
- achieve high standards of pedagogical work, to use a creative approach to the organisation of the training-and-educational process;
- create in the learning environment a favourable psychological microclimate of interaction, mutual help and support;
- analyse and summarize the advanced pedagogical experience, to acquaint with one's achievements the teachers of higher agricultural educational establishments;
- highlight the main ideas of the academic subject, to update it by means of modern achievements in the relevant field of the agrarian science;
- implement measures for the integration of knowledge, to construct the learning content as a system of cognitive tasks;
- apply efficient methods, forms and means of enhancing the students' educational and cognitive activity in order to achieve high results;
- open to the students new opportunities for self-improvement, self-development, to take into account their level of cognitive abilities, mentality and peculiarities of the socio-cultural environment in academic work;
- realise the role of the teacher exactly as an assistant, mediator, coordinator and consultant motivating the students to active acquisition of the future specialty;
- take a constructive position in pedagogical communication and flexibly rebuild it by changing the situation.

It should be emphasized that by mastering these skills the teacher develops a number of psychological qualities which also characterise his skills. This is, first of all, pedagogical erudition - a deep stock of up-to-date knowledge that the teacher uses in solving concrete problems. For a teacher of a higher agricultural educational establishment this is especially important: the contemporary agricultural production is constantly changing, it is modernised, developing. Instead of the conventional technologies there come new, environment-friendly, energy-saving technologies that combine the modern possibilities of science and production. For instance, the system of precision farming makes it possible to grow ecologically clean products, to raise the culture of farming, to predict the yield of agricultural crops by using a satellite navigation system. It is quite clear that only a teacher, who is thoroughly aware of the modern achievements in the agrarian science and, what is equally important, who independently carries out scientific research, can bring such knowledge to the students. As an important psychological characteristic of pedagogical professionalism should be regarded pedagogical thinking. This is a skill of the pedagogue to analyse pedagogical situations, to detect their indicators and peculiarities that are closely related to pedagogical intuition, pedagogical improvisation, pedagogical imagination, pedagogical observation, and so on. Another important quality of the teacher is pedagogical purposefulness. Development of this component of the teacher's professionalism makes it possible to create a need for compulsory planning of his wok; this helps in

turning the goals into certain concrete tasks; this allows optimal selection of forms, methods and means for the educational process, planning ways how to stimulate the students' activity.

It should be pointed out that the ideas of J. Komensky about the teacher and his role in society are topical still now, "Just as no thing can do anything else than being itself (the white to whiten, the hard to harden, the hot – to heat), so no one can make people wise but the wise; no one can make people eloquent but the eloquent; no one can make others moral or pious except those who are moral or pious themselves; no one can make people mathematicians, natural scientists or metaphysicians except an expert in these sciences" [11]. One should remember the answer of Socrates, who instructed with inspiration and perseverance young men, when asked why he would not take up any government office. But he responded to this, "There is much more benefit from the one who creates many that administer the affairs of the state than of the one who is the ruler of the state himself."

Conclusions

The results of the study allow making a conclusion that the efficiency of the lecture on technical disciplines depends on the logical lines selected by the teacher (inductive, deductive, and traditional, along the transfer of power, from the basic part, during the technological or physiological process).

In the final experiment 29 % of the students from the experimental groups demonstrated a creative level of the educational and cognitive activity, whereas in the control groups there were 22 % of such students.

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