



# METHOD FOR CONSTRUCTING THE TASKS OF EVALUATING THE LEARNING OUTCOMES OF TECHNICAL COLLEGE STUDENTS

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## Abstract.

*Relevance* is determined by reforming the content, methods, forms, technologies of engineering education, which is based on the competence approach and necessitates such diagnostic techniques that would effectively manage personality-oriented pedagogical interaction, objectively and reliably assess the level of mastery of components of educational and professional programs by future mechanics, technicians, technologists.

*Objective:* to develop a methodology for designing and assessing the complexity of individual learning tasks as a step-by-step procedure based on the analysis of the conditions of the proposed educational action and indicators of the novelty of its implementation by a student of technical college.

*The research* methodology is based on the unity of activity, system, personality-oriented and technological approaches, which has allowed to develop a student-centered, algorithmic (focused on the structure of educational activities) method of constructing individual tasks for assessing educational achievements of technical college students.

*Results:* (on the basis of the theory of gradual formation of mental actions), indicators of the description of educational actions in sequence of their formation are allocated (the form of representation of the contents of an approximate basis of action to the performer – the presence of the operation of the transformation of the object in the approximate basis – the form of representation of the object of action – the form of transformation of the object of action – the degree of novelty of the action performed for the student); examples of constructing a system of individual learning tasks of students are given.

*Conclusions:* the need to formalize the procedure for assessing the complexity of individual learning tasks of students by using indicators of the approximate basis of action, executive part and novelty of action for their differentiation from the simplest to complex, highly intelligent.

**Keywords:** *complexity of educational task, student, theory of formation of mental actions and concepts, estimation, method.*

**Introduction.** The rapid growth of innovation processes in the economy and industry, the introduction of interacting high technologies (telecommuni-

cations, information, nuclear, nanotechnology, microtechnology, biotechnology, engineering, etc.) necessitate significant modernization of vocational education, including engineering and technical, and

giving this process a systemic character. Based on the ideas of the competence concept, the technology of training the specialists should change significantly, the main criterion of which should be the quality of professional pre-higher education. Naturally, updating the content of technical education, methods, tools, forms, technologies of mastering modern knowledge by students should be accompanied by the development of such diagnostic techniques that would effectively manage personality-oriented educational process, objectively and reliably assess the level of students' mastery of the disciplines of the educational and professional program (Artiushyna et al., 2015).

These positions update the study of didactic problems on the principles, methods, tools for assessing students' knowledge. The study of tools and practices of multilevel control of educational achievements of future specialists in technical specialties is especially important and expedient. This is primarily due to the complexity of technical facilities and systems, features of modern professional activity of mechanics, technicians, the need for purposeful development of creative and technical potential of students and, accordingly, systematic reliable evaluation of their academic achievements (Titova, et al., 2019; Pashchenko, 2014).

At the same time, pedagogical science has not yet developed detailed theories and technologies that can reliably assess the level of mastery of future mechanics', technicians' professional skills, abilities, other complex competencies, defined by educational standards and learning outcomes. The lack of reasonable, (understandable to the general pedagogical community) valid diagnostic methods in some way affects the pedagogical practice. In particular, the tests used today to assess the level of professional competence of graduates are often composed intuitively, without a clear analysis of the actions that a specialist should have according to learning outcomes. In addition, the level of complexity of the test task is said more than it is determined in practice: currently there is a lack of specific, practically grounded methods that can objectively assess the complexity of the educational (and, therefore, test) task and, consequently, the test as a whole.

Therefore, the problem of developing a methodology for constructing individual tasks for assessing the academic achievements of future specialists in technical specialties is extremely relevant for both pedagogical theory and educational practice.

**Sources.** According to many scholars, the leading didactic characteristic of the educational task is its complexity. Some researchers attribute the complexity

of the task to the number of operations to solve it, other scientists, professing the provisions of psychological theory of activity, suggest calculating the complexity of the educational task taking into account levels of thinking and learning (Luzan et al., 2021).

In the scientific work (Naimushyna and Starychenko, 2010), devoted to the development of technology for estimating the complexity of educational tasks in Physics, it is proposed to take into account the following factors of complexity (when calculating): technical complexity (number of actions in solving problems); cognitive complexity (knowledge of formulas, laws, processes, creative application of knowledge, etc.); additional complexity (volume of text, system of equations, unusual problem, proportions, redundant data, etc.). It is not difficult to see that this approach is quite complex for practical application, and quantitative estimates of the significance of factors are plausible.

The algorithm for evaluating the structure and process of the educational task is substantiated in the dissertation of G. Kyrillova (2001). Here, the complexity of the educational task is proposed to be calculated by the following formula:

$$TD = f(T, K, H, Nh, Na, Nz, Nw),$$

where the task difficulty function (TD) depends on time (T), number of attempts (K), frequency of decision making (H), number of erroneous decisions (Nh), number of correct decisions (Na), number of objects and operations (Nz, Nw).

Thus, the technology of estimating the complexity of the educational task of the just mentioned method is based on serious experimental work regarding accumulation of statistical data on the results of pedagogical measurements (task time, number of erroneous and correct decisions, etc.), which, in our opinion, reduces its practical significance.

We are impressed by the approach to solving this problem by scientists (Demin, 1990), who associate the complexity of technical objects with the design features of parts, assemblies or machines. The main positions of this theory are represented in the following provisions:

- the concept of "complexity" expresses the fact that the object (system, subject, phenomenon, object) consists of systems, subsystems, parts of systems, elements. The name itself (complexity) focuses primarily on the quantitative composition of the object;

- "difficulty" is a subjective reflection of the complexity of the object, its characteristics in terms of educational and cognitive activities. The difficulty is determined by the properties of the object under study;

- the carrier of the difficulty is the educational object;

- when selecting the content of training, it is necessary, first of all, to take into account objective didactic conditions, which determine the difficulty of technical objects to study (the presence of complex parts in the object; accessibility of the object for inspection; density of parts, etc.).

The method of determining the difficulty of educational objects by taking into account the didactic conditions that hinder the educational and cognitive activities of learners, of course, can be successfully applied where students are offered to study the design of real technical devices, machines and equipment. However, it does not take into account the peculiarities of instructional materials (task conditions), the form of presentation of the object of educational and cognitive activities, the proposed transformation operations, the degree of novelty for the student of the action performed, and so on

Thus, in pedagogical theory there is still no clear answer to the question: in what sequence, by what criteria or indicators to determine the complexity of educational activities, develop control tasks and, accordingly, evaluate the results of implementation.

**The research methodology** is based on the unity of activity, system, personality-oriented and technological approaches, which provided an opportunity to develop student-centered, algorithmic (focused on the structure of educational activities) method of constructing individual tasks for assessing educational achievements of engineering students. The activity approach made it possible to consider the educational process as a complex multilevel activity, consisting of individual cognitive actions and operations, characterized by the transition from external practical action to internal mental action (Galperin, 1957; Talyizina, 1975). The personality-oriented approach allowed to introduce parameters of novelty of components of action for the student to indicators of complexity of the educational task. According to the requirements of the system approach, a set of indicators has been identified that reflects the student's mastery of the approximate basis of action, knowledge and skills of the actual implementation of operations to transform the object. This methodology determines the main task of the studied phenomenon – to develop a system of individual learning tasks that can systematically and consistently bring future engineers to higher levels of knowledge, as well as objectively and reliably differentiate students by levels of academic achievement. The technological approach helped to develop a method of designing (and evaluating) educational tasks as a

step-by-step procedure, which first studies and analyzes the nature of the approximate basis of action (the form of execution of the contents and presentation of operations to transform the object), then performance indicators, then parameters of action novelty to establish the level of complexity of the task.

**Results and discussion.** According to the psychological theory of activity, the performance of an individual task by a student is a learning action, which is not only an object but also a means of learning; the ultimate goal of learning is the ability to perform certain actions. These positions are taken into account by the theory of gradual formation of mental actions (Galperin, 1957; Talyizina, 1975), which allows us to identify the structural and functional (internal) structure of action. The leading provisions of this theory are the basis for assessing the complexity of educational activities. Let's dwell on these aspects in more detail.

The dominant position of the theory of gradual formation of mental actions is that the functional construct of action consists of three components – approximate basis of action (ABA), executive and control parts. Proponents of this theory are convinced that any human action is like a kind of management microsystem, which includes a tentative part – "governing body", executive – "working body" and control – mechanisms of tracking and comparison (Talyizyna, 1975).

ABA is an idea of the performer, his predictions about the composition and sequence of operations that he must perform. ABA consists of meaningful and logical parts. The meaningful part of the ABA is information about the object of action, and the logical part is information about the structure and nature of the transformations that the student must perform. Indicators of completeness and forms of its presentation are used to characterize the ABA. The completeness of the ABA submission is determined by the presence of all constituent elements of the object of action and the definition of operations for its transformation. The form of representation of the ABA is determined by the form of display of the object of action and operations for its transformation.

Example. *Complete ABA in material form* – factory instructions for use of household appliances – washing machine. Note that the instructions describe the object of action and operations for its application.

*The absence of ABA* is observed in the following training task: *adjust the gap in the intake valves of the D-240 engine*. It is not difficult to notice that the object of action that needs to be changed is named here, but there are no operations, tools and technologies of transformations in the given ABA.

Thus, to determine the nature of ABA, two indicators can be used:

1. The form of submission to the performer (pupil, student) of the contents of approximate basis of action (ABA).

2. Submission of operations for the transformation of the object to the ABA.

Each of these indicators has different types of implementation. Thus, the form of presentation of the contents of the ABA to the student can be:

*The real object.* A teacher or master demonstrates a real object, names and shows its components.

*Picture.* The student is given a picture (poster) with the image of the object, which is as close as possible to its natural state, and the perception of which does not require special training from the student.

*Drawings or diagrams.* To complete the learning task, the student receives a symbolic image of the object of action. In order to perceive and comprehend the information carried by such clarity, the student must be prepared in some way – be able to read and interpret drawings and diagrams. Possession of such specific skills and abilities is an important indicator of the level of professional competence of a person in certain professional activities.

*Description of the features of the object.* It is used when the student has formed an ideal image of the object of action, and the names of the elements are consciously associated with their real appearance. But in order to clearly define the field of activity, the student should be provided with information about the structure of the object of action, the name of its elements, and so on.

*Object name.* It can be used when the student is free to operate the components of the object of action in perfect shape.

Information about the nature and sequence of the operation to transform the object of action (logical part of the ABA) depends on the form of representation of the object and may be as follows:

*Real transformation.* The teacher or tutor demonstrates the transformation of the object and then asks the student to repeat the practical steps.

*Real transformation with linguistic explanation.* The teacher demonstrates to the student the real transformation of the object, accompanied by a verbal commentary on the practical demonstration of operations.

*Written instructions.* The student is shown the sequence of actions and described the operations for the transformation of the object.

*Named operations.* The operations to convert the object of the action are named, but it is not specified how they should be performed. For example: adjust the chain tension using the offset supports.

*There are no instructions.*

It may be worse noting, the first two options for presenting the logical part of the ABA are possible only if the substantive part is presented in material form.

Let's note that the ABA can be formulated by the performer or provided to him from the outside, it is constantly supplemented and improved in the process of performing the action. Completeness, accuracy and rationality of ABA are one of the determining conditions for the success of the formation of skills for its implementation. ABA differs in the form of presentation of information: it can be given in textual, graphical or material forms. The application form of the ABA must correspond to the

level of personal development and the level of training of the learner. For example, it is not possible to provide information about a complex object of action in the form of a drawing to students who have not mastered the course "Technical Drawing".

ABA also differs in the form of its formation: it can be completely ready-made, and can be formed by the student only independently or by analogy with similar previous actions. The higher the level of student's independence is during the preparation of the ABA, the higher its quality is – the strength of ideas, ease of transfer to new conditions and so on. It should be noted that the formation of ABA is a necessary condition, but not enough to decide that the student has mastered the necessary ability to perform the action. N. Talyizina (1975), one of the founders of the theory of gradual formation of mental actions, draws attention to this: "Whatever the quality of the approximate basis of the action is, and no matter how it is presented – in the form of ideas or external schemes – it still remains nothing more than a system of instructions on how to perform a new action, not the action itself. Our student does not have the action itself yet, he has not performed it at all, and without performing the action it is impossible for him to learn" (p. 64). Special attention should be paid to the last remark, as in the learning process some teachers are satisfied with the student's ability to explain how a certain action should be performed. Let's note that the student's explanation of the sequence and conditions for performing the action, learned by him from the lecture notes or textbook text, is not the actual action, but it is only a reproduction of its ABA, usually incomplete and inaccurate.

To fully master the action, the student must actually perform its executive part. Depending on the form of representation and transformation of the object, there are the following forms of action: material, materialized (perceptual), verbal (foreign, intralingual), mental.

Therefore, two main indicators are used to characterize the executive part of the action: the form of representation of the object of action and the form of its transformation. The form of representation of the object of action may have the following options:

*Natural object.* To complete the learning task, the student is given an object of action in kind – a real machine, a cut, an animal, a plant, a device, a seed collection, biological products, etc.

*Layouts or models.* The student is offered a specially prepared object for educational purposes, which in a real or simplified form reflects not only the external form but also the internal essence of the subject, the relationship and interaction of its elements.

*Picture.* To complete the task, the student receives a flat image of the object of action, as close as possible to the natural one.

*Schemes and drawings.* The object of the action is presented in a symbolic form, for which the learner must have a certain level of special training.

*Description.* The structure and characteristics of the object of action are presented in the form of text.

*Name.* Only the name of the object of action is communicated to the student.

The form of the transformation is related to the form of representation of the object of action and may have the following options:

*Material.* Real transformation of the object of action in order to achieve the desired results. It is only possible if the object is presented as a natural object, layout or model.

*Perceptual.* The transformation of the object takes place in the form of utterance (linguistic description of the procedure) of the contents of the action in the presence of visual support. It is possible with material and graphic forms of representation of the object of action.

*Verbal.* The transformation of an object takes the form of utterance (linguistic description of the procedure) of the contents of the action. It is possible if the object is presented in the form of a description and name.

*Mental.* The conversion of the object takes place in perfect shape without an external image and ends with a message of the result.

The material form assumes that the object is presented in real form, and in the process of action its material transformations are carried out: the machine is disassembled and tested, experiments with chemicals are conducted, biological medicine is prepared and studied, etc.

Perceptual action differs from material action in the way that the object can be given in material (real object, model, layout) or materialized (drawing, poster, stand, table, etc.) form, and its transformation is carried out visually. The conversion operation can be described in words. An example of perceptual action is the story of the operation of an induction motor using its layout or model.

Foreign language action is that the performer performs the entire operation of transforming an object into an oral (speaking) or written (describing) form without relying on a tangible or materialized object. That is, there is no object, it is just named. An example of an action in a foreign language is a story or description of the structure of a machine or the process of its operation from memory.

The intralingual form assumes that the performer speaks the operations if he thinks about their performance. Instead, the mental form of action implies that the student does not think about the contents and order of operations during the action.

Thus, using the provisions of the theory of gradual formation of mental actions, we can characterize the learning action on five indicators:

1. The form of submission to the performer of the contents of the ABA.
2. Presence of operations on transformation of object in the ABA.
3. Form of presentation of the object of action.
4. The form of transformation of the object of action.
5. The degree of novelty of the action performed for the student.

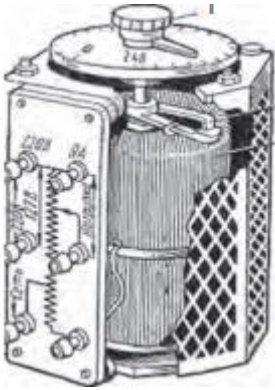

Using these indicators, you can give a general description of the actions in the sequence of their formation, improvement and complexity, both in terms of characteristics of the ABA and the characteristics of the executive part.

Here is a general description and examples of actions, starting with the simplest and ending with actions of high intellectual level (Table 1).

*Table 1*

**Description and examples of actions in material form**

Marking	Content of the action (operation)	Examples
1	2	3
1.1.1.1	To repeat (in material form) the procedure presented in material form and commented by the teacher.	1. After demonstrating and explaining to the teacher the sequence of measuring the density of the electrolyte with a hydrometer in the banks of the battery, repeat the operation. 2. After showing and explaining to the teacher the procedure for measuring power and electricity using a wattmeter and an AC electricity meter, repeat the operation.
1.1.1.2	To perform the operation in material form in accordance with the sample shown in real form or visually specified sequence of actions without linguistic explanation.	1. Draw a diagram of the technological process, which is performed by the teacher on the board. 2. After the practical demonstration of the operation of measuring the quality of the electrolyte by the teacher, repeat its actions.
1.1.2.3	To perform the operation in material form according to the provided written or oral language instructions and graphic representation of the object.	1. To study the characteristics of the engine with sequential excitation in idle mode, assemble an electrical circuit according to the provided scheme. 2. Using the manual, select the components of the DC motor on the rack.

1.1.3.3	To perform the operation in material form in accordance with the instructions provided in writing or orally.	<p>1. After the teacher explains the sequence of actions, set voltage of 12 V, 24 V, 110V on the output terminals of the laboratory autotransformer LATR.</p>  <p>2. Using the written instructions, adjust the clearances in the valves of the D-240 engine.</p>
1.1.2.4	To perform the operation in material form according to the given command to act.	<p>1. Demonstrate the sequence of passing the intersection by vehicles located on the model.</p> <p>2. Assemble the scheme of the experiment (physics, electrical engineering) according to the scheme provided in the instructions.</p>
1.1.3.4	To perform the action in material form according to the instructions given in verbal form and the named components.	<p>1. Assemble the scheme of the experiment from the named components according to the verbal instructions.</p> <p>2. Using the list of components and parts of the engine, select on the racks those that make up the lubrication system.</p>
1.1.4.4	To perform an action in tangible form, knowing only the name of the object.	<p>1. Among the lighting devices presented on the shelves, select fluorescent, halogen and LED lamps.</p>  <p>2. Perform the electrical circuit of the welding equipment.</p>

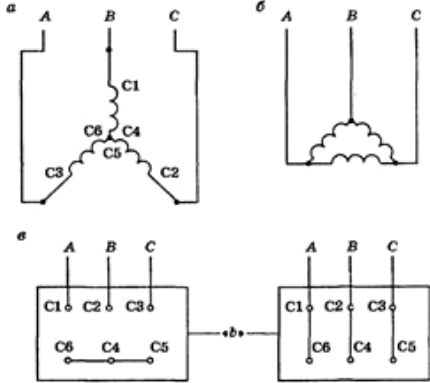
Listed actions (in Table 1) are performed in material form, but they differ in the level of presentation of the approximate basis. Performing such actions is very important, because without mastering the object in material form, it is impossible to form actions of higher intellectual levels. In our opinion, in the previous and current control, checking the formation of actions in material form should be mandatory.

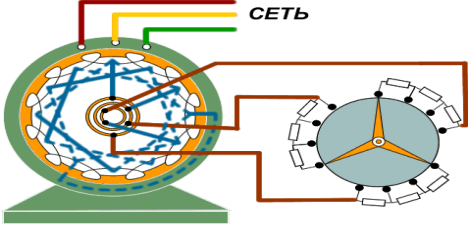
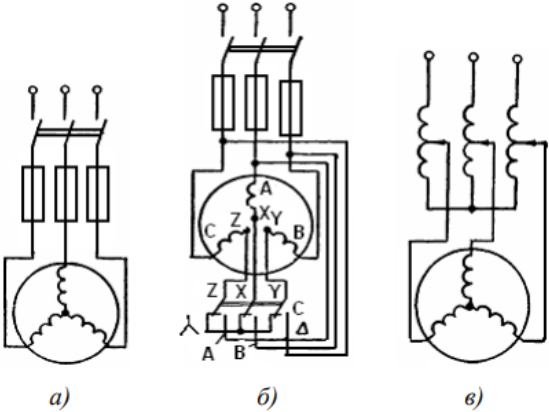
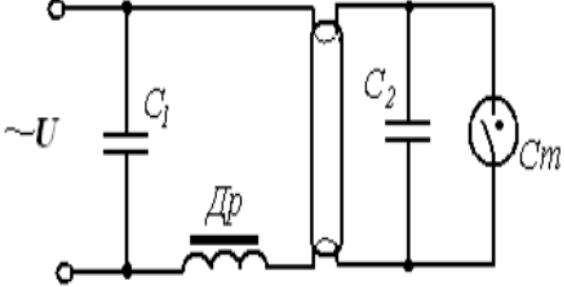
Instead, when forming actions in perceptual or verbal forms, tasks can be used in which the ABA is presented in material form, and the executive

part is carried out in perceptual, verbal or mental forms (Table 2).

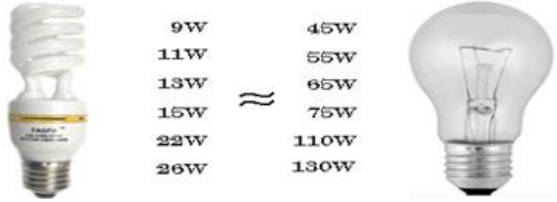
It is not difficult to notice that, in the Tables 1 and 2 (examples), the complexity of actions changes from the simplest (material) to the most complex (mental). Naturally, a clear definition of the characteristics of actions as a learning goal allows to determine the level of mastering the material, which should be assessed by means of test control (Ilin et al., 2010).

**Description and examples of actions in the perceptual, verbal and mental forms**

Marking	Contents of action (operation)	Examples
1	2	3
1.2.1.1	To perform a verbal operation based on the material object, commenting on the actions performed in the material form by the teacher or demonstrated on the screen.	1. After watching the video "Threading" explain the procedure for cutting the internal thread with taps 2. After the practical demonstration of the technology of processing of external cylindrical surfaces by the teacher or master, comment on the rules of installation of cutters on a lathe.
2.1.1.1	On the object presented in the graphic form, show the order of transformation, reproducing a practical demonstration of the teacher or a fragment of the video.	Show on the diagram of the SKIF-310 combine the sequence of passage of the grain straw mass after the teacher explains the technology of the combine on the current stand.
2.2.1.1	To perform the operation in verbal form based on the external image, commenting on the actions performed in material form by the teacher.	Show and explain the order of operation of the cylinders in the diagram of the engine SMD-62 after the demonstration by the teacher of its work in section.
1.2.2.3	To perform the operation in perceptual form according to the instructions with a diagram and verbal explanation.	Using the diagram and explanation instructions, find out and show the path of the oil from the pump to the valve rocker arm in the section.
1.2.4.4	To perform the operation in verbal form based on the external image of the given command to act.	<p>1. Using the layout of the intersection, name the sequence of traffic.</p> <p>2. Using the scheme of the combine "SKIF-310", name the units and aggregates through which the grain straw mass passes.</p> <p>3. Name which of the following connection diagrams of the stator windings of a three-phase induction motor is made "in star";</p>  <p>"in the triangle"; "in star and triangle on the terminal board of the electric motor"</p>

2.2.3.4	To perform operations in perceptual form according to the instructions given in verbal form.	<p>1. Using the assembly drawing of a two-stage reducer (conical-worm) select the details which can be made of bronze</p>  <p>2. Show the device which serves for reduction of starting current on the diagram</p>
2.2.3.4	To perform operations in perceptual form according to the instructions given in verbal form.	<p>1. Show the diagram of switching the stator windings of an induction motor from star to triangle.</p> 
3.3.3.4	To perform operations in verbal form by signs specified in verbal form.	<p>1. Name the order of movement of the plow unit on the slopes.  2. Name the type of bearing that is installed on the driven shaft of the belt conveyor.  3. Name the starting characteristics of DC motors.</p>
4.3.4.4	To perform operations in verbal form to determine certain features (components) of the named object.	<p>1. Name the parts of the bearing № 7306.  2. Justify which parts of the worm gearbox should be made of bronze.  3. Name the ways to connect three-phase motors to a single-phase network.  4. Name the main advantages and disadvantages of induction motors.</p>
2.4.4.4	To perform operations in mental form on a graphically defined object.	<p>Bearing in mind the principle of operation of a fluorescent lamp with first-generation ballast, the switching scheme of which is shown in Fig. 1, explain what processes take place when connecting an electrical circuit to the network. What are the functions of the choke <math>Dp</math>? What is the purpose of the starter <math>Ct</math>? What is the role of capacitors <math>C1</math> and <math>C2</math></p>
2.4.4.4	To perform operations in mental form on a graphically defined object.	 <p>Fig. 1. The scheme of switching on a fluorescent lamp</p>



4.4.4.4	Forecasting the results of activities in which these objects are involved.	<p>1. Predict how the power consumption in the workshop will change if incandescent lamps (5 units - 130 W, 15 units - 110) are replaced by energy-saving fluorescent lamps.</p> <div style="text-align: center;">  </div> <p>2. Explain how the situation will affect the operation of the mover, in which after the electric motor, put not a sleeve-finger, but cam-disk coupling (Oldem coupling).</p> <p>3. Imagine that when designing a single-speed gearbox with a spur gear, you have decided: make the gears not of steel 40, but of wood. Explain whether such a gearbox will be workable, which will change due to changes in the material of the gears.</p>
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Considering the indicators of action, it is not difficult to see that their combination affects the complexity of the educational task, requiring the learner to implement different levels of educational and cognitive activities. In view of the above, it is possible to assess the complexity of not only traditional but also test tasks, and, accordingly, to develop such tests that would really differentiate students or pupils according to their levels of academic achievement. This procedure can be formalized by entering the coefficient of complexity of the action. Let's focus on the quantitative method of assessing the complexity of educational activities in more detail.

The analysis of the indicators described above shows that the simplest actions are characterized by the following features: *the object* is presented in material form; *the transformation* is performed in material form; *meaningful and executive* parts of  $\Phi$ BA are set in material form; the action is performed by the student (student) **repeatedly** (Ilin et al., 2010).

Thus, 5 indicators of description were used to evaluate this action. The coefficient of complexity for each of these indicators in the simplest case is taken as 1. Naturally, if in the future the action is complicated by a certain indicator, the coefficient should increase by a certain amount.

As a result of theoretical and practical research, we came to the conclusion that when complicating the signs of action on the indicator "*form of representation of the object*" the corresponding coefficient of complexity acquires the following values:  $K_{fo} = 1$ , if the object is presented in material or materialized form;  $K_{fo} = 1,1$ , if it is presented in symbolic form (scheme or drawing);  $K_{fo} = 1,2$ , if the de-

scription of the object is given;  $K_{fo} = 1,3$ , if the object is just named. If the object of action is not named in the educational task (the student has to choose it independently), then  $K_{fo} = 1,4$ .

Accordingly, if *the transformation of the object* is performed in material form, the coefficient of complexity of the action on this indicator will be  $K_{po} = 1$ ; at the perceptual form of transformation  $K_{po} = 1,1$ ; at verbal form  $K_{po} = 1,2$ ; if mental operations are performed with a given object, then  $K_{po} = 1,3$ .

It is accepted that according to the indicator "*Form of presentation of the meaningful part of the approximate basis of action ABA to the performer (student)*" the coefficient of complexity acquires the following values:  $K_{zch} = 1$ , if the student is told that he must perform the learning activity on a real object; if the student is asked to use a drawing or diagram for this, then  $K_{zch} = 1,1$ ; description of the features of the object –  $K_{zch} = 1,2$ ; the name of the object –  $K_{zch} = 1,3$ ; in the absence of the meaningful part of the ABA in the task  $K_{zch} = 1,4$ .

According to the indicator "*Presentation of operations for the transformation of the object in the ABA*" there is also a rule: the coefficient of complexity in the simplest variant of action has a value of  $K_{ip} = 1$ , and each variant of complication of action increases its value by 0.1. In particular, if in the educational task the student is asked to perform the educational task after the demonstration of actions with their explanation by the teacher or master on the real object,  $K_{ip} = 1$ ; if the student has to perform the same task after he has been shown the sequence of actions by the teacher without explanation,  $K_{ip} = 1,1$ ; when the logical part of the ABA is given only by the language instruction,  $K_{ip} = 1,2$ ; provided that

in the task, the student is listed with operations that he must perform,  $K_{ip} = 1,3$ ; if the logical part of ABA is absent in the task,  $K_{ip} = 1,4$ .

It will be recalled that the values of the coefficients of complexity of educational activities on four indicators have been determined so far. The fifth indicator is integrative: it characterizes the learning activity depending on whether new or repeated for the student are signs of action and performance of the task as a whole. In view of the above, it was assumed that if the student has already performed such a task (all signs of action he had encountered before, he is familiar with the object, did similar operations to transform it, etc.), the coefficient of complexity of this indicator  $K_n = 1$ . If for the student one sign of action (for example, object) is new, the coefficient of complexity makes  $K_n = 1,25$ ; if there are two or three new signs of action in the task, the coefficient of complexity is  $K_n = 1.5$  and  $K_n = 1.75$ , respectively. Provided that all the signs of the action to be

performed and met for the first time by the student, are completely new to him, the coefficient of complexity is  $K_n = 2$ .

The total coefficient of complexity of the action, and, accordingly, the learning task, can be calculated by the formula:

$$K_z = K_{fo} \times K_{po} \times K_{zch} \times K_{ip} \times K_n,$$

where  $K_{fo}$ ,  $K_{po}$ ,  $K_{zch}$ ,  $K_{ip}$ ,  $K_n$  – coefficients of complexity of the action on the relevant indicators (Ilin, Luzan, Rudyk, 2010).

Consider examples of determining the overall complexity of a simple and complex educational task according to the proposed method.

**Example 1.** Using the provided drawing with explanation, find among the located on the rack (section, stand) parts that belong to the depicted mechanism, select and name them (the action is performed on a known student object).

№	Performance indicators	Characteristics of the indicator	Coefficient of complexity on the appropriate basis
1	Contents of ABA	Drawings and explanations to it	1
2	Logical part of ABA	Verbal (instruction)	1,2
3	Object presentation form	Material	1
4	Form of transformation	Material and verbal	1,1
5	Novelty	The action is repeated	1
Total coefficient of complexity of action			1,32

**Example 2.** Name the parts that make up the crank mechanism of an internal combustion engine (the action is performed with an object that is already known to the student).

№	Performance indicators	Characteristics of the indicator	Coefficient of complexity on the appropriate basis
1	Contents of ABA	Object name	1,3
2	Logical part of ABA	Verbal	1,3
3	Object presentation form	Verbal (name details)	1,3
4	Form of transformation	Mental	1,3
5	Novelty	The action is repeated	1
Total coefficient of complexity of action			2,86

In the first example, the coefficient of complexity of action is  $K_z = 1.32$ . This educational task is relatively simpler than the second one, in which the coefficient of complexity of action is  $K_z = 2.86$ . It is worth noting that if this action was completely new to the student, the specified parameter of the complexity of the task would be equal to 5.72.

**Conclusions.** Based on the provisions of the theory of gradual formation of mental actions and concepts, the following indicators of the complexity of the educational task are identified: the form of

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presentation of the contents of the approximate basis of action to the performer; the presence of actions of operations to transform the object in the approximate basis; the form of presentation of the object of action; the form of transformation of the object of action; degree of novelty for the student of the action being performed. The scientifically-grounded methodology of designing (and evaluating) the complexity of the educational task allows the teacher:

- to develop a complex, base of individual educational tasks for pupils or students on the principle "from simple to complex";
- by purposeful selection of educational tasks with a certain degree of difficulty to develop educational and cognitive activities of students from reproductive, executive levels, to productive, creative;
- to assess objectively the competence achievements of students, determine the level of quality of

professional training of future mechanical technicians, electrical technicians, etc. ;

- to interpret unambiguously the results of assessment of knowledge, skills and other abilities of students and effectively to manage the educational process.

Prospects for further research will be related to the substantiation of the technology of assessing the quality of training of specialists in technical specialties in colleges.

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## МЕТОДИКА КОНСТРУЮВАННЯ ЗАВДАНЬ ОЦІНЮВАННЯ РЕЗУЛЬТАТІВ НАВЧАННЯ СТУДЕНТІВ ТЕХНІЧНИХ КОЛЕДЖІВ

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### Реферат.

*Актуальність* визначається реформуванням змісту, методів, форм, технологій інженерно-технічної освіти, що відбувається на основі компетентнісного підходу й зумовлює потребу в таких діагностичних методиках, які б дозволили ефективно управляти особистісно орієнтованою педагогічною взаємодією, об'єктивно й надійно оцінювати рівень опанування майбутніми механіками, техніками, технологіями компонентами освітньо-професійних програм.

*Мета*: розроблення методики конструювання й оцінювання складності індивідуальних навчальних завдань як поетапної процедури, заснованої на аналізі умови пропонованої навчальної дії та показників новизни її виконання студентом технічного коледжу.

*Методологія* дослідження базується на єдності діяльнісного, системного, особистісно-орієнтованого та технологічного підходів, що дало змогу розробити студентоцентровану, алгоритмізовану, орієнтовану на структуру навчальної дії методику конструювання індивідуальних завдань оцінювання освітніх досягнень студентів технічних коледжів.

*Результати:* на основі концепції поетапного формування розумових дій виокремлено показники опису навчальних дій у певній послідовності їх формування (форма подання виконавцю змістової частини орієнтовної основи дії – наявність в орієнтовній основі дії операцій щодо трансформації об'єкта – форма подання об'єкта дії – форма трансформації об'єкта дії – ступінь новизни для здобувача освіти дії, що виконується); наведено приклади конструювання системи індивідуальних навчальних завдань студентів.

*Висновки:* доведено необхідність формалізації процедури оцінювання складності індивідуальних навчальних завдань студентів шляхом використання показників орієнтовної основи дії, виконавчої частини та новизни дії задля їх диференціації від найпростіших до складних, високоінтелектуальних.

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**Ключові слова:** *складність навчального завдання, студент, теорія формування розумових дій і понять, оцінювання, методика.*

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