

METHODOLOGY FOR CREATING METHODOLOGY GUIDELINES ON COMPUTER DISCIPLINES AT DIFFERENT LEVELS OF STUDENT'S EXPERTISE

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Abstract: *The methodology of creation of methodology guidelines on computer disciplines with the purpose of formation of engineering thinking at different levels of student's expertise is presented. The motivation for creating a system of methodology is determined. The content of the methodology guidelines, most widely used in the teaching environment, is presented. A distinction is made between the latter and the methodology guidelines considered by the author, taking into account the different levels of students' expertise. The concept of development of its two main parts is described, which are a feature of this study manual. The most significant moments in terms of content for each part of the methodology guidelines are determined from the point of view of practical experience. Key points and components that need to be tracked while working on this manual are highlighted. The purpose of each part of the methodology guidelines for different levels of students' expertise is determined. A sequence of work is described and recommendations are given on the final presentation of the manual. Studies on students' choice of methodological materials for laboratory works in AutoCad and Power Point programs are presented. The analysis of the obtained results is carried out. Conclusions based on the results of the study materials are summarized and generalized. Data are received on the priority of students' choice of a methodological guideline that takes into account the different levels of students' expertise. The data of the required directions in the study were obtained. The article is aimed at the further search for effective methodical systems for teaching computer graphics in order to form engineering thinking.*

Keywords: computer graphics, methodical systems, classification of techniques, propaedeutical stage, methodical guidelines, training of students.

With the purpose of training specialists at a qualitatively new level in the conditions of the information society, many universities are turning to the program of continuous computer training. A search for time resources for computer disciplines takes place as well as an expansion of the subject of elective courses related to the use of computers, effective graduate successive competence models are developed, work programs are adjusted to track the sequence of accumulation of knowledge and information technology skills.

The goal is "the formation of engineering thinking" because it is obviously relevant, understandable, is achieved by means of precisely

natural science disciplines¹. To carry out the planned program, the availability of trained highly professional personnel and the availability of a scientifically sound methodology of teaching is important.

Materials and methods

Engineering thinking is a special kind of thinking that is formed and manifested in the solution of engineering tasks that allow solving the tasks assigned to meet technical needs in knowledge, methods, and techniques quickly, accurately and ingeniously, in order to create technical means and organization of technologies². The study of natural science disciplines using a computer provides quickness in solving engineering tasks, eliminating routine work. They stimulate thinking; allow one to perform a quick analysis of devices and the operation principle of technical objects, to find a model for solving a problem or a task by trial and error, to make a comparison with the known types of tasks, to give reason for their actions, to get results and to draw conclusions³. From this follows the relevance of the possession of tools in computer technology.

Earlier, the author introduced a conditional classification of methods of teaching computer disciplines⁴. After identifying the specifics of the work of each pedagogical group and conducting an analysis of activities, directions were identified for further searching for effective methodological systems for computer graphics teaching. In particular, as one of the elements of the methodology of teaching disciplines using computer programs, it was proposed to use the methodical instructions at the first propaedeutic stage of education, which take into account the different levels of students' training: "advanced user", "beginner"⁵.

¹ A.P. Usoltsev, T.N. Shamalo, "On the concept of "engineering thinking"", in *Formation of engineering thinking in the learning process: materials of the international practical conference*, Ekaterinburg, 2015, p. 3-9.

² E.A. Duma, "Levels of formation of engineering thinking", in *Advances in Current Natural Sciences*, 2013, no. 10, p. 143-144.

³ A.R. Arzhanik, "Formation of engineering thinking of schoolchildren in the process of design and research activities in after-hours", in *Formation of engineering thinking in the learning process: materials of the international practical conference*, Ekaterinburg, 2015, p. 15-19.

⁴ N.I. Fokina, T.V. Boschenko, "Search for an effective methodical system for teaching computer graphics to students", in *Geometry and Graphics*, 2013, vol. II, no. 1, p. 68-69.

⁵ V.A. Gnevasheva, "The role of education in the development of Russian society", in *Russian Education and Society*, 2011, vol. 53, no. 4, p. 84-96.

The purpose of the following researches is the development of such methodological guidelines and efficiency checking of their use in the educational process.

Results and discussion

Development and verification of the efficiency of methodological guidelines usage for various levels of students' training (methodological guideline in two levels of knowledge) was conducted for the disciplines "Descriptive Geometry and Engineering Graphics" (AutoCad), "Business Illustrative Graphics" (Power Point). In AutoCad, the emphasis was on 3D-modeling, since it is the basis of 3D technology for design, construction and drawing⁶. This program, which contributes to a deep understanding of the tasks to be solved with the best visibility of parts' models, assembly nodes, is uniquely called upon to form engineering thinking⁷. The students were offered methodical material of two types with the same laboratory assignment. The observation and fixing of an individual choice of a certain methodical material were carried out.

An appeal to methodical instructions in two levels of students' training is conditioned by the requirement of educational standards in the formation of a competent specialist. This process is complex and multifactorial and includes the following components among equals:

- a fundamental knowledge base;
- a sustainable need for self-education in the context of a huge information space and a rapid change in technology;
- self-sufficiency of the person, expressed in the ability to adapt the activity to any conditions at continuous and constant education⁸.

When studying the disciplines of the computer cycle, it is justified to focus on the fact that the computer is only a tool for a particular practical application. Therefore, the study of the main toolkit of any program should be carried out in a short time and immediately on examples that are bound to a discipline. There is a reality that the level of

⁶ A.L. Kheyfets, *3D-technology of the drawing construction. AutoCAD*, BHV-Petersburg, Saint Petersburg, 2005.

⁷ A.L. Kheyfets, A.N. Loginovsky, "3D modeling of threaded connections, gear and worm gears in the course of computer engineering graphics", in *Information technologies and technical design in vocational education and industry: a collection of materials of the 1st all-Russian scientific and practical conference*, Novosibirsk, 2009, p. 35-48.

⁸ N.I. Fokina, M.I. Konovalova, (2006). "Disciplines of the graphic cycle in the formation of a competent specialist", in *Use of the educational potential of educational disciplines in the formation of competent specialists: theses of reg. scient.-method. conf.*, Tyumen, 2006, p. 204-206.

training of first-year students in the field of information computer technologies is different. And the task is to erase the boundary in the possession of the computer environment in the first stages of learning. The use of methodological guidelines in two levels of training allows students, when performing a task, to independently choose the way to achieve a result depending on their initial individual knowledge base.

A common standard interpretation of the content of the methodological guidelines sounds like this:

Methodical guidelines for laboratory work are designed to help students to perform laboratory work in the volume of a particular course or section. The guidelines may contain the following elements:

- orientation apparatus (foreword, contents, literature, appendices);
- the organization of laboratory work (the subject of laboratory work, the goals and objectives, the brief theoretical information, the sequence of laboratory work, tasks, methodological recommendations for the laboratory work, control questions, suggested reading).

Creating a methodical guideline in two levels of training differs from the generally accepted methodological guideline only in the section of the work sequence, where the first considers simultaneously two variants for the purpose of "advanced users" (having some experience with the program) and "beginners" (those, who does not have any experience in the program).

The preparation of methodological guidelines in two levels of training requires a certain qualification of the teacher. An experience in performing the given laboratory work or a task for which it is planned to issue methodological guidelines is required. Since experience will tell you the most optimal way, the scheme for performing a lab work or an assignment, and its key points. On the other hand, if the teacher conducted classes on this assignment in the classroom, he knows all the questions that arise when it is being done, knows the moments that cause special difficulties for students and the moments that require additional explanations in class.

The development of a methodical guideline in two levels of training should begin with step-by-step instructions, if this methodological guideline is intended for the first laboratory classes on discipline⁹. For the development of engineering thinking, a specialist needs a certain amount of knowledge and experience, which are accumulated in such kind of

⁹ N.I. Fokina, I.N. Spirina, *Methodical guidelines for laboratory, practical classes and independent work of students on the discipline "Business illustrative graphics"*, TSOGU, Tyumen, 2010.

educating process. For subsequent work, the content of this detailed part will be reduced until the student independently learns to use the toolkit of the program and is not ready to independently seek the necessary solutions. He will begin to see tasks more widely and unconventionally. The thought process will be more aimed at finding engineering constructive options. In subsequent laboratory work, it becomes unnecessary to bring detailed explanations, references to the toolkit of the program even for beginners. The greater emphasis in the methodological guideline should be placed on the search and application of the necessary reference information in a condensed form, providing illustrative examples, illustrating the fulfillment of the elements of the task that the student did not previously meet. The content of the laboratory assignment should involve different types of thinking such as logical, creative, visual-figurative, practical, theoretical, technical, and spatial. Consequently, the content of this section of the methodological guideline completely depends on the place and time in the educational process¹⁰.

The development of step-by-step instructions will allow one to optimally come to the structure of one of the most important parts in the methodical construction: a section for "advanced users". Since this section represents the key points of laboratory work in the necessary sequence. They will continue to be the main elements of the laboratory work assignments, and set the actions algorithm in the direction of achieving the goal and objectives of the work as a whole. From experience, it is recommended to construct this part with an illustrated sequence with a small text in the form of instructions for operations to perform the elements of the task.

In the work on the methodological guideline in the two levels of students' training, the following components take place:

a) concentration of information, which is based on the allocation of the main key elements from the total volume of laboratory work or assignment;

b) organizing of the logical scheme of the selected elements of the task, where each element of the task carries a semantic load and corresponds to a certain function:

- development of a new element (fragment);
- adding or finishing the previous element in the task using new commands or connecting the editing commands;

¹⁰ O.V. Zashchirinskaia, A.V. Lapteva, E.I. Nikolaeva, N.A. Medina Bracamonte, E.V. Zmanovskaya, "Concepts of friendship among primary school children with intellectual disability", in *Novosibirsk State Pedagogical University Bulletin*, 2018, vol. 8, no. 2, p. 26-42.

- repetition of an element for the purpose of fixing it in memory or acquiring a sustainable skill;

- repetition of an element with a slight modification;

- repetition of an element having a certain degree of difficulty and fixing skills for its implementation, etc.;

c) ensuring the coherence of the elements of the task as a whole, which consists in the fact that the goal and tasks of laboratory work (tasks) are the main thread, to which all its main elements are sequentially strung, taking into account the successive connection of the commands for creating and editing the objects;

d) assessment of the sufficiency of the base of knowledge and skills for coping with laboratory work in this form;

e) assessment of the availability and clarity of visual means of presentation of the sections of methodological guidelines in general, unambiguity of definitions and graph-based mappings¹¹.

If the development of a methodical guideline in two levels of training should be started with the development of the "beginner" section, then in the finished printed publication, a section for "advanced users" is recommended to be placed before the variant for beginners. At present, we are accustomed to read a huge information space in a selective manner, to highlight the key points and only what interests us at the moment.

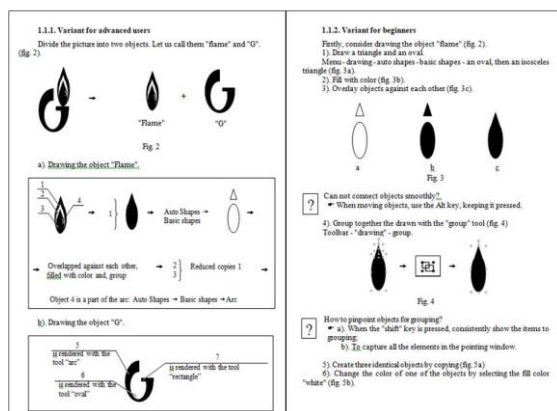


Figure 1: A fragment of the methodical guidelines in two levels of training for the discipline "Business Illustrative Graphics"

The section for "advanced users" represents all the laboratory work at once, gives the very essence, and then the student has a choice of

¹¹ N.I. Fokina, I.N. Spirina, *Methodical guidelines for the control works of extramural students in the discipline "Business illustrative graphics" of all specialties*, TSOGU, Tyumen, 2014.

his way of accomplishing the task. Somewhere it may be necessary to work out some element step by step on the next section. Somewhere, knowledge level will allow making the element of the task without any help¹².

A fragment of the methodical guidelines in two levels of training for the discipline "Business Illustrative Graphics" is presented in Figure 1.

Approbation of methodological guidelines for laboratory studies of first-year students in two levels of training was carried out in disciplines "Descriptive Geometry and Engineering Graphics" (AutoCad), "Business Illustrative Graphics" (Power Point program). The study on the preferences in methodological materials is presented in Table 1.

Table 1. The choice of methodological materials by students in the performance of laboratory work

Group No.	Number of people	Training program	Methodical material					
			Reference instruction, people		Step-by-step instruction, people	Methodical guideline in two levels of training, people		
			beginning of class	by the end of classes	beginning of class	by the end of classes	beginning of class	by the end of classes
1	13	Power Point	5	-	2	1	6	12
2	12	Power Point	6	-	2	-	4	12
3	11	Power Point	4	1	1	1	6	9
4	15	Power Point	5	1	4	2	6	12
5	10	Power Point	1	-	5	1	4	9

¹² N.I. Fokina, M.I. Konovalova, "Disciplines of the graphic cycle in the formation of a competent specialist", in *Use of the educational potential of educational disciplines in the formation of competent specialists: theses of reg. scient.-method. conf.*, Tyumen, 2006, p. 204-206.

6	12	Power Point	8	-	1	1	3	11
7	10	AutoCad	1	-	4	-	5	10
8	11	AutoCad	-	-	5	1	6	10
9	11	AutoCad	-	-	3	3	8	8
10	12	AutoCad	2	2	4	2	6	8
11	13	AutoCad	1	-	5	-	7	13
12	11	AutoCad	-	-	5	2	6	9
13	11	AutoCad	1	1	6	1	4	9

Analyzing the results of students' choice of this or that methodological material, it is possible to draw the following conclusions:

a) preference for reference instructions is given when studying the program which a student met in the framework of the school program (in our studies, it is the Power Point program). At the beginning of the lesson, students choose the supporting instructions, which represent only the essence and the course of work;

b) preference for a step-by-step instruction is given by students who are not familiar with the program or feel that help is needed when performing a task or if there is a factor of uncertainty in their knowledge;

c) the optimality of the methodological guideline in two levels of training is understood in the process of work.

Those who have chosen supportive instructions tend to overestimate their capabilities. The existing knowledge base is not enough, and they ask to give them a methodical instruction in two levels, where there are both key points and expanded material.

Those who chose step-by-step instructions, seeing the work of their fellow students, understand that it is possible to perform the task faster. Use the reference instruction when the element of the work is familiar, and in cases of difficulties, to fall back on the variant described in more detail. In the end, most students resort to methodological guidelines in two levels. This is clearly shown by the research data given

in Table 1 in the column "Methodological guideline in two levels of training", "by the end of class".

The data obtained show that it is expedient and effective at the first stage of training to use the methodological guidelines in two levels of students' training.

It is assumed that the application of this type of guidance in the educational process leads to a reduction in the time for learning the basics of computer programs and the optimal logical direction of thinking activity. Consequently, it significantly helps to perform more serious tasks, which form the corresponding engineering thinking. The presented fundamental principles, recommendations, conclusions on the creation of a methodical guideline can be used both in computer and other disciplines in any educational area.