# THE DISTANSE TRAINING OF STUDENTS IN GRAPHIC DISCIPLINES USING STEP-BY-STEP OPERATION CARDS

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**ABSTRACT**
The article deals with the organization and implementation of student's distance training to perform graphic tasks in the framework of the academic discipline "Engineering graphics". To ensure the graphic skills formation, we offer cards of step-by-step operations, which describe and illustrate step-by-step the algorithm of the student's activity in performing a typical task. The structure of cards of step-by-step operation is presented, consisting of coordinating, information-activity and control blocks. A content description and each block purpose of the step-by-step operation cards is provided. Organizational issues and methods of conducting training sessions with the use of step-by-step operation cards are described, which includes four main the teacher and student's work stages. For the distance learning organization, the ZOOM Internet video communication system is offered, in which classes are held online. The article describes the course of experimental work on the application of the developed methodology and cards of step-by-step operations in the student's remote training framework to perform graphic tasks in the academic discipline "Engineering graphics" using the ZOOM Internet video communication system. The experimental work tabulated results are presented, confirming the high efficiency of the developed methodology and methodological support - cards of step-by-step operations.
**Keywords:** distance learning, graphic training, cards of step-by-step operations, conducting classes methods, Internet video communication system, experimental testing

## INTRODUCTION

The students basic technical training is one of the most important areas of training focused on the formation and development of not only students general professional competencies, but also on the development of their professional competencies related to the perception and understanding of modern technical information. The complex of main technical disciplines is included in the curriculum of bachelors training – future engineering and technical employee. Distance training in main technical disciplines involves ensuring effective, managed by the teacher and independent work of students, which, in turn, requires the forms development of organization and methods for implementing the educational process, focused on the teacher’s monitored independent work of students.

## LITERATURE REVIEW

The theoretical basis of the study was Russian researchers' work in the field of distance learning in engineering graphics, as well as in the learning algorithms field. Research methods: literary sources analysis, forming a pedagogical experiment, statistical processing methods of theexperimental results.

The general technical training system has integrity (it is an interconnected set of educational disciplines of a general technical profile that form professional competencies among cadets and students) andhierarchy (disciplines are in a structural and substantive interrelation), and a completely new, emergent property of such a system appears – the educational space creation where pedagogical process of the students general technical training takes place.

One of the basic disciplines included in the course of students general technical training is the educational discipline "Engineeringgraphics," the study of which, accordingto E. Vekhter, V. Saf'yannikova (2015) and E. Emchenko (2019), allows students to form spatial representation, imagination, as well as constructive and technological thinking during solving graphic tasks and building drawings of technical objects: parts working drawings, assembly drawings ets.

Within the curriculum "Engineeringgraphics" there are a large number of practical lessons focused on independent, but pedagogically managed work of students, which should be implemented in the framework of distance learning, whichisdescribedintheworksofC.BurkovaandG. Vinokurova (2014), T. Bogdanova (2014) ets.

At the same time, when implementing distance learning, even using video communication technologies, the pedagogical management of students' independent work in the classroom is difficult, due to the impossibility of direct multi-vector pedagogical interaction with students, implemented during face-to-face classes, whichisdescribedintheworksof V. Trifonova, O. Belokrylova (2011), N. Dneprovskaja (2018), A. Shvajger (2005) ets.

  

Therefore, it is necessary to ensure effective management of students' independent work in distance practical lessons, ensuring the gradually implementation of practical work and the formation of an orientatial basis for students' actions. One of the directions of effective realization ofmanagement of studentsindependent workduring distance learning, accordingto V. Trifonova, O. Belokrylova (2011) and V. Panchenko (2020), is the formation an orientatial basis of actions by means of specially created educational and methodical documents - cardsofstep-by-stepoperation (CSSO) and also their application techniquesin distance learning. The cardofstep-by-stepoperation is a teaching and methodological development, which includes three main blocks: targeted, information-activity and control.

The target block is aimed at the orientation of students in the topic and content of the lesson, for its purposes, the necessary tools, materials and methods for presenting finished works to the teacher. The target block contains topic, diagnostic goal and objectives of the lesson, literature for preparing for it, etc.

The information-activity block presents an algorithmic description of students' actions to complete a typical educational task. The unit is formed according to the requirements set out in the European concept "Modularemployeableskills" (MES-concept), and consists of text paragraphs, each of which is matched with a reference figure illustrating the process of performing a typical training task.

The control unit is focused on monitoring the level of students knowledge and skills formation worked out during the study of the information part of the second unit. The control unit is a pedagogical test consisting of 10 test tasks on the training material of the previous unit with answer forms, as well as a sample of graphic work.

For the distance learning organizationin the discipline "Engineering graphics" such CSSOs were developed as "The intersection of straight lines in space", "The relative position of a straight line and a plane", "The projection conversion methods", "The truncated pyramide "," The intersection of geometric object: the method of secant planes "," The intersection of geometric object: the method of secant balls "," The graphic of the details of machines "," The cross section's of the details of machines "," The threads and threaded connections "," The assembly drawings ".

The use of CSSO in the context of distance learning requires the reorganization of training sessions in such a way that a training session conducted using videoconference could be relatively divided into two parts - theoretical and practical. The methodology for organizing and conducting distance learning classes using CSSO includes the following three main stages:

1. Preliminary stage. At the end of the lesson preceding the practical lesson, students received information from the coordinating block and information on the content of compulsory self-preparation for the lesson. For this, hours of independent work in the discipline are necessarily allocated in the class schedule.

2. Theoretical stage. A summary of the necessary training information and a detailed study of the cards of step-by-step execution of operations. At the same time, students were guided by the following methodology for working with CSSO recommended by the MES-concept:
- studying the text paragraphs of the left side of the CSSO, analyzing the illustrations accompanying each paragraph of the text part, establishing the correspondence of the description of the stage of performing the work to the image in the figure;
- restoration of the algorithm and the meaning of performing typical graphic work only from the illustrations of the right side of CSSO, for which all CSSO text paragraphs should be closed.

3. Practical stage of the lesson. Relying on the algorithm for completing a typical task and closing the illustrative part presented in the textual part of CSSO, students perform individual graphic work on tasks options that are informatively but not graphically consistent with a typical task. After completing the work, students perform a self-test, comparing the result with the sample given at the end of the CSSO, identify and correct possible errors. For implementing the developed methodology, distance learning lessons in the discipline "Engineering graphics" were arranged in a schedule for four hours and were conducted using the ZOOM video communication system.

**RESEARCH METHOD**

The experimental testing of the developed methodology was carried out during the implementation of practical classes in the discipline "Engineering graphics" by students studying in the Ural Institute of State Fire Service of EMERCOM of Russia in specialty training "Fire safety" and “Technosphere safety".

  

96 students took part in the experimental work, which made it possible to form the control and experimental groups, differing in approximately the same level of students training, revealed during the ascertaining part of the experiment. The control group included 45 students, and the experimental group included 51 students. The experiment results were assessed according to the approved rating 100-point system, which was translated into the traditional rating system as follows:

– passing grade от 0 до 50 – Unsatisfactory – low level of graphic skills formation;
– passing grade от 51 до 70 – Satisfactory – middle level of graphic skills formation;
– passing grade от 71 до 85 – Good – elevated level of graphic skills formation;
– passing grade от 86 до 100 – Excellently –high level of graphic skills formation.
The experimental testing included three main stages: ascertaining, forming and evaluating, which were carried out during the academic year.

At the ascertaining stage, the initial level of the students' graphic skills formation was determined with the help of control tasks complexes and the control and experimental groups of students were formed, differing in approximately the same initial level of graphic training. The results of the control experiment are shown in figure 1.
In the diagram shown in figure 1, it can be seen that the majority of students in the control and experimental groups are dominated by unsatisfactory and satisfactory grades. Gradesgoodandexcellentareabsentinbothgroups.
At the formative stage in the control group, traditional distance learning sessions were conducted using the ZOOM video communication system, during which the teacher gave students tasks, told them a short theory and general algorithm for completing the task. Then the students independently, but with the teacher's advice, performed graphic work.

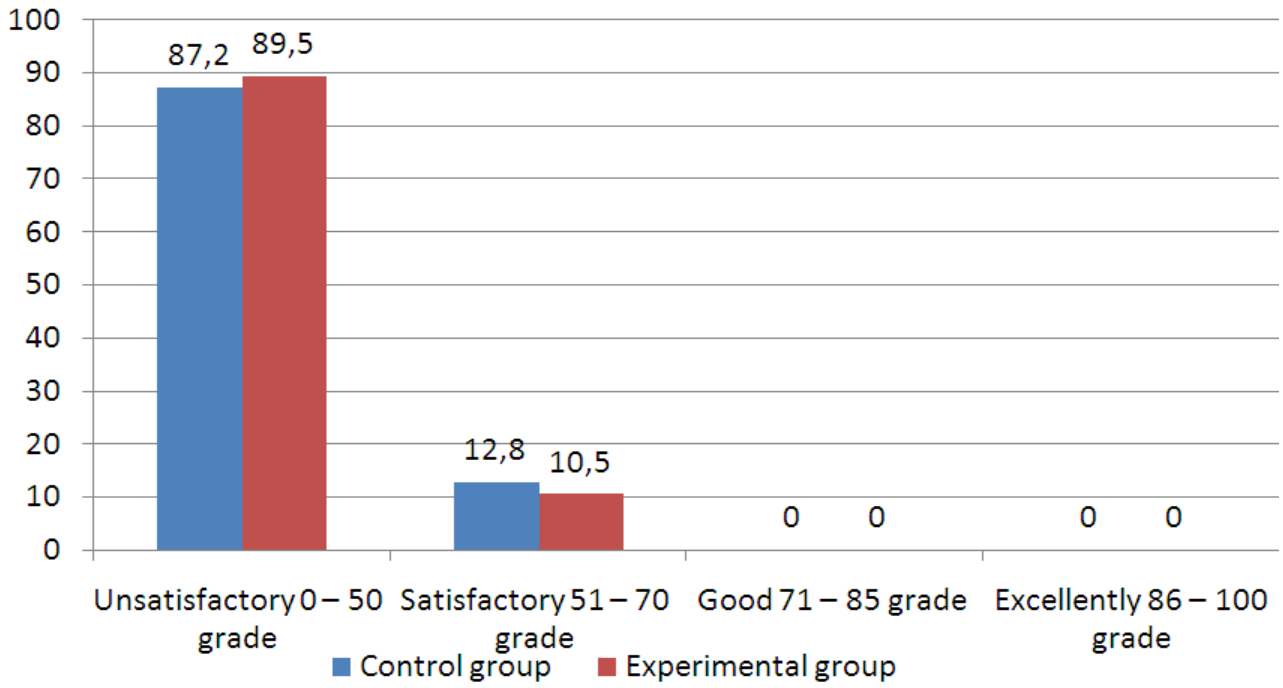


Figure1. Control experimental results

In the experimental group, distance learning sessions with students were conducted in accordance with the developed methodology and using CSSO. During the distance classes, video communication technologies were used with the use of the ZOOM system. The training sessions were held for four academic hours. The first two hours of the lesson were devoted to a brief presentation of theoretical information on the lesson topic, after which the teacher, together with the students, worked out the CSSO in detail, then the students completed the test given in the controlling part of the CSSO. The test results were promptly analyzed by the teacher, after which the main provisions of the CSSO were once again clarified during the conversation with the students.

  

The next two hours of the lesson were devoted to the students' independent work on the implementation of the practical assignment. Relying on CSSO, which presented a solution to a typical problem, the students performed graphic work, solving a similar problem, but with different initial data. At the same time, the teacher performed an advisory function, answering students' questions during remote interaction in the ZOOM video communication system. Students had to submit the final completed work for checking immediately after class or the next day. The papers for checking were presented in the photographs form sent to a specially created e-mail address of the discipline, access to which had all the teachers participating in the experimental work.

At the assessment stage, the students average rating score was deduced and an exam in the discipline "Engineering Graphics" is held. The exam is conducted through interviews with students on theoretical issues of the discipline and students' test task performance using videoconference in the ZOOM system. The exam also used a 100-point rating scale. The results of the forming experiment are shown in figure 2.

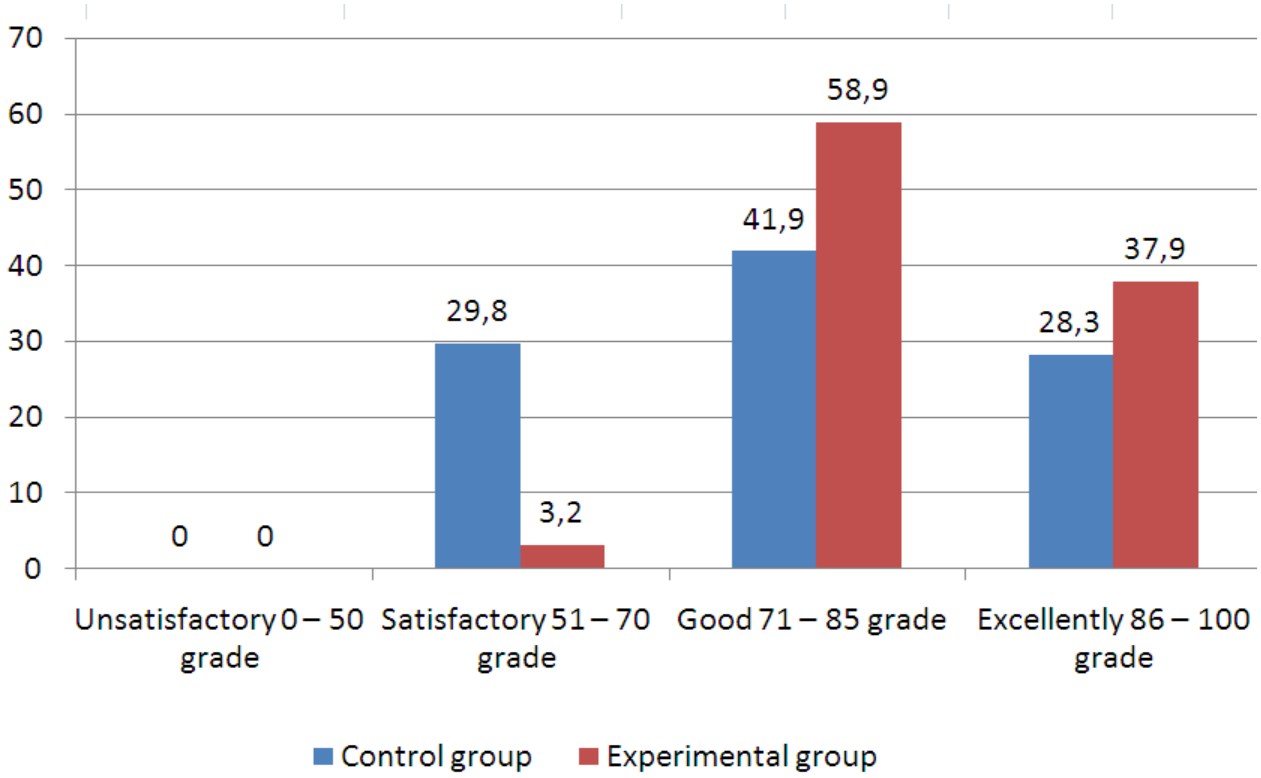


Figure 2. Forming experimental results

Comparison of the experimental work results (control and experimental groups) are given in Table 1, which indicates the percentage of students who scored certain points at the ascertaining stage of the experiment, according to the formative and control stages results of the experiment.

**Table 1:** The results of experimental testing

| Groupsofstudents | Percentage of students who showed different levels of graphic skills during the experiment | | | |
|---|---|---|---|---|
| | Unsatisfactory 0 – 50grade | Satisfactory 51 – 70grade | Good 71 – 85grade | Excellently 86 – 100grade |
| Control experimentalresults | | | | |
| Controlgroup | 87,2 | 12,8 | 0 | 0 |
| Experimentalgroup | 89,5 | 10,5 | 0 | 0 |
| Formingexperimentalresults | | | | |
| Controlgroup | 0 | 29,8 | 41,9 | 28,3 |
| Experimentalgroup | 0 | 3,2 | 58,9 | 37,9 |

  

## DISCUSSION AND CONCLUSION

The analysis of the experimental work results allows us to assert that at the ascertaining stage of the experiment, about 87 - 90% of students in the control and experimental groups found a low level of graphic skills formationand about 10 - 12% - an average level of graphic skills formation. According to the formative stage results of the experiment, during the level assessment of the students' graphic skills formation by the complex of work performed and the exam results, 29.8% of students in the control group found an average level of graphic skills formation, 41.9% - an increased level, 28.3% - a high level of graphic skills formation. In the experimental group, during the formative and evaluative stages, only 3.2% of students showed an average level of graphic skillsformation, an increased level of 58.9% of students, and a high level of graphic skills formation - 37.9% of students.

Consequently, the experimental testing results allow us to speak about the effectiveness of the proposed method of using cards of step-by-step operation for organizing and implementing remote graphic training of students - future specialists in the technosphere and fire safety field.

The reliability of the experimental testing results was assessed using a one-sided sign criterion, which is based on counting the number of unidirectional results by pairwise comparison (at the ascertaining and evaluative stages of the experiments). The reliability of the results of experimental testing is 95%, respectively, it can be argued that the use of the distance learning methodology developed by the authors using cards of step-by-step operation makes it possible to effectively form students' graphic skills related to the ability to perform graphic works, solve graphic problems, analyze and carry out drawings of machine parts and assembly drawings.

Thus, it can be said that the successful remote graphic skills formation, as well as the ability to analyze and read drawings of future specialists in the technosphere and fire safety field, is possible if the following conditions are met: inclusion of the "Engineering graphics" discipline in the complex of general technical disciplines implemented in a systemic totality in a specific educational space, including an organized software and material and technical environment (using Internet video communication); the presence of a developed specific educational and methodological support, which reflects the logically completed algorithmic learning content (cards of step-by-step operation); the development of specific system of teaching methods and techniques (reflected in the methodology of distance learning sessions using cards of step-by-step execution of operations); availability of pedagogical staff prepared for the implementation of the developed distance learning methodology.

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