Model of competently oriented teaching of stereometry to future engineers

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Abstract. The purpose of this study is to solve the problem of low level of mathematical competence of future workers specialized in mechanical engineering. The conducted researches made it possible to develop a model of the technique (methods) of competently oriented teaching of stereometry to students of the vocational school specialized in mechanical engineering. The developed methodology is based on the project method of training, gamification, makering and a system of competently oriented tasks. The internal structure of the experimental model is represented by four blocks: target, content, activity, and evaluation.

Keywords: *mathematical competence, stereometry, vocational school.*

Introduction. The engineering industry is one of Ukraine's most important strategic industries. The European integration process and the need to attract investment in the field of mechanical engineering require knowledgeable and experienced specialists from the country. Such a need led to the modernization of Ukrainian vocational education. The Law on Education adopted in 2017 emphasizes a new approach to the educational process and that is the competent approach.

The landmark of the educational process restructuring in the vocational school specialized in machine-building (engineering) was a graduate, i.e. a skilled worker of a new type who has deep theoretical knowledge and ability to apply it independently in non-standard, constantly changing working situations. Compliance with these requirements requires quality student training, particularly in stereometry.

In 2017, the conducted polls [2] in different regions of Ukraine among students of the vocational school specialized in mechanical engineering (208 respondents participated in the surveys) showed that 59.04% of respondents did not like to study stereometry. 34.94% of respondents do not understand why they should study stereometry at all, and 66.27% do not use knowledge of stereometry in everyday life. Such a result indicates a lack of profound and conscious mastery of stereometric knowledge, a low level of developing the skills to apply this knowledge to solve practical problems, and in future professional and life situations.

Monitoring the quality of education in 2017 showed that the level of educational achievement in the stereometry of future machine-building workers (engineering technicians) is average (4-6 out of 12 points) [1].

The reorientation of the education system and the low level of stereometric knowledge of the future workers of the machine-building specialty gave impetus to the development of a techniques model of competently oriented teaching of stereometry, the purpose of which is to develop the mathematical competence in students of the vocational school of machine-building profession.

1. Methodology model of competently oriented teaching of stereometry to future engineers

Public Inquiry: A competent machine-building (engineering) worker.

The target block is to determine the purpose of forming the mathematical competence of students of a vocational school specialized in mechanical engineering in the process of teaching stereometry.

The content block provides the content that should be used in the process of mathematical competence formation.

The activity block provides methods of form and means, which predetermine competently oriented education of students of the vocational school specialized in mechanical engineering.

The evaluation block of the model contains a system of criteria that provide an opportunity to determine the levels of mathematical formation in students of a vocational school of mechanical engineering.

The result would be a student with the formed level of mathematical competence sufficient for further professional and social activities.

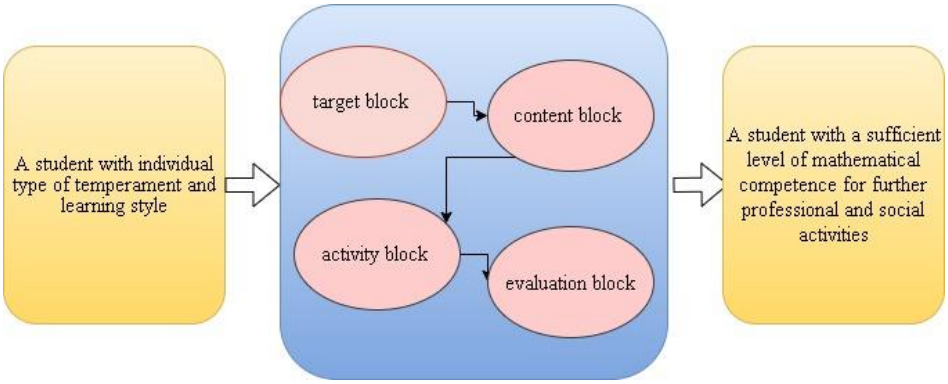

Fig. 1. Model

Let's consider each of the blocks of the model of competence-oriented teaching of stereometry to students of the vocational school specialized in mechanical engineering in more detail.

According to the goal set, the following tasks follow ***in the target block***:

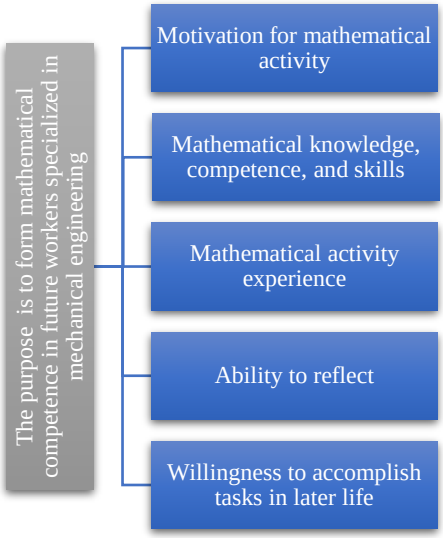

Fig. 2. Target block

- the need for mathematical activity;
- shall possess mathematical knowledge, competence and skills in stereometry;
- shall acquire experience in mathematical activity in stereometry;
- shall be capable of reflection;
- shall be ready to solve tasks in everyday life and professional activities related to stereometry.

Formation of mathematical competence in students of a vocational school specialized in mechanical engineering begins with awareness of the need to study stereometry, in order to better learn the discipline of general and professional training, in order to become a skilled worker and earn a living using this in the future.

The realized need for mathematical knowledge is the basis for the formation of students' motivation to pursue mathematical learning activities. At the motivational stage, students need to understand why and for what purpose they need to learn this instructional material, what they need to learn, and what their main learning task is.

The content block consists of three parts: the normative one, which is defined by the curriculum in mathematics for 10-11 grades (standard level), competently oriented, which, in our opinion, is best implemented in the form of a system of competency-oriented tasks and tasks of a research character.

The activity block consists of forms, methods and teaching aids. Forms of study include individual work in the classroom, group work in the classroom, and work with the teacher. The methods of training encompass the design method of teaching, gamification, and makering.

The evaluation block contains criteria, indicators, diagnostic tools and levels of mathematical competence.

Criteria:
• Motivational;
• Cognitive;
• Activity;
• Reflective.

Indicators:
• Motivation level;
• Distribution of students by educational achievements;
• Reflection development activity.

Diagnostics means:
• Polling of students;
• Performing a control task;
• Reflection diagnostics.

Levels of mathematical competence:

Low:
• selective interest in studying topics of stereometry;
• distortion of a small part of the educational material;
• inability to use mathematical skills to solve competently oriented tasks;
• inability to find errors

Average:
• manifestation of cognitive interest in the study of stereometry topics, however, this manifestation is temporary;
• reproduction of the basic educational material, but with inaccuracies;
• application of mathematical skills only when performing tasks on the sample;
• the answer is correct but not sufficiently reasoned;
• the student is rarely aware of and evaluates his or her own achievements, shortcomings in learning activities;
• seldom shows a tendency to self-analysis and self-esteem.

Sufficien:
• is aware of the need to study stereometry topics;
• has educational material;
• applies knowledge to solve competently oriented tasks, but with inaccuracies;
• the student is not always adequately aware and appreciative of his or her own achievements or shortcomings in educational and cognitive activity.

High:
• is aware of the intrinsic need to study stereometry topics;
• the value of mathematics is revealed;
• systematic, solid knowledge in the volume and within the requirements of the curriculum, consciously uses them in standard and non-standard situations;
• objective self-esteem, self-analysis and the ability to find mistakes when applying a skill to solvie a task (own or suggested for analysis).

2. Implementation of the model of competence-oriented methodology in the process of teaching stereometry to students of vocational school

Motivational component. In terms of organizing productive learning activities, the most appropriate for this stage is to:

- ask students what associations come up with the topic they are starting to learn;
- ask students what they already know about the topic to be studied;
- ask what they expect as a result of the topic studied;
- ask what they want to learn from a new topic;
- ask what is the desired form of learning the new material for students;
- ask what learning tools students will use when teaching this topic;
- ask what kind of control students see at the end of the topic.

The motivational stage provides students with awareness of the purpose and objectives of the proposed topic, while at the same time the installation of the need for their own active educational and cognitive activity is formed in order to master the learning material.

Cognitive component. According to our observations, students of a vocational school specialized in mechanical engineering who can solve purely mathematical problems almost always cannot solve a competent problem. We attribute this fact to some procedural irregularities in the educational process, in particular that the buffer stage has not been implemented in training. Future mechanical engineering workers should learn how to solve intermediate problems that are transitional between purely mathematical and competency problems, so that one can then better navigate competency tasks. Such intermediate tasks are competently oriented tasks. The use of competently oriented tasks in the process of studying stereometry is valuable in that the plot is formulated with the help of a life situation. The tasks involve objects from everyday routine, environment, and architecture. They contain elements of modeling the geometric shapes as well. This is first and foremost necessary so that students in the theoretical or vocational training are ready to correctly identify, measure and calculate certain elements on the models in detail.

In terms of research tasks, we suggest engaging students in the Show and Tell project, in which students are required to shoot a video where they demonstrate the practical application of the topic being taught and present it.

Activity component. In order for the future employees specialized in mechanical engineering to gain experience of mathematical activity in practical situations, it is important to gamify the teaching of stereometry. Lessons-trials, lessons in modeling cardboard toys, lessons in measuring and calculating the values of real objects have been conducted. The students had an opportunity to both work individually and to solve the teacher's suggested tasks as a team. In order to find the best solution for the task, students could use textbooks, tutorials, educational web resources, and mobile applications.

Reflective component. While practicing the reflection at stereometry lessons we suggest using the online service www.mentimeter.com. The service allows you to create presentations in which you can conduct surveys, quizzes, receiving instant feedback from students. Also, in order to get feedback at the end of each lesson, students were asked to do sync lessons, and at the end of the topic, they were invited to present their projects.

3. Results

The interim results of the research show that:

✓ the target block provides students with awareness of the purpose and objectives of the proposed topic, while at the same time forming the need for their own active educational and cognitive activities in order to learn the material;

✓ the content block provides the formation of mathematical knowledge, whereby students become aware of the connection of mathematics with the outside world;

✓ activity block provides a set of mathematical skills (analytical, computational, algorithmic, functional, geometric, stochastic, probabilistic, mathematical modeling) for solving typical practical problems by mathematical methods, while the student acquires experience of mathematical activities and standard activities;

✓ assessment block provides adequate self-analysis and self-assessment of the results of their mathematical activity, while the student seeks to improve the results of his activity.

Therefore, the proposed model of methodology of competently oriented teaching the stereometry makes it possible to adjust the process of teaching stereometry to students of vocational school specialized in mechanical engineering in accordance with the needs of society for competent workers of the new type.

REFERENCES

1. Tinkova, D. (2018). Monitoring studies of the initial geometric training of pupils of vocational school of machine-building profile. *Science and education a new dimension*, 64, 53-56.

2. Tinkova, D. (2017) Motivational component of educational activity of pupils of vocational school of machine-building profile: a confirmatory experiment. *Topical issues of natural science and mathematics education*, 10, 75-81.