Use of training technology in the preparation of students of engineering specialties

Uso de la tecnología de formación en la preparación de estudiantes de las especialidades en ingeniería

Uso de tecnologia de treinamento na preparação de estudantes de especialidades de engenharia

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Written by:
Ekaterina P. Sedykh (Corresponding Author)[140]
Ludmila N. Zanfir[141]
Olga I. Vaganova[142]
Zhanna V. Smirnova[142]
Marina N. Bulayeva[142]

Abstract

The content of higher education is influenced by the market economy, computerization and technological development of society. To discover the potential of students, new approaches to learning are required. In Russia, in the field of vocational education, the technology of project training is implemented, which meets the new emerging requirements of the state and society. Project training technology contributes to the most productive training of students as highly qualified specialists, and also allows them to consciously address their activities, establish professional tasks and perform them independently. The purpose of the article is to consider the experience of using technology in the training of projects in graduates of engineering specialties. As a result of the theoretical analysis of the pedagogical literature, we selected the pedagogical conditions for the implementation of these technologies (didactic, psychological, social, pedagogical, organizational and pedagogical). At the Nizhny Novgorod State Pedagogical University named after Kozma Minin, the study was conducted among the students on the "Construction" and "Technology" training profiles. The total number of respondents was 212 people. According to the data received, 88% of the students noticed the effectiveness of the application of the project method in the study of the graphic disciplines, 72% indicated that the

Resumen

El contenido de la educación superior está influenciado por la economía de Mercado, la informatización y el desarrollo tecnológico de la sociedad. Para descubrir el potencial de los estudiantes, se requieren nuevos enfoques para el aprendizaje. En Rusia, en el campo de la educación vocacional, se implementa la tecnología de capacitación de proyectos, que cumple con los nuevos requisitos emergentes del estado y la sociedad. La tecnología de capacitación en proyectos contribuye a la formación más productiva de los estudiantes como especialistas altamente calificados, y también les permite abordar conscientemente sus actividades, poder establecer tareas profesionales y realizarlas de manera independiente. El propósito del artículo es considerar la experiencia de utilizar la tecnología en la capacitación de proyectos en graduados de especialidades de ingeniería. Como resultado del análisis teórico de la literatura pedagógica, seleccionamos las condiciones pedagógicas para la implementación de estas tecnologías (didáctica, psicológica, social, pedagógica, organizativa y pedagógica). En la Universidad Pedagógica Estatal de Nizhny Novgorod que lleva el nombre de Kozma Minin, el estudio se realizó entre los estudiantes sobre los perfiles de capacitación "Construcción" y "Tecnología". El número total de encuestados fue de 212

[140] Minin Nizhny Novgorod State Pedagogical University, Uljanov street, 1, Nizhny Novgorod, Russia
[141] Industrial University of Tyumen, VolodarskyStr, 38, Tyumen, Russia
[142] Minin Nizhny Novgorod State Pedagogical University, Uljanov street, 1, Nizhny Novgorod, Russia

design method promotes a deeper study of the material. In general, the experiment showed that the level of training using the project's training technology was significantly higher.

Keywords: Technology of project training, method of projects, student, engineer, professional activity, experimental group.

personas. De acuerdo con los datos recibidos, el 88% de los estudiantes notó la efectividad de la aplicación del método del proyecto en el estudio de las disciplinas gráficas, el 72% indicó que el método de diseño promueve un estudio más profundo del material. En general, el experimento mostró que el nivel de capacitación utilizando la tecnología de capacitación del proyecto fue significativamente mayor.

Palabras claves: tecnología de formación de proyectos, método de proyectos, estudiante, ingeniero, actividad profesional, grupo experimental.

Resumo

O conteúdo do ensino superior é influenciado pela economia de mercado, informatização e desenvolvimento tecnológico da sociedade. Para descobrir o potencial dos estudantes, novas abordagens para a aprendizagem são necessárias. Na Rússia, no campo da educação profissional, implementa-se a tecnologia de treinamento em projetos, que atende às novas exigências emergentes do estado e da sociedade. A tecnologia de treinamento do projeto contribui para a formação mais produtiva dos alunos como especialistas altamente qualificados, e também permite que eles abordem conscientemente suas atividades, estabeleçam tarefas profissionais e as executem de forma independente. O objetivo do artigo é considerar a experiência de usar a tecnologia na formação de projetos em graduados de especialidades de engenharia. Como resultado da análise teórica da literatura pedagógica, selecionamos as condições pedagógicas para a implementação dessas tecnologias (didáticas, psicológicas, sociais, pedagógicas, organizacionais e pedagógicas). Na Universidade Pedagógica do Estado de Nizhny Novgorod, em homenagem a Kozma Minin, o estudo foi conduzido entre os estudantes nos perfis de treinamento "Construção" e "Tecnologia". O número total de entrevistados foi de 212 pessoas. De acordo com os dados recebidos, 88% dos estudantes notaram a eficácia da aplicação do método de projeto no estudo das disciplinas gráficas, 72% indicaram que o método de projeto promove um estudo mais profundo do material. Em geral, o experimento mostrou que o nível de treinamento usando a tecnologia de treinamento do projeto foi significativamente maior.

Palavras-chave: tecnologia de formação de projetos, método de projeto, estudante, engenheiro, atividade profissional, grupo experimental.

Introduction

The project activity in the world educational practice is an effective tool. However, each direction of training has its own specifics, and design methods need to be adjusted for them properly. In addition, leading experts in the field of science and education talk about the need to improve the quality of engineering education (Nagarajan & Prabhu, 2015). One of the most important elements of becoming an engineer are disciplines of the geometric-graphic cycle: descriptive geometry, engineering graphics, computer graphics (Markova et al, 2017). In the conditions of system informatization and constant updating of technologies, the teaching methodology should correspond to the innovative principles of the development of education. All these facts determine the relevance of the topic.

The use of design techniques in teaching of geographic disciplines is actively engaged in the modern world (Kutepov et al, 2017). There is a positive experience in the use of such techniques, however, the peculiarities of the method of functioning of the project method have not yet been fully understood.

An analysis of foreign literature has shown that many large companies use the project method with an orientation toward technological progress and the needs of the consumer (Ilyashenko, 2017). That is, using the method of

projects in the teaching of students, the learner gets used to it and can acquire not only the necessary competences on its basis, but also use it independently in their professional activities (Iltaldinova et al, 2017). The engineering direction provides a fairly broad framework for the application of the project method. For example, the use of mini-projects in the implementation of laboratory work on geometry. This decision was given by V.A. Starodubtsev. His proposal is to organize an individual team work, and each student has his own mini-project, the totality of which gives a total of one large general educational project. In conclusion, the students exchange their results. V.V. Larionov proposed his methodology for using the project method in vocational-oriented teaching of geometry in technical universities. As a basis, he took the problem. And already on this the formulation of the project is under construction. V.A. Dmitriev proposed the use of project technology in the concept of "advanced training". In his ideas he based on the theory of G.S. Altshuller on the solution of inventive problems. This idea undoubtedly draws attention to itself, however, it cannot be considered fully constructive, since graduates in this case will be oriented only to inventive activity, whereas in production engineers are required to operate, maintain equipment, etc. E.A. Rumbeshta and Yu.V. Maslova use the method of projects in organizing a laboratory workshop for engineering students using the electronic educational environment Moodle. They note that the project activity should be clearly algorithmized, therefore it is necessary to develop a step-by-step action plan. We will make the amendment that the development, which is presented in electronic form, is not always obtained during the study of real objects.

Methodology

The effectiveness of the use of project training was tested during the experiment, which was conducted for three years at the Nizhny Novgorod State Pedagogical University named after Kozma Minin, the profiles of the preparation "Construction" and "Technology". 212 bachelor students took part in the experiment.
The work was built using the technology of project training. In the experimental group, author's coats and complexes were used, realizing the technology of project training.

At the stage of ascertaining experiment, the level of graphic training was assessed. Test tasks were compiled in the disciplines "Geometry" and "Drafting" taught in the general education school. Also at this stage, the attitude to learning activity (motives and interests of students) was evaluated. Control and experiment all groups were formed.

The forming stage was represented by training the control group using the traditional method, and working with the experimental group was built taking into account the technology of project training.

Results

The design work was carried out in accordance with these stages:

- formulation of the problem;
- the formation of a hypothesis;
- development of a project plan (Tsyplakova et all, 2016);
- implementation of the project for operations (Manikandan&Muthumeenakshi, 2018);
- analysis of the results obtained and the possibility of their implementation;
- Project protection (Ajeenkya & Patil, 2014) .

Table 1: Correlation between the stages of the project and project skills

Project implementation stage	Generalized project skills	Design skills
Problem statement	The ability to raise a problem	-is the ability to identify contradictions and justify the -need to resolve them; ability to formulate a problem

Formationof a hypothesis	The ability to form a hypothesis	- the ability to generate ideas; - the ability to present an idea as a hypothesis; - the ability to critically evaluate the hypothesis according to the requirements imposed on it
Formation of the project plan	Ability to make a plan	- the ability to create the conditions necessary for the implementation of the project; - ability to act in relation to available resources (technical, material, temporary); - ability to choose methods of project implementation; - the ability to compose an algorithm of actions
Project implementation	Ability to correctly plan the implementation of the project	- the ability to evaluate each action according to the algorithm
Analysis of the results obtained and the possibility of their implementation	Ability to analyze the activities and results of this activity, as well as the possibility of their implementation	- the ability to determine the appropriateness of adjusting the results of the project activity; - ability to make predictions on the success of the implementation of the results
Project Protection	Ability to present the results of the project	- the ability to give a reasoned view of your point of view; - ability to build the text of the report according to logic; - ability to conduct a presentation; - ability to dialogue

At the stage of posing the problem, a question is posed for which it is necessary to find the answer (Vaganova et al, 2017). The basis for posing the problem is the student's knowledge of his ignorance. The problem should conceal a hidden contradiction in itself (Zulkharnaeva et al, 2017).

The stage of the formation of the hypothesis is characterized by the proposed assumptions about the ways to resolve the existing contradiction. The hypothesis, unlike the conjecture, is purposeful, predictive, diagnostic, consistent and has a certain potential (Vaganova et al, 2018).

The plan is the beginning of the project implementation process. At this stage, a sequential list of actions of each project participant, management methods, implementation time (Bicheva & Filatova, 2017) is determined.

The operational implementation of the project is the stage at which the actions are coordinated in accordance with the plan. The complexity of the project determines the number of actions performed (Bulaeva et al, 2017).

Analysis of results. This stage contains the identification of shortcomings and the search for ways to eliminate them.

Protection of the project and its implementation is described below. Students publicly present the results of their activities (Barber et al, 2013). The presentation material should correspond to the project implementation plan. An important part of the presentation is the reflection of the resulting contradiction and the result of the work (Dyakonov et al, 2015).

Each completed stage forms students with certain project skills that will be useful to them in the future (Markova et al, 2017). In general, these are generalized skills necessary for graduates of modern engineering universities.

Next, it is worth highlighting the principles on which the method of projects is based.

Table 2: Principles of the project method that form the content aspects of professional competence (Smirnova et al, 2017)

Project method	Professional competence
Reliance on the learner's experience	Knowledge of existing experience
Problem	Ability to make choices
Development of educational needs, contextuality	Orientation to success in professional activity
Effectiveness	Development of a sense of personal responsibility for the results of work
Independence, systemic, individualization	Ability to self-improvement, activity

These principles lead the project method among the others to the fore.

We conducted a study that showed the role of project technologies in the formation of graphic and key competencies important for the student-engineer (research, design, information) (Kashtanova et al, 2017).
Didactic conditions include the content of training, form, methods of the means, which contribute to the achievement of educational tasks (Vandergrift, 2007). According to the GEF, all areas of training related to engineering, technology and construction technologies in the future professional activity will lead to research, design, production, technological, organizational and management activities (Ilyashenko, 2018). This means that the project theme and training tasks should be related to these activities. Among such topics, we can distinguish: the construction of complex geometric objects based on the proposed images, develop an electronic model for the details of the intended purpose, the development of the electronic model of the assembly unit, and the execution of the architectural and construction drawing (Nemova et al, 2016).

Psychological and pedagogical conditions take into account the individual qualities of the student, the training of a particular trainee, his project literacy (Braine, 2013). When developing tasks, it is necessary to focus on the diversity of intellectual qualities of students. The project method is designed to help students overcome their shortcomings and teach them how to show their individuality by working in a team (Sneha & Deepa, 2018).

We have identified the most essential personality characteristics that should be taken into account: the direction (how the student behaves in the team, overcomes difficulties); learnability (independence in the study of disciplines, readiness for solving complex research problems); training (existing experience, knowledge).

These conditions, mentioned above, were tested at Nizhny Novgorod State Pedagogical University named after Kozma Minin, the profile of the preparation "Construction" "Technology". 212 bachelor students took part in the experiment. At the stage of ascertaining experiment, the level of graphic training was assessed. Test tasks were compiled in the disciplines "Geometry" and "Drafting" taught in the general education school. Also at this stage, the attitude to learning activity (motives and interests of students) was evaluated. Control and experimental groups were formed.

The forming stage was represented by the training of the control group by the traditional method, and the work of the experimental group was built in accordance with the technology of project training. In work with the experimental group, author's electronic educational resources were used: virtual information-methodical laboratories, electronic educational-methodical complexes. It should be noted that electronic educational methodological complexes for disciplines are designed for the needs of the teacher and students. Because the teacher decides how best to provide information. For example, the most logical thing at the beginning of thecourse is to put theoretical material. This is shown in Figure 1.

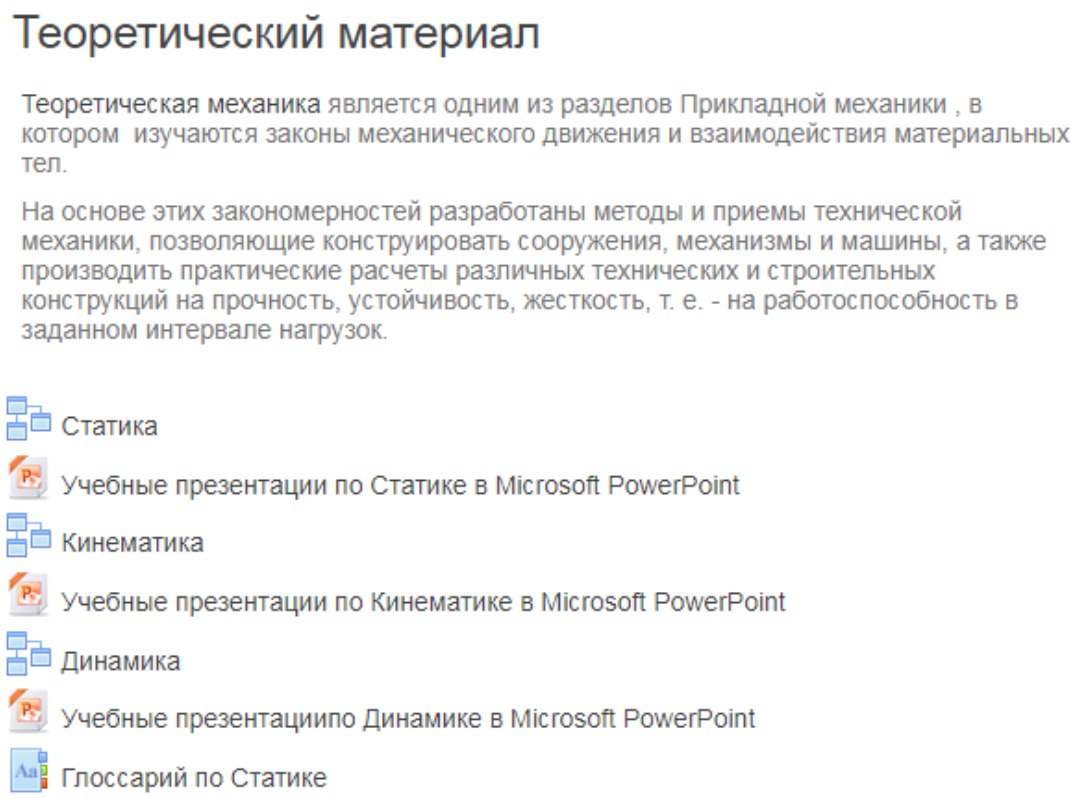

Figure 1- Example of the element of the electronic educational-methodical complex "Theoretical material"

Further, the teacher can post examples of typical tasks, so that students can more easily cope with the task, so that they can see specific examples, and already starting from them, they could develop their creative component, which is important. Next, we give an example of a project assignment for the discipline "Engineering Graphics".

- Construction of simple cuts in details on the proposed images - individual tasks. Individual tasks can vary both in complexity and subject, depending on individual preferences of students.
- Designing details created and invented by the students themselves. In this case, the teacher gives topics and introduces the necessary conditions.

- 3. Construction of complex incisions in detail.
- Preparation of sketches of parts taking into account their design features and manufacturing technology.
- Construction of a complex drawing.

When carrying out the project, the task is first of all, the search and selection of information is carried out, theoretical research is conducted and then the practical implementation is carried out.

To assess the quality of training, we distinguish four levels:

- low (it is also called elementary);
- medium (sufficient);
- high (optimal);
- creative (the level at which the student approaches the task in an original way, applying non-standard solutions). We have already mentioned the creative component. It is useful for reaching the highest level.

The criteria for the level of preparation are:

- knowledge of terminology and concept, ability to operate them;
- ability to solve typical tasks and tasks of increased complexity;
- execution of drawings according to the requirements of a single system of design documentation;
- Possession of skills in the implementation of drawings of varying degrees of complexity;
- Among the methods of diagnosis were selected:
- testing;
- expert evaluation of research and graphic works (Smirnova et all, 2017);
- observation of students' learning activities;
- Questionnaire to identify students' attitudes toward learning activity, readiness for research (Sasank et all, 2017).

The forming experiment showed that the students of the experimental group reliably ($p \leq 5\%$) on the degree of training bypassed another group. A fairly high level of knowledge, skills and habits was noted.
The students of the experimental group showed great interest in conferences, preparing abstracts and scientific reports, that is, they showed themselves in scientific research. The experimental group also showed a high percentage of students who noted the benefits of the design work. In the anonymous questionnaire, the question "Are you satisfied with the educational process in graphic disciplines?" 88% of students noted the unconditional benefit from the introduction of project technologies, 72% of students stressed the ability of design techniques to deepen the knowledge gained.

Table 3- Results of research on the impact of design technologies

№	Year of experiment behavior	Level of graphic preparation	Groups			
			Control		Experimental	
			Initial stage	The final stage	Initialstage	Thefinalstage
I	2015-2016	Low	76	11	71	3
		Average	22	58	25	32
		Tall	2	24	3	50

		Creative	0	7	1	15
		Low	72	7	78	0
		Average	24	60	22	36
2	2016-2017					
		Tall	3	25	0	46
		Creative	1	8	0	18

Organizational and pedagogical conditions are a complex of measures to implement the method of projects. Here, the number of participants, the duration of the project, its conditions, and the criteria for evaluating the results should be determined. The next stage is the development and design of educational resources on paper and electronic media that provide project activities (assigning different levels of training, group and individual assignments).

The study of geometric-graphic disciplines begins with the first course with the study of descriptive geometry. It is generally accepted that the effectiveness of the design method can only be obtained by studying the basic concepts. It should be said that students need to learn algorithms and clear programs of action to solve problems. After studying the algorithms, students can better perceive problem learning tasks.

Conclusions

The obtained results indicate the effectiveness of the introduction of design technologies in the preparation of engineering students. The conducted research has shown it. The group of subjects, who were involved with the help of project methods, showed better results than those trained by traditional methods. The table of the results of the study shows that at the final stage the level of training became much higher.

Increasing the level of effectiveness of teaching graphic disciplines in using the pedagogical conditions specified by us becomes more productive. To achieve high and creative levels of graphic preparation, students should be given more typical tasks, on the basis of which they can practice using their creative non-standard solutions in already more complex situations.

Project methods are a significant factor in the formation of competences. It is also worth mentioning that using the project methodology in combination with traditional methods brings its results. Our research proves the effectiveness of this approach.

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