

OPPORTUNITIES FOR THE PRACTICAL USE OF CAD SOFTWARE IN DEVELOPING STUDENTS' SKILLS IN CREATING PERSPECTIVE DRAWINGS

Valiev Azamjan Nematovich, Associate Professor, Uzbekistan National Pedagogical University.
+99899 190 72 00. valiyev72@inbox.ru

Toxirov Sardorbek Muzaffar o'g'li, Master's student, Uzbekistan National Pedagogical University. +99893 484 15 41. toxirovsardor296@gmail.com

Abstract. This article analyzes the methodological potential of using modern CAD systems in the teaching of engineering graphics disciplines. The study examines the functional capabilities of several graphic software tools used in the design of perspective drawings, namely KOMPAS-3D, Revit, SolidWorks, and AutoCAD. Using a single object as a case study, perspective images were modeled in each software environment and their didactic significance and technical capabilities in the teaching process were comparatively evaluated. The results of the study showed that while some programs offer broad capabilities for spatial modeling and visualization, AutoCAD stands out due to its ability to facilitate step-by-step learning of the geometric principles of perspective construction. Therefore, this program is recommended as an effective methodological tool for teaching perspective drawing.

Keywords. CAD software, perspective drawing, graphic modeling, characteristic points, horizon line, picture base, graphic education, computer graphics, AutoCAD.

INTRODUCTION

In recent years, the modernization of the education system in our country, the widespread introduction of digital technologies into the learning process, and the development of innovative pedagogical approaches have been defined as priority directions at the level of state policy. In particular, the Decree on 'Approving the Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030' specifically emphasizes the need to broadly implement modern information and communication technologies in higher education institutions, digitize the educational process, and develop practical skills. Similarly, the 'Development Strategy of New Uzbekistan' sets the equipping of young people with modern professional competencies and the development of innovative and technological thinking as priority tasks.

Based on these regulatory documents, the effective use of computer-aided design (CAD) software in the process of forming students' skills in creating perspective drawings within the teaching of graphic disciplines has emerged as a pressing pedagogical challenge.

Modernizing the education system and introducing modern information technologies into the teaching process is one of the most urgent issues of today. Various educational tools play an invaluable role in improving the quality of students' knowledge. "Teaching tools are understood as objects created by humans and nature. They are used in the educational process as carriers of information, as tools in the activity of the teacher, and as means for students to achieve their educational and developmental goals." Digital modeling tools serve as an important factor in developing students' spatial thinking, improving graphic literacy, and strengthening practical competencies.

Today, the necessity of moving away from traditional teaching methods and making effective use of multimedia tools is growing. Research conducted in this area shows positive results. 'Analysis of the experience of conducting lectures using traditional and multimedia teaching systems shows that in the latter case, the activity, volume, and quality of students' knowledge acquisition increases significantly.' Understanding the essence of these technologies begins with knowing their definitions.

CAD (Computer-Aided Design) software is a set of software tools designed for modeling, editing, and visually representing objects in two-dimensional and three-dimensional environments in the fields of engineering, architecture, and design. Using these programs, drawings are produced with high precision, in compliance with technical requirements, and in a visually perfect manner.

CAD software is considered one of the modern pedagogical tools widely used in teaching graphic disciplines, particularly perspective drawing. The ability to work in an interactive environment allows students to observe and analyze the process of forming a perspective image step by step. As a result, they effectively develop the skills to receive, spatially analyze, and apply graphic information in practical activities. Through these software tools, students learn to perceive as a whole the spatial position of objects, the perspective foreshortening of their dimensions, and the changes dependent on the viewpoint. This process serves to consciously understand the theoretical and geometric foundations of perspective drawing. In this regard, the use of CAD technologies is of significant pedagogical importance in improving students' graphic literacy, developing spatial thinking, and forming professional competencies.

LITERATURE REVIEW

As Y.F. Katkhanova noted: 'The high rate of development of computer technologies leads to a reassessment of the attitude not only toward the existing system of knowledge, but also toward the search for new ways to improve traditional methods and approaches to teaching.'

E.I. Ruziev, in his scientific research, developed an integrative course called 'Graphics,' which addresses the problems of teaching computer graphics and its connection with other disciplines.

In addition to orthogonal drawings, the use of three-dimensional models of geometric objects and animated videos helps to emotionally engage students in the process. This is especially important in teaching engineering graphics disciplines.

The development of computing technology and the emergence of personal computers and automated design systems led to the emergence of a new direction in engineering graphics — engineering computer graphics. This academic discipline involves the use of computers in the educational process of engineering graphics. In this regard, the use of modern CAD software is becoming an integral part of education.

The use of graphic software in studying engineering graphics disciplines helps to develop students' research capabilities and strengthen their skills in using theoretical and practical knowledge. This is one of the pressing tasks facing higher education.

The most complete, accurate, and visual source of information about an object is its three-dimensional model. If necessary, design documents can be produced from it on electronic or paper media. Therefore, 3D modeling technologies hold a special place in engineering education.

As N.V. Fedotova noted: 'We believe that with the development of three-dimensional (3D) technologies, descriptive geometry needs to be modified and the proportion of hand-drawn work

should decrease.' This view shows that digital technologies are gaining priority importance in modern education.

People with rich spatial imagination receive and analyze information quickly. They are recognized as highly skilled professionals in their field. Therefore, developing spatial thinking is one of the main goals of engineering graphics as a discipline.

According to A.K. Khamrakulov and G.M. Tubaev, the visual demonstration of images in AutoCAD and 3D MAX programs develops students' spatial imagination. This once again confirms the importance of CAD software in education.

Three-dimensional modeling is a process of embodying the designer's ideas in realistic and reliable images on a computer screen. Through this technology, even complex objects can be easily understood and analyzed.

To summarize the above, as a result of scientific and technological progress, the volume of knowledge students need to acquire is growing, but the time allocated for teaching remains unchanged. Therefore, the effective use of computer technologies and comparative teaching of several CAD programs in modern pedagogical approaches is of great importance.

At the same time, the selection of various CAD programs in teaching engineering computer graphics is important, and it is advisable to select the most convenient and effective programs for students and teachers. Foreign experience shows that students achieve higher results by mastering several programs.

METHODS

Graphic software differs from one another in terms of functional capabilities and field of application. Therefore, when conducting a methodological analysis, it is appropriate to categorize them separately as CAD (Computer-Aided Design) systems and 3D modeling and visualization software. This classification makes it possible to clearly define the didactic potential of each software tool in the process of teaching perspective drawing and to comparatively evaluate their pedagogical advantages.

In this study, graphic modeling, comparative analysis, and computer graphics tools were used. During the research, the capabilities of modern CAD software for creating perspective images were studied.

As a test case, a single object — a simple residential house model — was selected and modeled in various graphic environments. The processes of creating a spatial view, changing the perspective, and forming the perspective image were analyzed.

During the research, the CAD systems mentioned above were used. The perspective view of the object was created in each program and their functional capabilities were comparatively analyzed.

RESULTS

During the research process, the selected house model was modeled in various CAD environments and their capabilities for creating perspective images were practically tested.

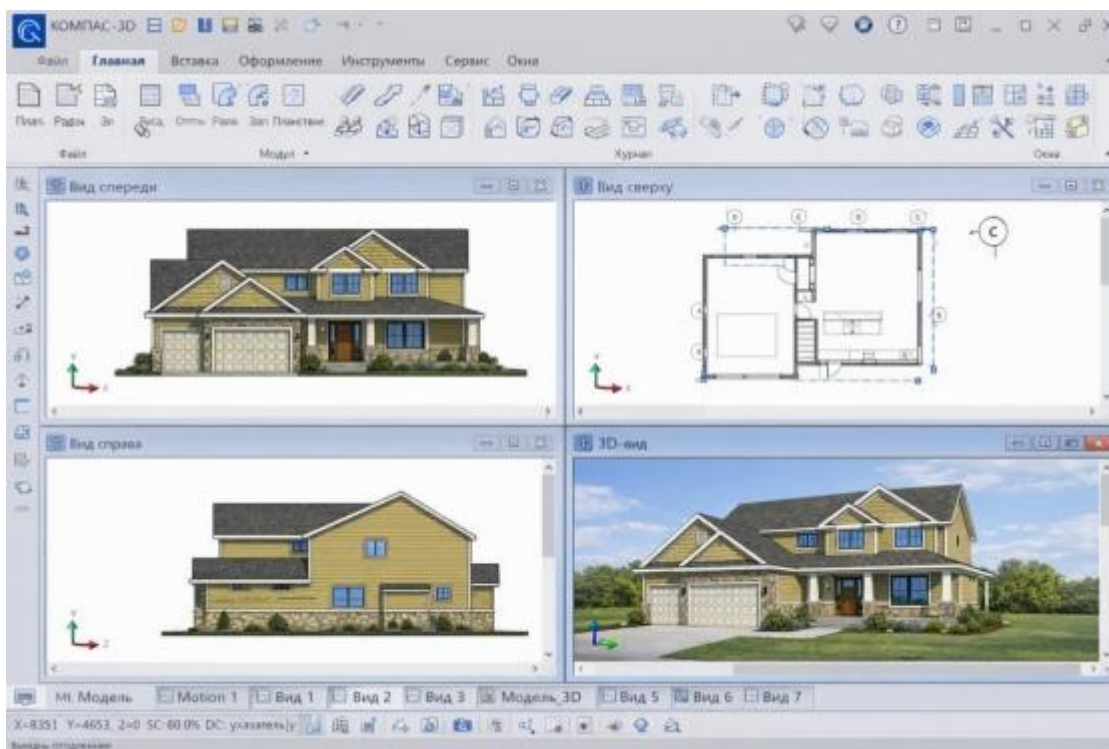


Figure 1. Perspective view of the house model in the KOMPAS-3D environment. (The image was generated using artificial intelligence technology.)

KOMPAS-3D software. KOMPAS-3D is a three-dimensional modeling system widely used in mechanical engineering and technical design. In the program, objects are represented as three-dimensional models. Based on this model, its two-dimensional technical drawings — i.e., the main projections (horizontal, frontal, and profile) — are then automatically generated. From the perspective of perspective drawing, KOMPAS-3D allows viewing a finished three-dimensional model from various angles. However, in this case, the visual result of the model is prioritized over the theoretical and geometric stages of perspective construction. Therefore, while the program is effective in developing spatial perception, it has limited methodological capabilities for teaching perspective drawing step by step on a scientific basis.

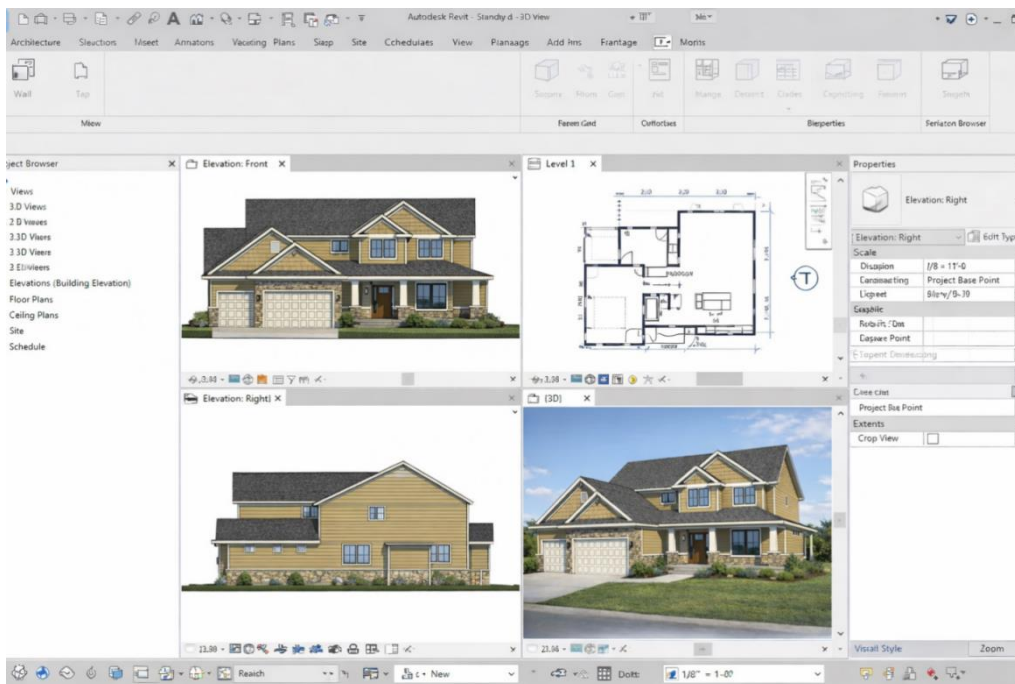
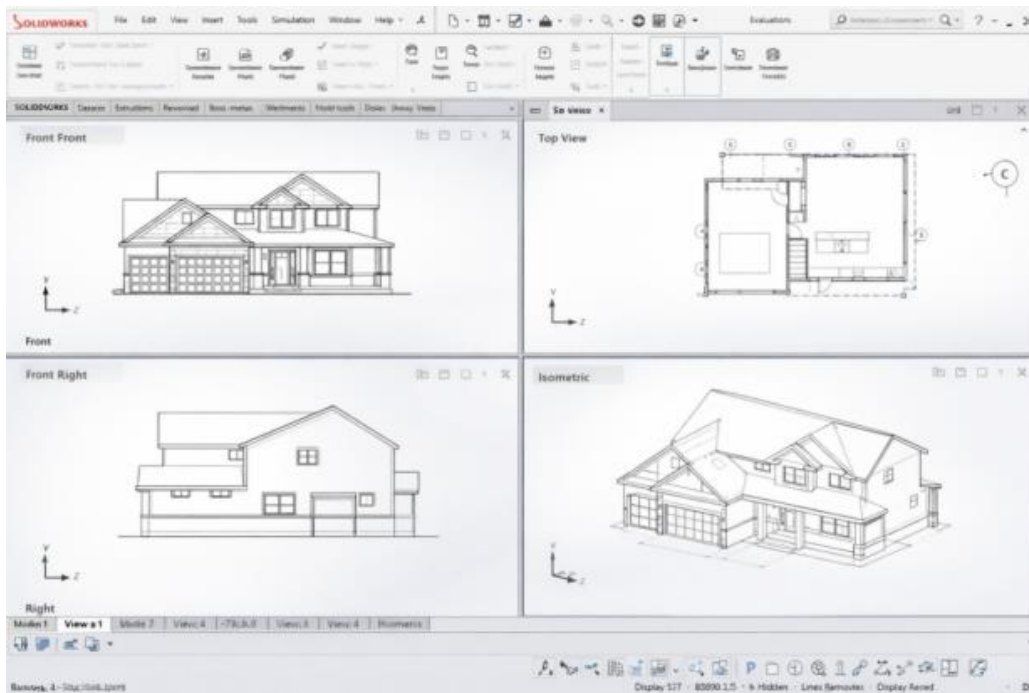


Figure 2. Perspective view of the house object in Revit. (The image was generated using artificial intelligence technology.)

Revit is an architecture and design program based on BIM (Building Information Modeling) technology that allows buildings and structures to be drawn as information models. In the program, the structural, functional, and visual parameters of an object are integrated within a single model. In the process of creating a perspective view, Revit depicts a real spatial view through camera tools. As a result, the user can imagine the object close to a real environment. However, the geometric construction of perspective foreshortening and vanishing points is performed automatically by the program. Therefore, Revit is effective as a visual demonstration tool, but is not sufficient as the main methodological tool for teaching theoretical perspective construction.

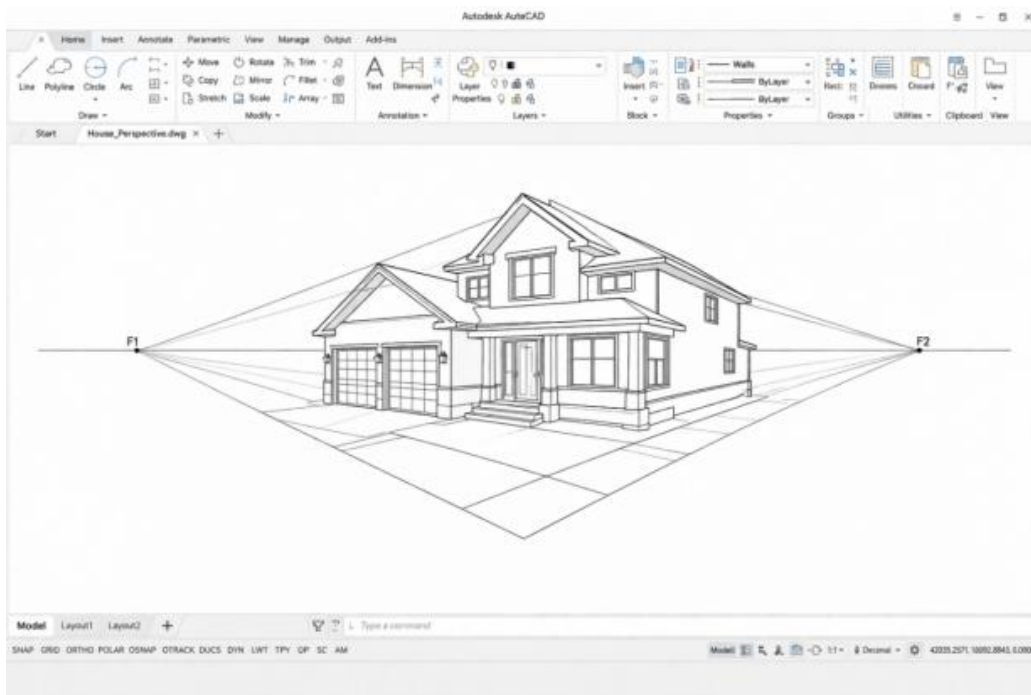
Figure 3. Perspective view of the house model in SolidWorks. (The image was generated using artificial intelligence technology.)



SolidWorks is a parametric 3D design system developed by Dassault Systèmes, widely used in mechanical engineering, industrial design, and construction. The program provides the ability to model parts based on parameters, analyze them, and produce technical documentation.

The perspective view in SolidWorks is formed as an automatic graphic mode. The ability to rotate the model, take cross-sections, and view it in three-dimensional form is available. This serves to develop students' spatial thinking. However, the perspective construction elements are not formed as a separate didactic stage.

Figure 4 shows the final result of the perspective view constructed in AutoCAD. During the perspective construction process, all the identified points were connected to each other, creating a complete view of the object. As a result, the perspective of the building was expressed in a clear and visually understandable form.



This method is significant in that it clearly demonstrates the geometric foundations of perspective drawing. Therefore, AutoCAD serves not only as a tool for drawing graphic images, but also as an important methodological tool in teaching perspective drawing.

DISCUSSION

The research results show that all of the CAD programs examined have the ability to generate perspective views based on three-dimensional modeling. However, the method of execution varies depending on the program.

In KOMPAS-3D, Revit, and SolidWorks, perspective images are generated automatically. This allows the user to obtain a quick visual result. At the same time, the geometric stages of constructing perspective images are performed in a way that is hidden from the user.

In AutoCAD, however, the process of constructing perspective images is carried out step by step by the user. As a result, the horizon line, vanishing points, and the laws of perspective foreshortening are practically demonstrated. This is of significant didactic importance in teaching graphic disciplines.

Criteria	AutoCAD	Revit	SolidWorks	KOMPAS-3D	3ds Max
Methodological advantage (in teaching)	Teaches logically, step by step	Explains through a ready-made model	Develops spatial thinking through 3D	Convenient for technical drawings	Provides realistic visualization

THE MULTIDISCIPLINARY JOURNAL OF SCIENCE AND TECHNOLOGY

VOLUME-6, ISSUE-5

Criteria	AutoCAD	Revit	SolidWorks	KOMPAS-3D	3ds Max
Perspective construction capability	Performed manually and logically	Automatic (logic hidden)	Automatic (logic hidden)	Automatic (logic hidden)	Automatic (logic hidden)
Opportunity to learn from mistakes	Mistakes are immediately visible and easy to analyze	Mistakes may be hidden; system corrects automatically	Mistakes may be hidden; system corrects automatically	Mistakes can be identified, but visual aspect is limited	Mistakes may be hidden; system corrects automatically
Development of abstract thinking	Develops to a high degree, as all drawings are based on geometric foundations	Partially develops, as many processes are automated	Develops spatial thinking, but theoretical basis is limited	Develops logical thinking, but abstraction is lower	Barely develops abstract thinking
Support for students' independent work	Student is required to perform each stage independently	Relies more on ready-made elements; independence is relatively low	Student is more oriented toward model creation	Independent creative work is possible, but no scientific basis	Relies more on ready-made elements; independence is relatively low
Ease of monitoring for teachers	Each line and construction stage is monitored	Can be monitored, but internal processes are closed	Result is monitored; process is monitored less	Easy to monitor; drawings are clear	Difficult to monitor; subjective

CONCLUSION

In this study, the capabilities of modern CAD software for creating perspective images were analyzed, and their methodological significance in the process of teaching graphic disciplines was examined. During the research, perspective images were drawn in several graphic software environments using a single object — a house model — as an example, and their functional capabilities were comparatively analyzed.

The analysis results showed that in KOMPAS-3D, Revit, and SolidWorks, perspective views are generated automatically, mainly based on three-dimensional models. This approach allows the user to display the spatial view of the object quickly and conveniently, and serves to develop spatial thinking. However, in this process, the geometric construction stages of the perspective drawing are not fully observed by the user.

The research results also showed that in AutoCAD, the process of constructing perspective images is carried out step by step on a geometric basis. In this process, the horizon line, viewpoint, picture base, and the laws of perspective foreshortening are clearly visible. Therefore, this program is an effective tool not only for obtaining visual results in teaching perspective drawing, but also for studying its scientific and geometric foundations.

Based on this, it can be concluded that the use of CAD software enriches the teaching of graphic disciplines with modern technologies and serves to develop students' spatial thinking and graphic literacy. In particular, AutoCAD is of special importance as a methodologically convenient and effective tool for teaching perspective drawing on a scientific basis.

In the future, it is advisable to further integrate CAD technologies into the graphic education process and to improve the methodology of teaching perspective drawing through the integrated use of various graphic software.

REFERENCES

1. <https://lex.uz/docs/4545884>. Decree No. PF-5847 of the President of the Republic of Uzbekistan, dated October 8, 2019, 'On Approving the Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030.'
2. <https://lex.uz/docs/5841063>. Decree No. PF-60 of the President of the Republic of Uzbekistan, dated January 28, 2022, 'On the Development Strategy of New Uzbekistan for 2022–2026.'
3. Valiyev, A. N. (2023). Practical Application of Geometric Constructions in Solving Positional Tasks in the Perspective. *Current Research Journal of Pedagogics*, 4(03), 79–91.
4. Nematovich, V. A. Z. (2025). Markaziy proyeksiyalash usuli (perspektiva)dagi ayrim pozitsion masalalarning amaliy ahamiyati. *Строительство и образование*, 4(1), 210–216.
5. Nematovich, V. A. Z. (2024). Talabalarda oddiy geometrik shakllarning perspektiv tasvirini qurish ko'nikmalarini shakllantirish va rivojlantirish. *Строительство и образование*, 3(1), 64–71.
6. Nematovich, V. A. Z. (2023). Markaziy proyeksiyalash (perspektiva) dagi ayrim pozitsion masalalar yechimiga mantiqiy yondashuv. *Journal of Innovation, Creativity and Art*, 142–145.
7. Dilshodbekov Sh.D. Classification of engineering computer graphics software. NSPU Scientific Reports. Tashkent, 2019. No. 3. pp. 97–101.
8. Freeberg S.A. Development of cognitive abilities and independence of students in the study of engineering graphics through the introduction of computer technologies. Dissertation for the degree of Candidate of Pedagogical Sciences: 13.00.02. Moscow: RGB, 2007. 134 p.
9. Solovyova-Gogoleva L.V. Activation of cognitive activity of students in the process of teaching graphic disciplines. Dissertation for the degree of Candidate of Pedagogical Sciences. Yekaterinburg, 2001. 176 p.
10. Fedotova N.V. Formation of graphic competence of students of a technical university based on three-dimensional modeling. Dissertation for the degree of Candidate of Pedagogical Sciences. Tambov, 2011. 180 p.
11. Madumarov K.Kh., Kakharov A.A. Factors of improving spatial thinking. *Problems of Integration of Science and Production*. Namangan. May 29–30, 2008. pp. 399–400.
12. Khamrakulov A.K., Tubaev G.M. Possibilities of using computer technologies in teaching descriptive geometry. *Nauka. Mysl': electronic periodical journal*. No. 4. 2016. pp. 87–91.
13. Korneev V.R., Zharkov N.V., Mineev M.A., Finkov M.V. *KOMPAS-3D by Examples: For Students, Engineers and More*. St. Petersburg: Nauka i Tekhnika, 2017. 272 p.

14. Yakushkina L.P. Technology for organizing extracurricular independent work of university students. Dissertation for the degree of Candidate of Pedagogical Sciences. Orel, 2007.
15. Telnoy V.I. New approaches to the study of the discipline 'Engineering Graphics' using modern information technologies. Bulletin of MGSU. 2013. No. 8. pp. 168–176.

