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| RESEARCH ARTICLE

Exploring Challenges Faced by Engineering Students in Graphic Preparations of Perspective Geometry

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| ABSTRACT
Perspective geometry is a fundamental, challenging, and captivating subject within the engineering bachelor's degree program. It holds significant importance in developing graphic skills, analytical abilities, sketching proficiency, and comprehension of drawings. Moreover, it plays a crucial role in organizing the architectural components of a bachelor's thesis. However, the teaching and learning of perspective geometry often reveal various difficulties and shortcomings. Moreover, one of the various systems of symbols and languages created by global cultures is the graphical language, which is an exceptional and unparalleled language for understanding scientific and technical information. This language is considered the oldest international language. Every visual piece of information in various processes of human life has been formed through the graphical language, which is composed of various geometric shapes. In this research, data has been gathered from the perspectives of first-year students from the 2013 batch regarding the difficulties encountered in perspective geometry. A questionnaire was distributed to collect their opinions, and three graphical tasks with different levels of complexity were given to the students. The results obtained from this study indicate that employing suitable teaching methods and providing adequate resources can alleviate most of the learning difficulties associated with graphic skills. Instructors also play a pivotal role in resolving learning obstacles. Therefore, efforts should be made to enhance the quality of teaching graphic subjects by updating the content and curriculum of educational programs and improving teaching methods through the use of technology. In higher education institutions, conditions for fostering students' professional knowledge, enhancing their ability to draw maps and create technical documents can be facilitated through computer graphics education. Updating the teaching methods plays a crucial role in improving the quality of graphic education. The mentioned factors provide a suitable environment for the growth of graphic knowledge and the implementation of projects related to professional subjects.

| KEYWORDS

Graphic Difficulties, Learning Challenges, Individual Work, Perspective Geometry.

| ARTICLE INFORMATION

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1. Introduction

The purpose of learning is to develop the power of thinking, which includes the ability to think correctly, use knowledge to solve problems and cultivate creative and innovative minds. When focusing on graphic education for students, it becomes apparent that several factors influence the learning process. According to Bruner, the following points should be considered for effective learning(Rusinova, 2012):

1. Willingness and preparedness to learn.
2. Methods that can be used to present information and knowledge in a structured way that enables easy absorption for students.

3. Sequencing of materials and subject content

If perspective geometry is taught using an argumentative approach with dry definitions, it will receive less attention. However, if it is taught practically and applied in a manner that addresses common educational problems, it can generate enthusiasm and interest among students, thereby fostering their intellectual growth. To enhance comprehension of perspective geometry, geometric concepts such as drawing methods, perpendicular drawing, surfaces, etc., should be taught clearly(Красовская & Сычева, 2019).

The topics of perspective geometry are interconnected. Without a solid understanding of the theoretical basics, students may struggle to focus on new topics and learn them effectively(Хубиев, 2016).

Students often perceive perspective geometry as an important yet challenging and ambiguous subject, which can undermine their self-confidence in learning. By presenting the subject matter according to students' comprehension levels and abilities, their interest can be sparked, leading to greater responsibility for their own learning. Additionally, incorporating aspects of research into the lessons can enhance student engagement(Özerem, 2012).

Teaching perspective geometry as a foundational subject provides a platform for nurturing talented students and motivates them to pursue further studies in technical and engineering fields.

According to Michael (2001), learning problems can be defined as concepts or arguments that hinder students from mastering a particular field(Leopold, Gorska, & Sorby, 2001).

To create comprehensible perspective geometry classes and facilitate better learning, it is crucial to adopt an applicable teaching method that engages the students themselves. By incorporating the students' own details into the teaching process, they can actively participate in implementing these concepts on paper(Bruner, 1974).

Alex and Maman (2016) explain that, in order to enhance the teaching of perspective geometry, students' spatial imagination should be developed so that they can mentally visualize objects. To achieve this, a series of exercises can be conducted where students practice drawing three-dimensional objects on a two-dimensional plane.

Piron Haley and his wife, Dina Geldof van Haley, were professors who recognized the learning difficulties faced by their students in perspective geometry classes. Their efforts to address these challenges led to the formulation of an opinion in the field of geometry education. This theory was subsequently explored by Batissa, Clements, and Gadd (1960), revealing its strengths in the context of geometry education (Hiele, 1986).

Van Haley's learning model introduces various types of thinking that students experience when encountering geometric shapes. It encompasses the stages of visually perceiving geometric shapes and understanding geometric images. Van Haley's model comprises three levels of thinking: visual, descriptive, and theoretical (Hiele, 1986). Dividing geometry into different levels based on Van Haley's theory is highly appropriate and logical.

This research investigates the influential factors for the high success of educational activities and graphic skills in the subject of geometric drawing. The success of educational activities generally relates to tangible and mental factors. Creating necessary conditions for teaching and addressing educational needs are important factors that have positive effects on the quality of higher education(Luneta, 2015).

2. Objective of Study

- Identifying graphic-related problems experienced by students and finding solutions to address these issues.
- Investigating influential factors in educational activities.
- Utilizing assessment results to enhance the quality of education.
- Determining an effective teaching method that facilitates student success.

3. Methodology

Teaching descriptive geometry in different universities across the country presents a series of common and exceptional challenges. According to the curriculum, the subject of descriptive geometry is taught in engineering faculties with two credits, including lectures, graphic work, and exams. 50% of the time is allocated for students to learn, perform individual tasks, and work on projects outside of class.

Table 1. Number of credits for teaching perspective geometry in engineering courses

Number of credits	Lecture	Practical	Graphical Activity	Exam
2	1	2	10	Mid-semester exams

The methodology used in this research can be categorized into two parts. First, a questionnaire was distributed to the students. Second, three graphical tasks with different levels of complexity were given to the students.

To identify the factors that affect the outcomes of students' graphic activities, this research evaluated the learning difficulties in Perspective geometry. The questionnaires were distributed to students of the Construction faculty at Jowzjan University, where the teaching is conducted by professors from the departments of Perspective geometry and technical drawing.

First, students are requested to answer the following questions (Table (2) to table (5).

Table 2. Percentage of teaching problems in Perspective geometry

Basic factors	Number of students	Students' opinions
Lack of theoretical knowledge of Perspective Geometry	60	33
Lack of technical drawing knowledge	60	30

Table 3. The basic cause of problems in learning Perspective geometry

The cause of the problems	Number of students	The percentage of students' opinions
Low level of graphic preparation after graduating from school	60	92
Spatial inability to imagine	60	60
Not having a goal to learn	60	18
Lack of interest in education	60	18

Table 4. The purpose of choosing a field of study by percentage

Target	Total	Students' opinions
Interested in the chosen field	60	74
Having a higher educational degree	60	57
passing the Kankor exam	60	38
Advice from family and friends, etc	60	66

Table 5. Learning goal of drawing geometry subject in percentage

Target	Total	Students' opinions
Improving the level of knowledge	60	92
The importance of the course	60	100
passing the exam	60	18

A three-stage process was implemented to evaluate the students' learning progress.

During the first stage, the students' proficiency in solving graphic problems related to the basic themes of the engineering department was assessed. This evaluation involved assigning a simple task, as depicted in Figure (1), where the students were required to draw three front and side horizontal views of a specific part.

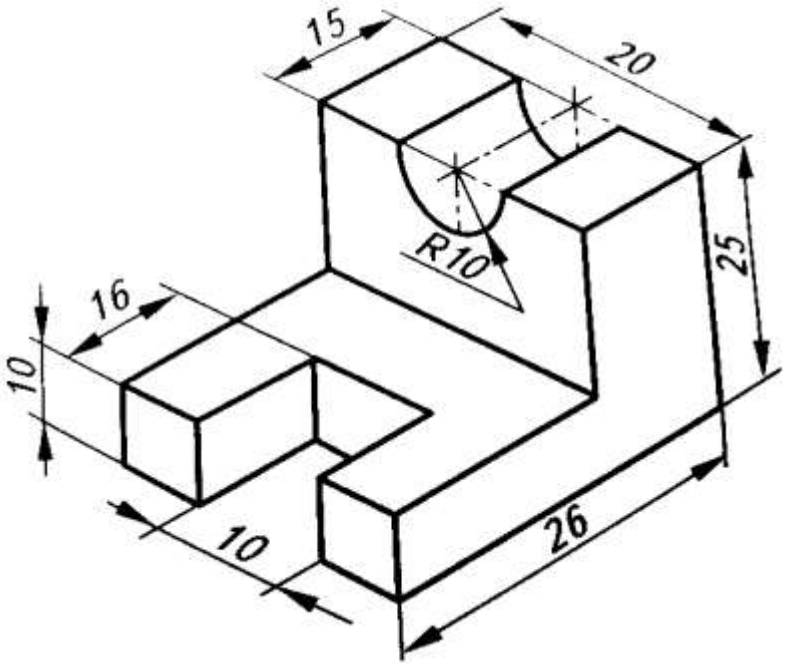

Figure 1. Given task with the first level of complexity

Moving on to the second stage, the level of learning achieved by the students after studying additional subjects and mastering drawing basic geometric elements in space was evaluated. The assessment in this stage involved solving various problems and tasks illustrated in Figure (2).

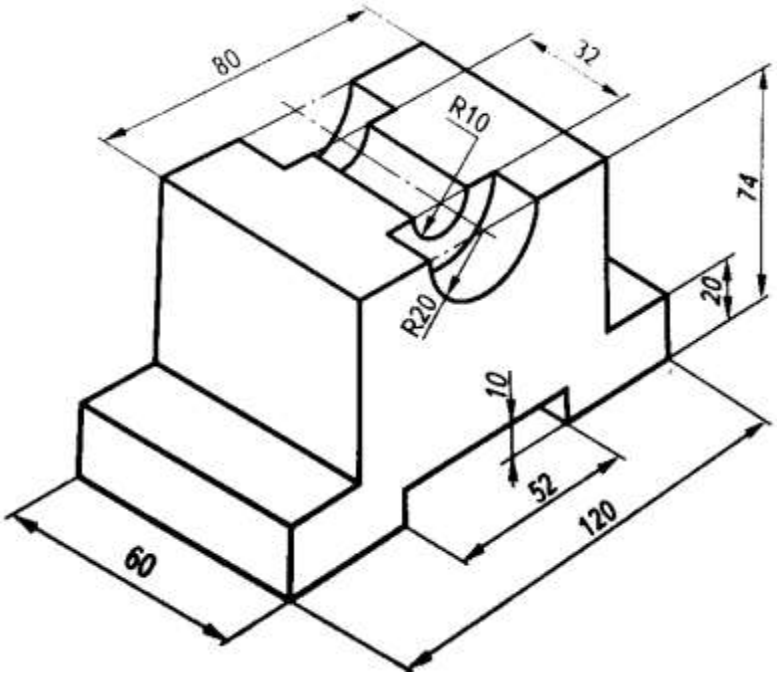

Figure 2. Given task with the second level of complexity

Finally, in the third stage, following comprehensive training covering all aspects of the topics, the students' understanding and skills were evaluated through a task presented in Figure (3).

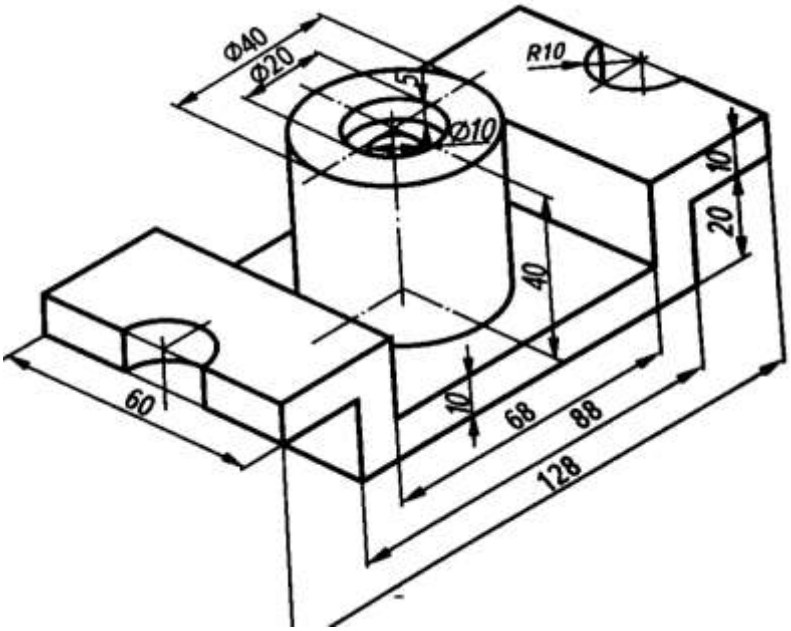

Figure 3. Given task with the third level of complexity

4. Results and Discussion

Modern teaching materials provide comprehensive information and details for Perspective geometry, making students' results more dependent on allocated study time rather than basic graphic skills. However, students with low levels of skills require more time to learn. Using computer programs instead of traditional drawing systems improves the quality and accuracy of drawings while reducing the impact of elementary skills. Basic computer skills have a positive effect on the success of graphic activities and accelerate the learning process.

The number of class hours dedicated to teaching geometry in the curriculum is insufficient. It is difficult to integrate project guidance, question-solving, and theoretical discussions into practical lessons. Conducting evaluations in optional advisory sessions leads to delays in the academic calendar. In many leading universities worldwide, attending classes is not mandatory as lessons are taught individually online using technology.

Student talent is now determined based on educational achievements, efforts, regular attendance in advisory courses, and evaluations. Recent advancements in teaching methods have improved the evaluation process. Two types of evaluations should be implemented: continuous evaluations, which monitor student progress and provide feedback during teaching, and cross-sectional evaluations, which assess overall understanding and higher-level thinking skills.

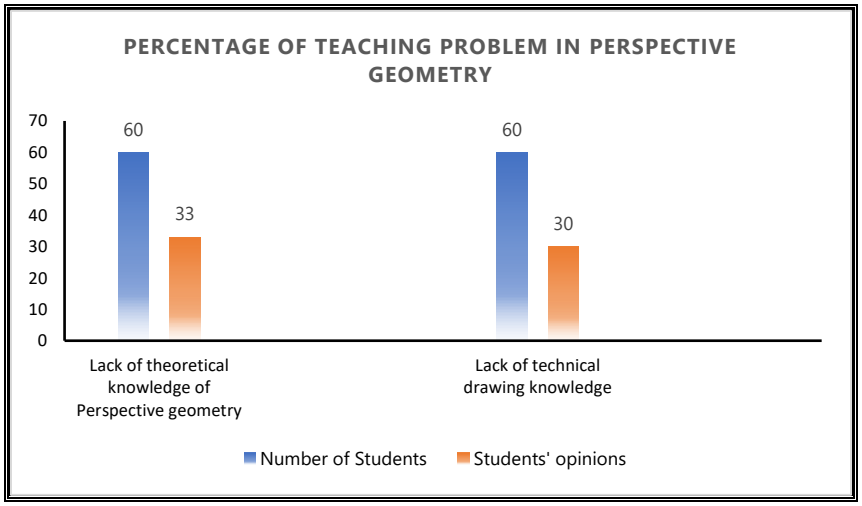

Figure 4. Percentage of teaching problems in perspective geometry

Several students attribute the primary difficulties in learning the subject of Perspective geometry to a lack of understanding of the subject's terminology, failure to read the geometric drawing material in textbooks, and the absence of an effective teacher-student communication and instructional relationship.

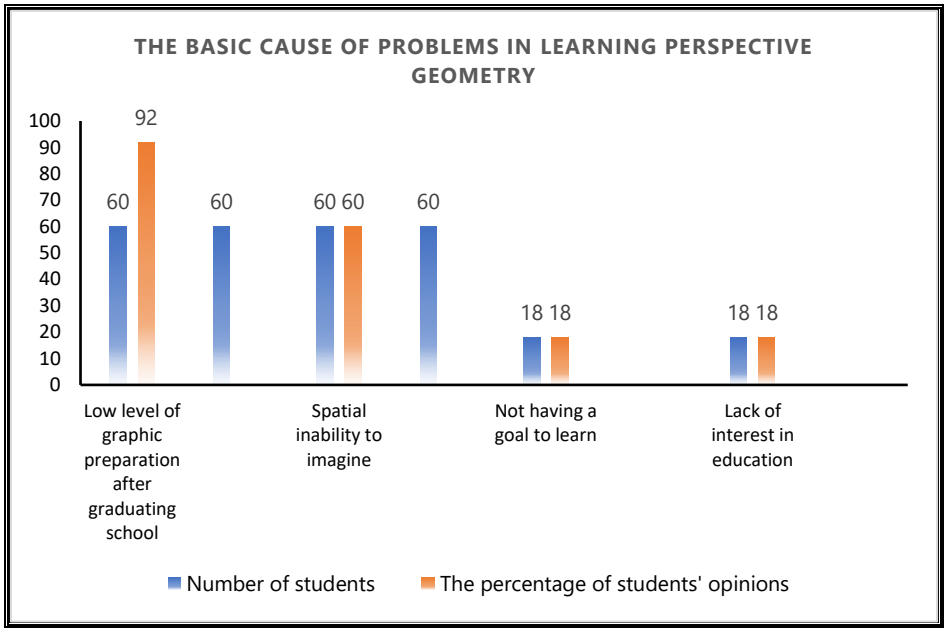

Figure 5. The basic cause of problems in learning perspective geometry

A fundamental factor contributing to learning difficulties in higher education institutions is the lack of a solid theoretical foundation and practical implementation of geometric concepts. Another significant factor, accounting for 28% of the reasons, is the unclear learning objectives of the subject, lack of interest in teaching, and students' inappropriate choice of academic major. The survey results indicate that 28% of students pursue higher education in order to obtain a degree. Additionally, around 11% of students experience uncertainty in choosing the right academic major. Furthermore, 20% of students do not intend to work in their field of study after graduation(Leopold, 2003).

Since the majority of surveyed students have insufficient knowledge about the concept of their future academic major, determining the content of this subject or that subject becomes quite challenging for them. Therefore, we asked students to prioritize one of three main learning objectives in geometry drawing based on its importance: enhancing knowledge level, the significance of the academic major, or passing the exam. Some students considered all three objectives essential.

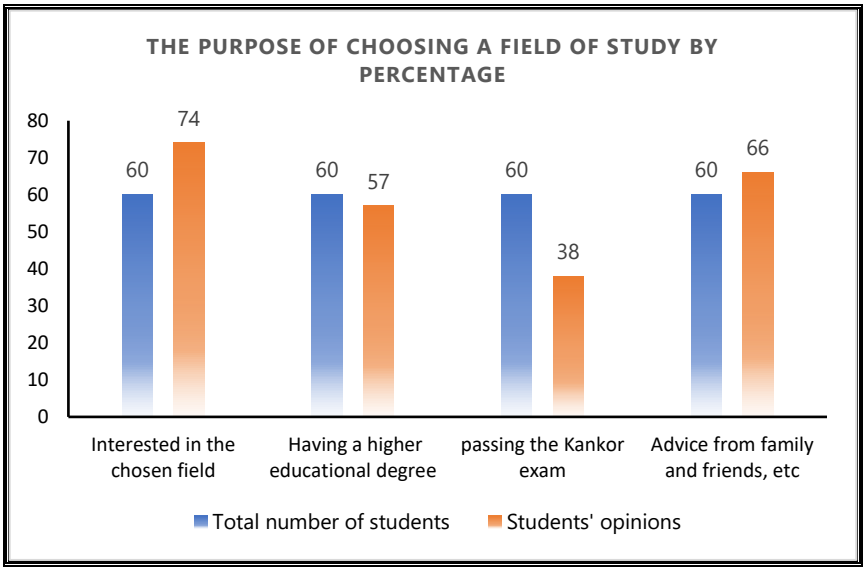

Figure 6. The purpose of choosing a field of study by percentage

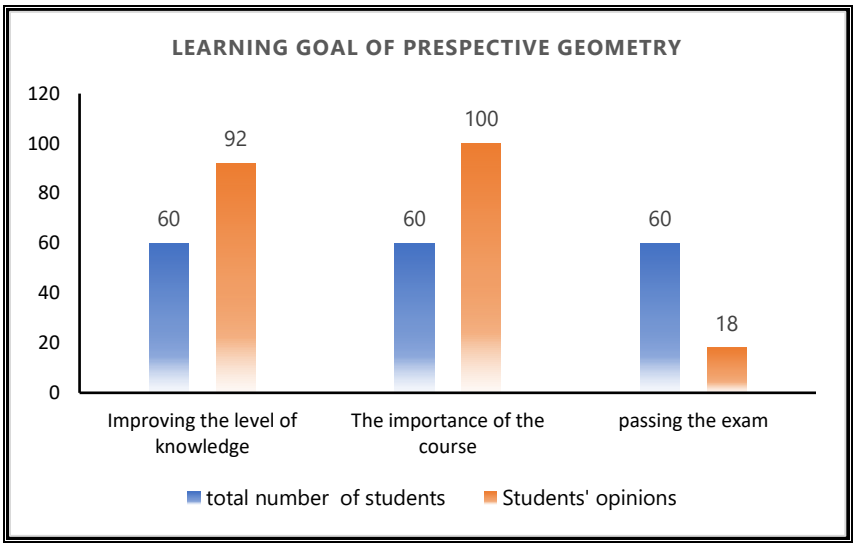

Figure 7. Learning goal of perspective geometry

Many students believe that the lack of regular practice in perspective geometry is the main reason for the difficulties experienced in this subject. According to research, the average time spent on learning geometry in universities is less than what is planned, which exacerbates the problem. The inability to perform individual practical tasks leads to problems at various levels of learning, including a lack of interest and negative results. This creates two negative situations for students: relying on teacher supervision during activities, indicating a lack of self-confidence, and seeking ways to deceive the teacher's evaluation, which negatively impacts the quality of education.

The students' tasks in the Second part are graded according to the following criteria:

- 30 points for excellent performance
- 20 points for good performance
- 10 points for successful completion
- Less than 10 points for failure.

Figure (7) presents the stages of both the initial and final evaluations, along with a comparison of the results from each stage prior to the final evaluation. Based on this data, it can be inferred that during the initial segment of the educational program, students were taught fundamental concepts related to drawing tools, the rules of drawing a 3D object on a 2D screen, and their

interrelationships. As anticipated, after completing the entire course, there was a significant increase in students' knowledge by 28%.

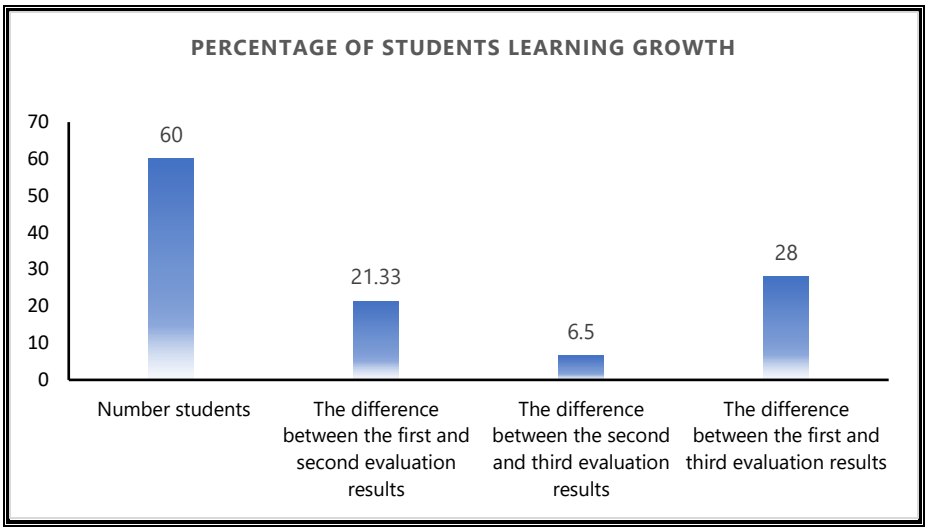

Figure 8. Percentage of students learning growth

Experience has shown that despite the completion of tasks in the second and third stages of evaluation, students' ability to grasp the fundamentals of the topics has improved. A small number of students have received low grades, which can be attributed to increased absenteeism in classes after the completion of assigned tasks.

Students with advanced levels of geometric-graphic education have successfully completed their individual tasks and projects within the given timeframe. These students acknowledge that a limited number of individuals possess an innate talent for learning, and their aptitude, absorption level, and ability to depict objects on a two-dimensional screen may vary. However, the lower level of understanding and learning when it comes to graphic themes does not impede the education of these students.

In short, it can be concluded that an engineer who lacks knowledge in perspective geometry and computer communication is unable to create closed graphic objects, plan the utilization of their technical system, and transform their plans into reality. In such a scenario, the significance of perspective geometry as the fundamental theoretical framework for modeling becomes paramount in engineering education.

One of our primary objectives is to enhance the content and materials of the educational program, enabling a novel approach to teaching and the incorporation of information technology for the improved education of students.

5. Conclusion

After comparing experimental education and the results of the questionnaire, we have reached the conclusion that in order to enhance learning and ensure educational success, it is crucial to utilize a variety of teaching and learning methods.

For effective curriculum learning, professors must possess a correct understanding of the subjects being taught and the expected outcomes for students. This understanding aids in achieving learning goals and educational objectives.

In recent years, significant scientific advancements have been made across various fields of study. As professionals, professors should stay updated with new developments in their respective fields, utilizing new techniques to acquire new information. They should then analyze the new content and its relationship with existing knowledge. During the analysis phase, professors evaluate the validity of the new knowledge, determine how to integrate it with existing content and devise optimal ways to present it in the classroom. This process ensures that the subject matter remains updated and enriched, encompassing all intellectual skills necessary for effective teaching: 1) learning related to the new content, 2) integration of existing knowledge, and 3) effective teaching strategies.

To enhance learning in perspective geometry courses, it is recommended to implement practical assignments where students themselves engage in drawing exercises. Each student should be provided with detailed instructions from the teacher, which they can replicate on paper.

Perspective geometry education primarily relies on imagination and visualization. Therefore, a series of exercises should be conducted to develop students' spatial imagination talent, enabling them to visualize objects mentally and draw them accurately later on. Students should be capable of representing 3D objects on a 2D surface.

When teaching concepts in perspective geometry, relying solely on argumentative methods and dry definitions may result in decreased student engagement. However, adopting practical and hands-on approaches helps alleviate some of the challenges in teaching and learning. It sparks enthusiasm and interest among students, making the learning experience more enjoyable. The utilization of animations and computer software in education also enhances the effectiveness of lessons.

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