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Intensive Methods for Developing Design Skills in The Professional Activities of Engineering Students

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Abstract: The article addresses the issue of developing graphic design skills in students based on engineering and computer graphics courses. It provides scientific analysis and recommendations regarding the relevance of developing 2D and 3D design skills among engineering students, identifies existing problems, and proposes solutions related to the design of equipment, products, and parts specific to their field.

Keywords: 2D, 3D, multimedia technologies, engineering and computer graphics, graphic disciplines, design competence.

Introduction: In the world's most developed countries, the effectiveness of the educational system is closely linked with high performance in socio-economic, technical, technological, and agricultural sectors. The cornerstone of economically advanced nations is their highly qualified intellectual workforce. Such workforce demonstrates independence, strong graphic competencies, design skills, and creative thinking, all fostered within their educational process.

In continuous education, particularly through innovative methods in teaching graphic subjects such as "Engineering and Computer Graphics," developing design-graphic competencies significantly enhances students' spatial imagination, creative thinking, and overall graphic learning efficiency. Today, employing multimedia computer technologies in teaching "Engineering and Computer Graphics" has become particularly relevant for advancing students' design skills.

As a result of consistent educational reforms in our country, the Concept for Higher Education Development until 2030 has been adopted. This emphasizes innovative educational activities, career orientation, and project-design preparedness. Developing design competencies among engineering students is vital for fostering creativity and generating new professional ideas, thus meeting current educational and professional demands.

Literature Review

Issues related to improving educational and methodological aspects of graphic education, enhancing graphic design competencies, graphic thinking, and spatial imagination among students have been studied extensively by Uzbek scholars such as R. Xorunov, I. Rahmonov, A. Xolmirzayev, Sh. Murodov, D. Kuchkarova, R. Ismatullayev, T. Rixsiboyev, E. Ro'ziyev, A. Xamrakulov, S. Saydaliyev, A. Qahharov, Sh. Dilshodbekov, D. Achilova, Ch. Shokirova, N. Yadgorov, and others.

Research on teaching disciplines such as "Descriptive Geometry and Engineering Graphics," "Drafting," "Engineering and Computer Graphics," as well as the development of design competencies among students, has been addressed by international scholars, including I.P. Istomina, L.V. Zanphirov, L.P. Rusinov, A.V. Piliper, Yu.A. Volkova, A.I. Khubiyev, L.N. Anisimov, P.A. Ostrojkov, Zh.Zh. Dzhanabayev, as well as foreign researchers Charles A. Rankowski, Minarut Galey, Neda Bokan, Marko Ljzokovic, Srdjan Vukmirovic, Ramon Rubio Garcia, Javier Suarez Quiros, Ramon Gallego Santos, Santiago Martin Gonzalez, Samuel Moran Fernandez, Putz C., Rodriguez de Abajo F. J., Rubio R., Toledo E., Martinez M. X., James L. Mohler, Bertolin G., Burton T., Wiley S., Bishop J., and Dejong P.S.

However, analyses reveal insufficient research dedicated specifically to field-oriented graphic design issues. Particularly, graphic design matters in fields

such as agriculture, transportation, and similar educational areas require deeper investigation and further academic attention.

DISCUSSION

Design competence of future engineers is an integrated quality consisting of motivational, intellectual, practical, and creative components. It involves freely mastering professional knowledge, skills, and abilities required for effective design tasks, meaningful cognitive activities across various fields, and creatively solving projects of varying complexity [22].

Designing is a structured activity focused on identifying, researching, and solving problems, formally presenting results, and continuously improving knowledge and practical skills [23].

In our interpretation, when students systematically engage in the design process, the following aspects require particular attention: mastering design methods, gathering relevant design-related information, independently exploring and tracking project completion, analyzing project quality, and practically implementing projects [23].

Designing is an integral component of engineering activity, aimed at creating designs necessary for developing structures. Engineering design, as a stage of designing, includes developing alternative construction solutions, performing calculations, and executing operational steps [21].

Design skills represent an engineer's capability to integrate engineering knowledge into practice. Such skills enable future engineers to identify professional problems, employ specialized knowledge and competencies to design solutions aligned with advancing technological standards, and synthesize knowledge from their specific professional domain to address challenges through an individual approach.

For instance, in teaching the course "Engineering and Computer Graphics" in agricultural education, students should acquire practical skills for designing machinery, parts, and related devices used in agriculture. Specifically, training students in virtual modeling of tractor components and additional agricultural equipment significantly enriches their professional knowledge. Integrating interdisciplinary approaches thus effectively fosters the development of professional competencies.

RESULTS

In organizing the educational process for the subject "Engineering and Computer Graphics," the following methods are recommended:

Traditional method: Drawing on the blackboard using chalk or markers.

Non-traditional method: Demonstrating step-by-step implementation through multimedia presentations.

Modern method: Demonstrating the process of transforming studied drawings into digital models and editing them with active student participation. Simpler drawings should be selected for effective teaching, and the instructor should adhere strictly to the lesson's technological map. In her scientific research, V.V. Kondratova [87, p.14] emphasized that employing computer graphics to visually present the necessary details in class significantly enhances learning efficiency.

Applying software in organizing lectures and practical sessions for the "Engineering and Computer Graphics" course achieves the following outcomes:

1. Students comprehend the importance, objectives, and tasks of the subject and understand its role within their selected educational direction.
2. Students develop a comprehensive understanding of the subject.
3. Students cultivate creativity and develop independent and logical thinking skills.
4. Students acquire independent learning skills and practical abilities in creating graphic drawings.
5. Students meet the subject's educational requirements, mastering essential knowledge and competencies effectively.

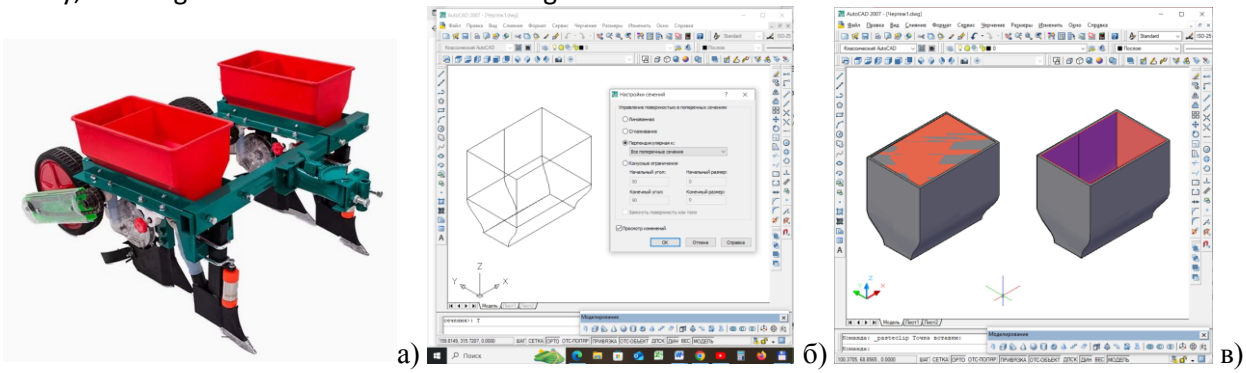
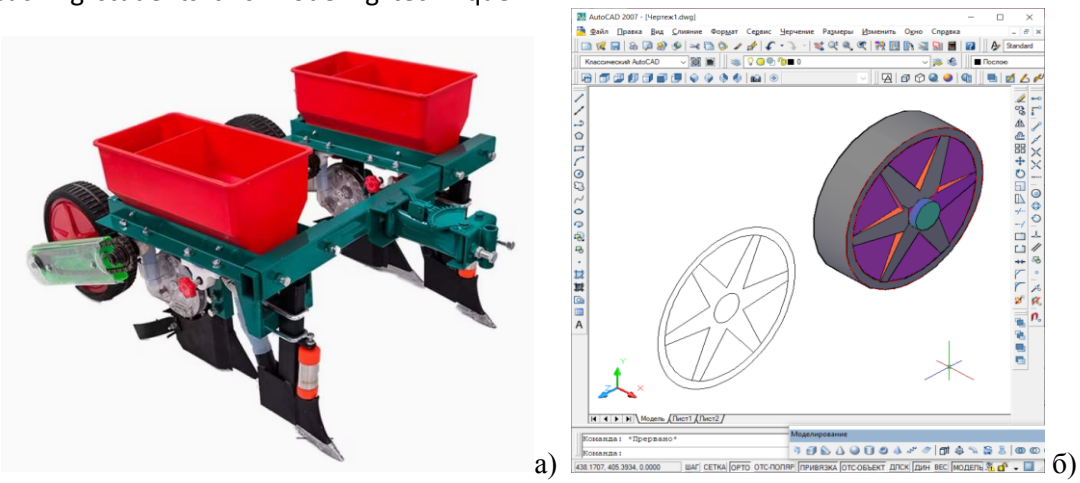

а) б) в)

Figure 1. ***a – Currently used agricultural seeding apparatus model; b – 2D modeling of this apparatus using AutoCAD software; c – 3D modeling of the selected component.***

Figure 1 illustrates the process of computer-aided modeling of the presented model using computer graphics. Teaching students this modeling technique enables them to analyze the design and encourages a creative approach towards engineering problem-solving.



а) б)

Figure 2.
a – Currently used agricultural seeding apparatus model;
b – 2D and 3D modeling of the apparatus wheel using AutoCAD software

Figure 2 demonstrates the process of modeling the wheel of an agricultural seeding apparatus. By utilizing computer-aided virtual design capabilities, it becomes possible to model specific agricultural equipment components accurately. Through such computer-aided design activities, students continuously develop practical engineering design skills and competencies. Integrating interdisciplinary approaches during the learning process contributes significantly to the advancement of the field and fosters the generation of innovative ideas.

Practical Application

Emphasizing the development of students' design skills during the teaching of "Engineering and Computer Graphics," particularly through creating and editing 2D and 3D drawings related to their professional fields, significantly enhances their professional competencies. It is crucial to orient agricultural coursework, design projects, and graduation qualification works towards comprehensive digital modeling using computer graphics. Future engineers inevitably engage in production enterprises and design organizations; hence, higher education institutions must focus on developing full-scale digital modeling capabilities to effectively demonstrate students' professional knowledge in practice.

Currently, Namangan Technical University is conducting scientific research specifically in this direction. Based on experimental testing and analysis, pedagogical experiments conducted at the beginning and end of the semester showed that 8 students (19.5%) produced error-free designs, 12 students (29.3%) made minor errors, 17 students (24.4%) correctly selected the projection method but had minor mistakes in their designs, while 4 students (48.8%) made substantial errors in projection methods and other areas. Overall, the students' interest in design activities and their professional knowledge notably increased from 50% to 88%.

CONCLUSION

In organizing the educational process for the course "Engineering and Computer Graphics," it is crucial to deliver knowledge clearly and accessibly, ensuring that students effectively develop practical skills and competencies based on this foundational knowledge. To achieve this goal, creating methodological resources that suit all types and forms of educational activities is necessary. Enhancing educational effectiveness requires continuous methodological improvement and regular monitoring of students' knowledge acquisition progress.

Therefore, fully implementing the defined tasks of the "Engineering and Computer Graphics" course provides a solid foundation for students to acquire subject-specific knowledge and apply it practically. Moreover, extensively employing computer graphics significantly fosters creativity among students in professional design projects, leading to the intensive development of their design skills.

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