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RESEARCH ARTICLE

Opportunities For Using Software Tools In Developing The Professional Competencies Of Future Engineers

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Abstract

This article examines the opportunities for using software tools in the development of professional competencies of future engineers. The rapid growth of digital technologies requires specialists who are able not only to possess theoretical knowledge, but also to effectively apply modern software solutions in practical and professional activities. The study analyzes the pedagogical potential of digital platforms, simulation systems, computer-aided design environments, and collaborative tools in improving technical thinking, problem-solving skills, creativity, and independent learning.

KEYWORDS

Context, development, transformation, the industrial revolution, AutoCAD, ANSYS, MATLAB, SolidWorks, virtual laboratories, computer animations, calculations, digitalization conditions, modeling, build graphs, conduct algorithmic, effective integration, ICT, development opportunities, software tool opportunities for the use of software, impact on transversal competence, considered.

INTRODUCTION

Today, in the context of the rapid development of industry and technology, the professional competence of technical engineers is the most important factor determining their productivity and effectiveness in creating high-quality and innovative products. It should be emphasized that the use of software tools plays a crucial role in developing the professional competence of engineers. What software modern engineers use today, what opportunities it provides, and how it can be created are considered among the current scientific novelties.

The processes of digital transformation, the industrial revolution, and the widespread implementation of information and communication technologies have fundamentally changed the requirements for technical specialists. Software represents a set of algorithms, programs, and functional tools that ensure information processing, management, modeling, and analysis.

In our republic, the possibilities of using software are diverse, and a number of scholars have contributed to this field. Sh.E. Berdikulova emphasizes the improvement of teaching methods in mechanics under digitalization conditions. According to the author, simulation programs, virtual laboratories, and computer animations create opportunities for a deeper understanding of concepts. Through programs such as AutoCAD, ANSYS, MATLAB, and SolidWorks, students develop practical engineering problem-solving competencies [2].

Boltayeva.Sh.O. focuses on strengthening mathematical training in engineering education. Software such as GeoGebra, MathCAD, Wolfram Mathematica, and MATLAB is considered an important tool for developing the mathematical competencies required in engineering. With these programs, students can perform complex mathematical modeling, build

graphs, and conduct algorithmic analysis of problems [3].

Begimqulov. U.Sh notes that when engineers use software in mathematical calculations, it enhances the development of practical skills. With the help of engineering programs such as AutoCAD, MATLAB, and SolidWorks, theoretical knowledge is reinforced through practical exercises. Modeling and visualization of complex systems, processes, and devices make understanding easier [4]. Software tools also create an interactive learning environment, developing independent thinking and problem-solving skills. Fast analysis and calculations increase accuracy and efficiency.

In traditional education, practical training was often insufficient, with an emphasis mainly on theory. ICT and software have filled this gap. Engineering software enables solving real-life problems using different approaches, increases student engagement, and automates time-consuming calculations, ensuring fast and reliable results [4].

Gulomov.S.S, Alimov.R.X, Lutfullayev.X.S, and Begalov B.A highlight the importance of software in engineering activities, considering it an integral tool in production, design, management systems, control, and monitoring. The use of ICT saves time and labor while increasing accuracy, optimality, and reliability [5]. They point out that when data collection, processing, and decision-making are performed manually, the process becomes slow and error-prone. Software solves this by enabling automatic data processing, rapid preparation of reports and technical drawings, and the use of mathematical models in planning [5].

The advantages include automation, optimization of resources such as time, materials, and workforce, visualization through drawings and graphs, integration of all stages from design to production, and reduction of human errors.

In his dissertation titled "Methodology for Creating and Using Databases in Informatics and Information Technologies", Khojakov.N.B developed methods for creating databases and using them effectively. The system allows monitoring students' knowledge, systematic storage of information, quick search, sorting, and statistical analysis [6]. This approach helps engineers manage information rationally and serves as a powerful assistant in working with and analyzing data.

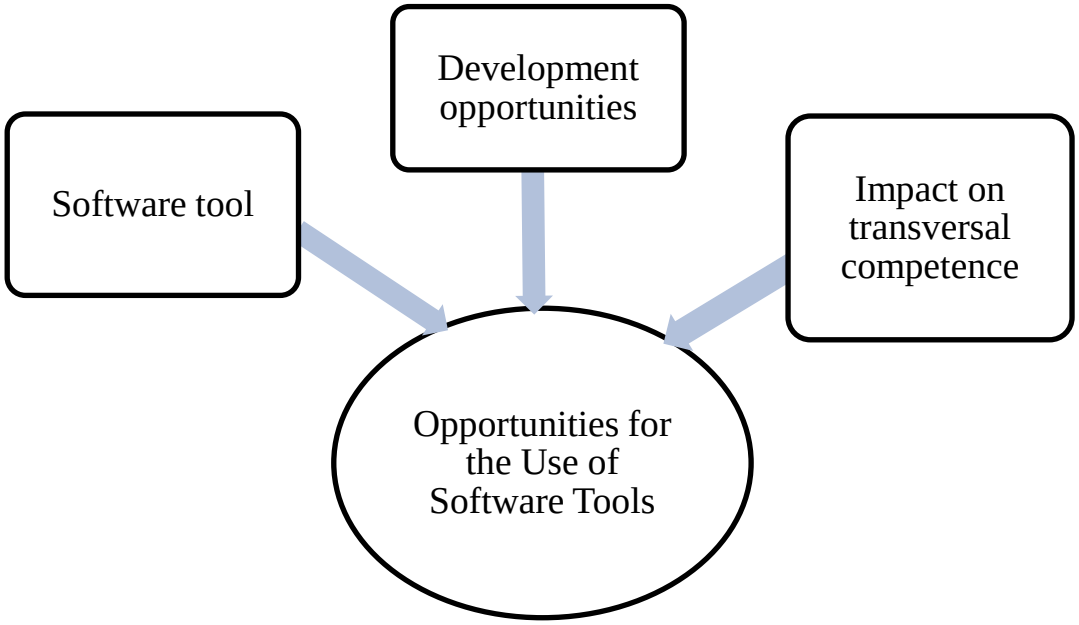
Moreover, software makes it possible to establish interaction between students and computers, even if they do not have special training. Research by J. Raven, Yu.N. Semin, L.T. Hel, and B.A. Shtoff confirms the importance of developing information and telecommunication systems. Computer technologies allow the integration of local databases and educational and scientific institutions into a unified model of professional activity [7, 8].

The pedagogical opportunities of developing future engineers' professional competencies through software include the creation of an effective, interactive educational environment via electronic learning platforms, online resources, virtual simulations, and digital technologies. These tools not only help students gain knowledge but also create conditions for becoming creative professionals in the future.

Pedagogical conditions aimed at improving education quality include the pedagogical environment, technical support, information approaches, electronic resources, online learning opportunities, and resource bases.

R.S. Safin's research is devoted to the introduction of modern pedagogical technologies in technical universities. He developed scientific and theoretical foundations for organizing the educational process based on ICT. The proposed methods deepen students' knowledge, develop practical skills, and increase independent learning abilities [1]. As a result, interactive teaching models, the effectiveness of distance learning technologies, and the use of virtual laboratories and digital resources in engineering education were substantiated [9].

In R.V. Yesin's dissertation on the formation of mathematical competence among bachelor students in informatics and computer engineering, the novelty lies in the effective integration of mathematics and information technologies. The developed software helps students master mathematical knowledge while enhancing logical and algorithmic thinking, thereby improving their ability to solve professional problems in the future [10].



Opportunities of software in developing the professional competencies of future engineers

Among the weaknesses of software tools are the high cost of licenses, the relative difficulty of initial learning, and, in some cases, significant memory requirements. In large projects, performance may decrease. One of the most important opportunities is the possibility of using such software as a scientific analysis tool in innovative startups and engineering projects. A potential threat is the dependence on correct software selection and on constant version updates, which may affect compatibility and continuity of the educational process.

One of the main strengths of Mathcad is the possibility to write formulas in a clear and visual form, creating mathematical and engineering calculations in the format of structured mathematical documents. It provides broad opportunities for understanding formulas and building diagrams. However, compared to MATLAB, its capabilities for complex simulation and coding are limited. In many cases, it is mainly suitable for analytical and computational tasks.

At the same time, Mathcad offers important opportunities: integration of digital documents into the learning process, use as interactive guidance in teaching materials and laboratory work, and rapid solution of small- and medium-complexity engineering problems.

MATLAB and Mathcad are considered powerful pedagogical tools for developing the professional competencies of future engineers. These programs ensure the integration of theoretical knowledge with practical activities. By modeling and analyzing complex engineering problems, they form analytical, problem-oriented, and systems thinking among students.

Furthermore, the use of MATLAB and Mathcad develops digital and technological literacy, algorithmic thinking, and the ability to operate in a modern engineering environment. Virtual experiments and simulations expand the transfer of theoretical knowledge to real production processes, thereby strengthening practical professional training.

These software tools also contribute to the development of research and innovation competencies. They allow forecasting technical processes, selecting optimal solutions, and effectively planning engineering projects. Presenting calculation results in graphical and visual forms enhances students' abilities in information presentation and technical communication. As a result, systematic and purposeful use of MATLAB and Mathcad in education becomes an important factor in preparing competitive, independent-thinking, innovative, and professionally mature specialists.

Integration of Mathcad with digital educational platforms, including LMS, online laboratories, and virtual training environments, increases the effectiveness of the learning process and activates students' independent and practical activities. Through this integration, calculation-oriented practical classes can be organized in an online environment.

Students solve engineering problems in Mathcad and upload calculation procedures, formulas, and results to the platform, establishing feedback with the instructor. This approach enables the implementation of a competency-based model in engineering education.

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