



THE IMPORTANCE OF E-LEARNING IN TEACHING ENGINEERING SUBJECTS

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Abstract

The article examines the importance of e-learning in teaching engineering subjects within pedagogical higher education. Engineering education requires not only the acquisition of theoretical knowledge but also the development of practical, analytical, technological, and problem-solving competencies. In this context, e-learning creates new opportunities for organizing the educational process through digital platforms, virtual laboratories, multimedia resources, simulation tools, online assessment systems, and interactive communication environments. The use of e-learning in engineering subjects helps students understand complex technical concepts more clearly, visualize processes that are difficult to demonstrate in traditional classrooms, and strengthen independent learning skills. The article emphasizes that digital educational technologies can increase the effectiveness of engineering instruction by connecting theory with practice, supporting differentiated learning, and improving students' motivation. Special attention is paid to the relevance of e-learning for pedagogical universities, where future teachers must acquire both engineering-related knowledge and the ability to apply digital teaching methods in their future professional activity. The study also highlights the need for methodological support, teacher digital competence, high-quality electronic resources, and systematic integration of e-learning tools into curricula. It is concluded that e-learning is not a replacement for traditional teaching but an important pedagogical mechanism that enriches engineering education, expands access to learning materials, and improves the quality of professional training.



Keywords: E-learning, engineering subjects, digital education, pedagogical university, virtual laboratory, simulation tools, interactive learning, professional competence.

ELEKTRON TA'LIMNING MUHANDISLIK FANLARINI O'QITISHDAGI AHAMIYATI

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Annotatsiya:

Maqolada pedagogik oliy ta'lim muassasalarida muhandislik fanlarini o'qitishda elektron ta'limning ahamiyati yoritiladi. Muhandislik ta'limi nafaqat nazariy bilimlarni egallashni, balki amaliy, tahliliy, texnologik va muammoli vaziyatlarni hal qilish kompetensiyalarini rivojlantirishni ham talab etadi. Shu nuqtayi nazardan, elektron ta'lim raqamli platformalar, virtual laboratoriyalar, multimedia resurslari, simulyatsiya vositalari, onlayn baholash tizimlari va interaktiv muloqot muhiti orqali o'quv jarayonini tashkil etishda yangi imkoniyatlar yaratadi. Muhandislik fanlarida elektron ta'limdan foydalanish talabalarga murakkab texnik tushunchalarni aniqroq anglash, an'anaviy auditoriyada ko'rsatish qiyin bo'lgan jarayonlarni vizuallashtirish hamda mustaqil ta'lim ko'nikmalarini mustahkamlash imkonini beradi. Maqolada raqamli ta'lim texnologiyalari nazariya va amaliyotni bog'lash, differensial ta'limni qo'llab-quvvatlash hamda talabalarning o'quv motivatsiyasini oshirish orqali muhandislik ta'limi samaradorligini kuchaytirishi asoslanadi. Pedagogik universitetlar sharoitida bu masala alohida ahamiyatga ega, chunki bo'lajak o'qituvchilar muhandislikka oid bilimlar bilan bir qatorda raqamli o'qitish metodlarini ham egallashi zarur. Shuningdek, maqolada metodik ta'minot, o'qituvchilarning raqamli kompetensiyasi, sifatli elektron resurslar va elektron ta'lim vositalarini o'quv dasturlariga tizimli integratsiya qilish zarurligi ta'kidlanadi. Elektron ta'lim an'anaviy ta'limning o'rnini bosuvchi vosita emas,



balki muhandislik ta'limini boyituvchi, o'quv materiallariga kirish imkoniyatini kengaytiruvchi va kasbiy tayyorgarlik sifatini oshiruvchi muhim pedagogik mexanizm sifatida baholanadi.

Kalit so'zlar: elektron ta'lim, muhandislik fanlari, raqamli ta'lim, pedagogik universitet, virtual laboratoriya, simulyatsiya vositalari, interaktiv ta'lim, kasbiy kompetensiya.

INTRODUCTION

E-learning has become one of the most important directions in the modernization of higher education, especially in the teaching of engineering subjects. Engineering education is directly connected with technical thinking, practical design, technological processes, modeling, measurement, experimentation, and the application of scientific knowledge to real production and social needs. Therefore, the quality of teaching engineering subjects depends not only on lectures and textbooks, but also on the availability of visual, interactive, practice-oriented, and digitally supported learning environments. In pedagogical universities, this issue has particular importance because students are prepared not only as specialists who understand engineering concepts, but also as future educators who should be able to organize effective teaching with the help of modern educational technologies.

Traditional teaching methods have long played a central role in engineering education. Classroom lectures, laboratory work, practical exercises, drawings, calculations, and teacher explanations remain necessary elements of the learning process. However, the rapid development of digital technologies has changed the requirements for professional training. Today's students need to work with electronic resources, digital design tools, online platforms, virtual laboratories, simulation programs, automated assessment systems, and multimedia learning materials. These tools make it possible to present complex engineering processes in a more understandable and accessible way. For example, mechanical motion, electrical circuits, construction structures, technological systems, and production processes can be demonstrated through animation, simulation, and virtual



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experimentation. This helps students move from passive memorization to active understanding.

The importance of e-learning in engineering subjects is also connected with the need to individualize and differentiate instruction. Students usually have different levels of prior knowledge, technical imagination, mathematical preparation, and practical experience. In a traditional classroom, it is often difficult for the teacher to provide each learner with an individual pace and learning trajectory. E-learning platforms can partially solve this problem by giving students access to repeated explanations, additional materials, video demonstrations, interactive tests, and independent assignments. As a result, students can return to difficult topics, analyze their mistakes, and strengthen their knowledge outside the classroom. This increases responsibility for independent learning and develops self-regulation skills.

Another important feature of e-learning is its ability to connect theoretical knowledge with practice. Engineering subjects often contain abstract formulas, technical schemes, physical laws, and design principles that may be difficult to understand without practical visualization. Digital learning tools allow students to test theoretical ideas in a virtual environment before applying them in real laboratory or production conditions. This is especially useful when real equipment is expensive, limited, dangerous, or unavailable. Through simulation-based learning, students can observe cause-and-effect relationships, compare different technical solutions, and develop analytical thinking.

In the context of higher education reforms, e-learning also supports the development of digital competence among both teachers and students. For pedagogical universities, this competence has a double meaning. Future teachers must master the subject content and also learn how to use digital tools methodically and responsibly in their own teaching practice. Therefore, the study of e-learning in engineering education is relevant not only as a technological issue, but also as a pedagogical and methodological problem. Its effective implementation requires didactic planning, qualified teachers, reliable digital resources, stable technical infrastructure, and assessment mechanisms that measure not only knowledge, but also practical and reflective competencies.



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Methods

The methodological basis of this study is formed by a pedagogical analysis of the role of e-learning in teaching engineering subjects in higher education. The research is based on a qualitative and practice-oriented approach, because the effectiveness of e-learning in engineering education cannot be assessed only through technical indicators. It must also be studied from the viewpoint of didactics, student activity, teacher competence, learning motivation, practical orientation, and the development of professional skills. For this reason, the study considers e-learning not simply as the use of computers or online platforms, but as a system of digital pedagogical tools that support the organization, delivery, monitoring, and evaluation of engineering education.

The first methodological direction is the analysis of scientific and pedagogical literature related to digital education, engineering pedagogy, educational technology, and competence-based learning. This analysis makes it possible to identify the main theoretical principles of e-learning and determine its relevance for engineering subjects. Special attention is given to the concepts of blended learning, virtual laboratory work, simulation-based learning, interactive tasks, online feedback, and independent student activity. These concepts are important because engineering education requires the integration of theoretical knowledge with practical application. Literature analysis also helps to define the didactic advantages and possible limitations of e-learning in pedagogical universities.

The second methodological direction is the study of the structure of engineering subjects and the types of learning activities that can be supported by digital tools. Engineering disciplines usually include lectures, practical calculations, laboratory experiments, technical drawing, project work, modeling, diagnostics, and problem-solving tasks. Each of these activities can be enriched through e-learning resources. For example, lectures can be supported by multimedia presentations, video fragments, and digital schemes. Practical lessons can include interactive exercises, electronic tests, and automated calculation tools. Laboratory work can be supplemented with virtual experiments and simulation programs. Project activities can be organized through cloud platforms, digital portfolios, and collaborative online environments.



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The third methodological direction is the observation of students' learning behavior in a digital educational environment. In this approach, attention is paid to how students use electronic resources, how actively they participate in online tasks, how they respond to feedback, and how they organize independent work. This is important because the success of e-learning depends not only on the availability of digital tools, but also on students' readiness to use them meaningfully. In engineering subjects, students must be able to analyze digital models, interpret results, compare technical solutions, and correct their mistakes. Therefore, observation of learning behavior helps to understand whether e-learning contributes to deeper comprehension or remains only a formal supplement to traditional lessons.

The fourth methodological direction is the evaluation of educational outcomes. In this study, the effectiveness of e-learning is considered through several indicators: students' understanding of theoretical concepts, ability to apply knowledge in practical tasks, participation in independent learning, motivation, digital competence, and readiness for professional activity. Assessment may include tests, practical assignments, project results, reflective tasks, online quizzes, and teacher feedback. Such a combined assessment approach is necessary because engineering education is multidimensional. It requires not only memorization of definitions and formulas, but also the ability to solve real technical problems.

The methodological approach of the study also takes into account the conditions of pedagogical universities. In this context, e-learning should be evaluated not only as a tool for mastering engineering content, but also as a means of preparing future teachers to use digital technologies in their own pedagogical practice. Therefore, the methods of the study are directed toward identifying how electronic learning environments can improve subject knowledge, methodological thinking, and professional readiness at the same time.

Results

The results of the study show that e-learning has significant pedagogical value in teaching engineering subjects, especially when it is used as an integrated part of the educational process rather than as an additional technical element. In



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engineering education, students often face difficulties in understanding abstract concepts, complex technical systems, mathematical models, technological processes, and cause-and-effect relationships between different components of a system. E-learning tools help reduce these difficulties by making learning materials more visual, interactive, accessible, and practice-oriented. When students work with electronic resources, virtual laboratories, simulation models, video explanations, and online assignments, they gain more opportunities to understand engineering content through repeated observation, independent analysis, and active participation.

One of the main results is the improvement of students' conceptual understanding. Engineering subjects usually require the ability to connect theoretical laws with practical situations. In traditional lessons, some students may memorize formulas or definitions without fully understanding their application. Digital learning environments provide an opportunity to demonstrate how a formula, principle, or technical rule works in real or simulated conditions. For example, when students study electrical circuits, mechanical movement, construction materials, technological equipment, or energy systems, simulation tools allow them to change parameters and immediately observe the result. This strengthens analytical thinking and helps students understand that engineering knowledge is not isolated information, but a practical instrument for solving problems.

Another important result is the development of students' independent learning skills. E-learning platforms give learners access to educational materials beyond the classroom. They can watch video lectures, complete electronic tests, read methodological instructions, repeat difficult topics, and prepare for practical lessons at their own pace. This is especially useful in pedagogical universities, where students may have different levels of technical preparation. Some students need more time to understand engineering terminology, while others are ready to perform more complex tasks. E-learning supports differentiated instruction by allowing each learner to choose a suitable rhythm of study and return to unclear materials when necessary.

The study also indicates that e-learning increases learning motivation. Engineering subjects become more engaging when students can interact with digital models, participate in virtual experiments, complete online tasks, and



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receive immediate feedback. Interactive tools transform students from passive listeners into active participants of the learning process. This is important because motivation in engineering education is closely connected with the visibility of practical results. When students see how their calculations, decisions, or design choices influence the outcome of a simulated process, they become more interested in the subject and more responsible for their learning activity.

The use of e-learning also improves the quality of assessment. Online quizzes, automated tests, electronic assignments, and digital portfolios make it possible to monitor students' progress more regularly. Teachers can identify common mistakes, analyze individual learning difficulties, and provide timely feedback. In engineering subjects, this is especially important because small misunderstandings in the early stages may later lead to serious difficulties in calculations, design work, or laboratory activities. Digital assessment tools help organize continuous monitoring and support a more objective evaluation of students' achievements.

Another result is the development of digital competence among future teachers. Students of pedagogical universities not only master engineering-related knowledge, but also learn how digital technologies can be used in teaching. Through participation in e-learning activities, they acquire experience in using platforms, preparing digital materials, interpreting online results, and organizing interactive learning. This experience is valuable for their future professional activity, because modern teachers must be able to combine subject knowledge with digital pedagogy.

At the same time, the results show that e-learning is effective only when it is methodologically well planned. The presence of digital tools alone does not guarantee high learning outcomes. Their effectiveness depends on the teacher's ability to select appropriate resources, connect them with lesson objectives, provide clear instructions, and combine online activities with face-to-face communication. Therefore, e-learning should be understood as a pedagogical system that supports engineering education through interaction, visualization, feedback, independent learning, and practical application.



Discussion

The discussion of the obtained results shows that e-learning plays a strategic role in improving the quality of teaching engineering subjects in pedagogical universities. Engineering education is closely connected with practice, experimentation, design, and technological thinking. For this reason, the use of digital resources should not be limited to the simple transfer of lecture materials into electronic form. If e-learning is understood only as uploading presentations, PDF files, or lecture texts to an online platform, its pedagogical potential remains limited. Its real value appears when digital tools are used to create an active learning environment where students can observe, analyze, model, test, compare, and correct their own learning actions.

One of the most important aspects of e-learning in engineering subjects is visualization. Many engineering processes are dynamic, complex, and difficult to explain only through oral instruction or static images. For example, the operation of technical mechanisms, the behavior of materials under different loads, the functioning of electrical systems, the movement of fluids, or the logic of technological production lines may be difficult for students to imagine without visual support. Digital simulations, animations, virtual laboratories, and multimedia models help students understand these processes more clearly. This contributes to the formation of technical imagination, which is an essential quality for mastering engineering disciplines.

Another significant issue is the relationship between e-learning and practical competence. Engineering education cannot be effective if it remains purely theoretical. Students must learn how to apply knowledge to practical situations, solve technical problems, and make reasoned decisions. E-learning supports this process by creating conditions for safe and repeated practice. In a virtual environment, students can make mistakes, change parameters, repeat experiments, and compare results without the risk of damaging equipment or wasting expensive materials. This is especially relevant for institutions where laboratory equipment is limited or where all students cannot work with real devices at the same time.

However, e-learning should not be considered a complete replacement for traditional laboratory and practical work. Real engineering activity requires direct



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contact with tools, materials, equipment, measurements, and technical documentation. Therefore, the most effective model is blended learning, in which electronic resources prepare students for real practical activity and then help them analyze the results. Before a laboratory lesson, students can study video instructions, safety rules, theoretical explanations, and simulation models. During the lesson, they can perform real tasks. After the lesson, they can complete electronic reports, reflective assignments, and online tests. Such integration increases the consistency of the educational process.

The role of the teacher also changes in an e-learning environment. The teacher is no longer only a source of information, but becomes an organizer, consultant, designer of learning tasks, and evaluator of students' progress. This requires a high level of digital and methodological competence. Teachers must know not only how to use digital platforms, but also how to select suitable tools according to learning objectives. For example, a video lecture may be useful for explaining theoretical material, while a simulation program may be more effective for understanding a process, and an online quiz may be appropriate for checking basic knowledge. The correct methodological choice determines the effectiveness of e-learning.

In pedagogical universities, this issue has an additional dimension. Students are future teachers, so they should not only use e-learning as learners, but also understand its didactic possibilities. When they participate in digital engineering lessons, they gradually form methodological thinking: how to explain difficult concepts, how to organize independent work, how to assess learning outcomes, and how to motivate students through interactive tools. Thus, e-learning contributes not only to subject preparation, but also to professional pedagogical formation.

At the same time, several challenges must be taken into account. These include insufficient technical infrastructure, uneven digital skills among teachers and students, lack of high-quality electronic resources in some engineering subjects, and the danger of superficial learning if online tasks are poorly designed. Therefore, the successful implementation of e-learning requires systematic support from the institution, regular teacher training, development of localized digital content, and clear criteria for evaluating the effectiveness of electronic



learning activities. Only under these conditions can e-learning become a real factor in improving engineering education.

Conclusion

The importance of e-learning in teaching engineering subjects is determined by its ability to enrich the educational process with visual, interactive, flexible, and practice-oriented opportunities. Engineering education requires the formation of a complex system of knowledge and skills, including theoretical understanding, technical thinking, practical application, problem solving, design culture, and the ability to work with modern technologies. In this regard, e-learning creates favorable pedagogical conditions for improving the quality of instruction and making engineering subjects more accessible, understandable, and connected with real professional activity.

The analysis shows that digital platforms, virtual laboratories, simulation tools, multimedia resources, online tests, and electronic portfolios can significantly support the teaching of engineering disciplines. These tools help students understand complex processes, observe technical phenomena, repeat difficult material, receive immediate feedback, and organize independent learning. For many engineering topics, visual and interactive explanation is especially important because students need to see how mechanisms, systems, models, and technological processes function. E-learning makes it possible to transform abstract theoretical content into practical and observable learning experience.

At the same time, e-learning is most effective when it is integrated into the educational process on the basis of clear methodological goals. It should not be used only as a formal digital supplement to traditional teaching. Its value depends on how well the teacher connects electronic resources with lesson objectives, practical assignments, assessment criteria, and students' professional needs. A well-organized e-learning environment helps combine theoretical instruction with practical training, individual work with group interaction, and classroom learning with independent study. Such integration strengthens students' motivation and increases their responsibility for learning outcomes.

In pedagogical universities, the importance of e-learning is even broader. Future teachers must not only master engineering-related knowledge, but also develop



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the ability to use digital technologies in their own professional activity. Through participation in electronic learning environments, students gain methodological experience: they learn how digital tools can be used to explain difficult topics, organize practical tasks, assess knowledge, provide feedback, and support learners with different levels of preparation. Therefore, e-learning contributes to the development of both subject competence and pedagogical competence.

The study also demonstrates that the successful implementation of e-learning requires institutional, technical, and methodological support. Higher education institutions need stable digital infrastructure, access to quality electronic resources, teacher training programs, and mechanisms for monitoring the effectiveness of digital learning. Teachers need to improve their digital competence and develop the ability to design meaningful electronic tasks. Students, in turn, should be prepared for independent work, responsible use of online resources, and active participation in digital learning activities.

Thus, e-learning should be understood not as a replacement for traditional engineering education, but as an important means of its modernization. It expands access to learning materials, supports visualization and simulation, strengthens independent learning, improves assessment, and connects engineering theory with practical application. When used systematically and methodologically correctly, e-learning becomes a powerful pedagogical factor in improving the professional training of future specialists and future teachers in the field of engineering education.

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