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# FORMING THE BASIC PROFESSIONAL COMPETENCE OF FUTURE ENGINEERS IN THE PROCESS OF MATHEMATICAL TRAINING USING THE METHOD OF FLIPPED LEARNING

# ФОМУВАННЯ БАЗОВОЇ ПРОФЕСІЙНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ІНЖЕНЕРІВ У ПРОЦЕСІ МАТЕМАТИЧНОЇ ПІДГОТОВКИ ЗА ДОПОМОГОЮ МЕТОДУ ПЕРЕВЕРНУТОГО НАВЧАННЯ

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Reform and digital transformation of higher education require new approaches to the organization of the educational process. Notwithstanding the ongoing martial law in Ukraine, educators continue to actively reorganize the educational process by integrating traditional teaching methods and innovative ones. In the Strategy for the Development of Higher Education in Ukraine for 2022-2032, the third strategic goal, which is responsible for "ensuring quality educational and research activities, competitive higher education that is accessible to different groups of the

population", identifies the need to "promote the use of innovative technologies and advanced teaching tools in the educational process" [5, p. 28].

Unlike traditional teaching methods, active learning promotes the development of critical thinking, creativity and independence, encouraging students to discover their own solutions and experiment with new ideas and concepts, which increases motivation to learn. Consequently, it contributes to the deepening of knowledge and development of skills necessary for successful adaptation in the modern information society, which in turn affects the formation of basic professional competence. As S. Reznik notes, "active teaching methods allow students to gain practical experience in simulated conditions, develop skills and abilities at a sufficiently high level, and contribute to the development of the ability to independently and creatively apply the acquired knowledge" [4, p. 55].

Such an active method is flipped learning, which allows students to engage in the learning process, solve problems in a team, and apply their knowledge in practical terms. This method was developed and implemented in the educational process by American teachers of the Faculty of Natural Sciences, Jonathan Bergmann and Aaron Sams, in 2007–2008. A. Sams came to the conclusion that students need the help of a teacher not as a person who provides ready-made material during lectures but as a mentor or consultant who will help to deal with the issues that arise during independent study of theoretical material, as well as share the experience of practical application of the acquired knowledge [1, p. 16].

Taking into account positive experience of applying this method in the United States of America [1], Ukraine [2, 3], and the needs of modern Ukrainian society, we consider the implementation of the flipped learning method in the process of mathematical training of engineers to be an important prerequisite for effective training of specialists in this field.

Mathematical preparation is the cornerstone of general technical education, the foundation for the development of engineering skills and analytical thinking. In this aspect, when implementing the flipped learning method, we can emphasize students' independent work on theoretical material outside of class time and free up a significant portion of classroom work for practical exercises under the guidance of the teacher, as well as for collaborative task-solving. Let's focus on the primary advantages of implementing flipped learning to enhance the development of fundamental professional competencies among future engineers during mathematical preparation.

One of the primary advantages is the increased autonomy and engagement of learners in the learning process. Hence, students are introduced to the theoretical material before class, typically through videos or readings. This enables them to come to auditorium(or join online) already familiar with and understanding the topic, ready for active discussion of theory, debates, expressing their opinions, as well as for practical exercises, tasks, projects, etc. Additionally, since mathematical preparation may contain content that some students find difficult to grasp, future engineers have more time to ask questions, receive explanations, clarify problematic issues for themselves, and more deeply analyze and comprehend the essence of the studied material.

The second advantage is ensuring student-centered learning through personalization. Students can watch prerecorded lectures or materials at their own pace, pausing or replaying them as needed. This flexibility accommodates different learning styles and allows students to focus on aspects that require their additional attention. As noted by A. Kushniruk, "an important advantage of the flipped learning technology is that students can review the material they do not understand several times, communicate with classmates if they encounter difficulties in understanding assigned tasks, etc." [2, p. 142].

The third advantage of flipped learning for the development of basic professional competence of future engineers in the process of mathematical preparation is the increased interactivity of this method. In traditional lecture-based learning, students often have limited interaction with their peers and the instructor, whereas in a flipped classroom, students spend more time collaborating with each other and engaging in discussions with the instructor. Such a collaborative environment fosters a deeper understanding of mathematical methods and the acquisition of skills in working with various mathematical concepts, as students learn from each other and receive timely feedback from the instructor.

The fourth advantage of flipped learning is its promotion of critical and analytical thinking. By engaging with the material before class, students are better prepared to tackle complex problems and achieve a deeper understanding of mathematical methods, theorems, and definitions during classroom activities. Additionally, flipped learning makes educational resources more accessible to learners. Specifically, individuals can revisit previously studied topics and materials at any time, which is particularly beneficial for reviewing complex mathematical material or preparing for ongoing and final assessments in the discipline. Moreover, with the implementation of the flipped classroom method, there is the opportunity

to utilize various digital platforms and online resources, providing students with the autonomy to choose their preferred learning methods.

Despite the significant number of advantages of the flipped learning method, in our opinion, its implementation also has its drawbacks and challenges. Specifically, students need to possess a high level of self-organization and self-discipline, which not all are adequately prepared for. Some may find it difficult to independently manage their time and complete tasks outside the classroom without the instructor's supervision. Gaps in learning may occur during students' independent work.

Among the drawbacks for instructors, one can mention significant time investment in preparing various educational materials required for both in-class and out-of-class work with students; preparation of assessment tools and so on. However, the main challenge of flipped learning, and we agree with this viewpoint, is "to hand over control of learning to the students. For many teachers, this is very difficult. But when learning is in the hands of students, not the teacher, real learning takes place" [1, p. 122].

Thus, the formation of basic professional competence of future engineers through the flipped learning method in the process of mathematical preparation has both advantages (active engagement of learners in the learning process, personalized learning experience, enhanced interaction, development of critical and analytical thinking skills, accessibility of resources) and disadvantages (varying levels of student self-organization, likelihood of gaps in student learning, increased workload and the need for additional time for instructors to organize students' work using the flipped classroom method). However, by implementing this method, instructors can create an accessible learning environment focused on learners, which will help future engineers become competent, confident, and experienced professionals. The conclusions drawn from the research can be used in the educational process to improve the quality of mathematical preparation for future engineers.

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