Teaching higher mathematics through english: challenges and learning outcomes in engineering education

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The internationalization of higher education and the integration of Ukraine into the European educational and scientific area have significantly increased the importance of bilingual education in engineering training. English is no longer viewed solely as a foreign language but increasingly serves as a medium of instruction that enables students to access international educational resources, participate in academic mobility programmes, and develop professional communication skills. Consequently, bilingual teaching has become one of the promising approaches to improving the quality and competitiveness of engineering education. Teaching higher mathematics in English is a particularly demanding task because students must simultaneously master mathematical concepts and acquire professional terminology in a foreign language. The effectiveness of this approach depends on several pedagogical and organizational factors, including students' initial English proficiency, methodological support, instructors' experience, and the adaptation of teaching materials to national educational standards. This study aims to identify the main challenges of bilingual teaching of higher mathematics for engineering students and to determine whether learning mathematics through English influences students' mastery of subject content. The research was conducted at Zaporizhzhia Polytechnic National University among first-year students majoring in

Power Engineering, Electrical Engineering and Electrical Mechanics. The experiment involved students from both English-medium and Ukrainian-medium groups.. Both groups studied according to the same curriculum and completed identical assessment tasks; the only substantial difference was that English-medium students attended additional English language classes and studied higher mathematics entirely in English.

The pedagogical observations demonstrated that bilingual instruction creates several specific challenges. First, many first-year students have insufficient English proficiency to perceive complex mathematical explanations immediately. This often requires instructors to simplify explanations or spend additional time clarifying terminology and concepts. Second, teaching in English proceeds at a slower pace than teaching in the native language, reducing the amount of material that can be covered during scheduled classroom hours. Third, instructors have to provide Ukrainian equivalents of mathematical terminology to ensure that students are able to use professional vocabulary correctly in both languages. Furthermore, differences between Ukrainian and international approaches to mathematics education make it impossible to rely exclusively on authentic English-language textbooks. Therefore, specially designed methodological materials, including bilingual lecture notes, workbooks, calculation assignments and multilingual mathematical dictionaries, become an essential component of bilingual instruction. Despite these challenges, bilingual teaching offers considerable educational advantages. Students continuously improve their English language competence while studying mathematics, acquire professional engineering vocabulary, gain easier access to international scientific literature, and become better prepared for academic mobility, international Master's programmes, internships, and standardized English examinations such as IELTS, TOEFL, TOEIC, and GRE. inations such as IELTS, TOEFL, TOEIC, and GRE.

To evaluate whether bilingual instruction influences academic achievement, students' examination results in higher mathematics were statistically analysed. To verify the research hypothesis, the results of both groups were analysed using the Z-test for independent samples. The English-medium sample consisted of 46 observations with a mean score of 71.78 and a variance of 65.08, whereas the Ukrainian-medium sample included 80 observations with a mean score of 69.36 and a variance of 28.38. At the significance level $\alpha = 0.05$, the empirical value of the test statistic ($Z = 1.8192$) was lower than the critical value ($Z = 1.96$). Therefore, there were no statistical grounds to reject the null hypothesis concerning the equality of the mean scores. The obtained results indicate that the observed differences between the two groups are attributable to random variation rather than to the language of instruction.

The findings demonstrate that English-medium instruction in higher mathematics does not reduce students' academic achievement when appropriate methodological support is provided. Therefore, bilingual instruction may be considered an effective approach for teaching not only mathematics but also other fundamental and professional engineering disciplines. These results support the further expansion of English-medium instruction in Ukrainian technical universities and provide a basis for future research on the development of bilingual mathematical competence and effective instructional strategies. **Keywords** *higher mathematics, bilingual instruction, English Medium Instruction (EMI), bilingual mathematics education, subject-oriented bilingual teaching/learning models.*

Bibliography

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