МАТЕМАТИКА И МАТЕМАТИЧЕСКО ОБРАЗОВАНИЕ, 2026
MATHEMATICS AND EDUCATION IN MATHEMATICS, 2026
Proceedings of the Fifty-Fifth Spring Conference
of the Union of Bulgarian Mathematicians
Tryavna, Bulgaria, April 5–9, 2026

UKRAINIAN EXPERIENCE IN TEACHING HIGHER MATHEMATICS IN ENGLISH: OUTCOMES AND CHALLENGES

Nataliia Snizhko
Department of Higher Mathematics,
Zaporizhzhia Polytechnic National University, Zaporizhzhia, Ukraine
e-mail: `snizhko.nataliia@gmail.com`

This article examines the implementation and effectiveness of an English-medium mathematics course for engineering students at the National University "Zaporizhzhia Polytechnic". The study analyzes student attitudes, challenges, motivational factors, and academic outcomes among participants of EMI and traditional Ukrainian-language groups. Quantitative results show no significant differences in final grades, confirming that foreign-language instruction does not hinder students' acquisition of mathematical content. Qualitative findings highlight the cognitive benefits of bilingual learning, including enhanced attention to conceptual structures and improved professional language skills. The study identifies the need for adapted teaching materials and emphasizes the importance of methodological support for successful EMI implementation.

Keywords: higher mathematics, bilingual instruction, English Medium Instruction (EMI), bilingual mathematics education, subject-oriented bilingual teaching/learning models

УКРАИНСКИ ОПИТ В ПРЕПОДАВАНЕТО НА ВИСША МАТЕМАТИКА НА АНГЛИЙСКИ ЕЗИК: РЕЗУЛТАТИ И ПРЕДИЗВИКАТЕЛСТВА

Наталия Снижко
Катедра „Висша математика“,
Национален университет „Запорожка политехника“, Запорожие, Украйна
e-mail: `snizhko.nataliia@gmail.com`

Статията разглежда внедряването и ефективността на курс по висша математика на английски език за студенти по инженерни специалности в Национален университет „Запорожка политехника“. Анализирани са отношението на студентите, основните затруднения, мотивационните фактори и учебните резултати в EMI групата

https://doi.org/10.55630/mem.2026.55.214-222
2020 Mathematics Subject Classification: 97C30, 97C50, 97M10.

и традиционната група на украински език. Количественият анализ показва липса на значима разлика в крайните оценки, като потвърждава, че обучението на чужд език не възпрепятства усвояването на математическото съдържание. Качествените резултати подчертават когнитивните ползи от двуезичното обучение, включително засилено внимание към концептуалните структури и подобрени професионални езикови умения. Проучването изтъква необходимостта от адаптирани материали и методическа подкрепа за успешното прилагане на EMI.

Ключови думи: висша математика, двуезично обучение, обучение чрез английски език (EMI), двуезично математическо образование, предметно-ориентирани модели за двуезично обучение/преподаване

Introduction

The ongoing processes of globalization and the international integration of higher education systems require technical universities to reconsider their instructional strategies and learning settings. As the dominant language of international communication, English has become an essential element of engineers' professional skill sets. The Bologna Process further promotes student mobility and enhances the competitiveness of graduates, motivating Ukrainian institutions to align their academic programs with European educational frameworks.

Bilingual instruction (Ukrainian – English) presents a productive pathway for fostering both intercultural awareness and professional competencies. Within such courses, English functions not only as a language to be learned but also as the primary medium through which subject knowledge is delivered (EMI – English Medium Instruction). While EMI practices in technical disciplines are still evolving in Ukraine, their relevance is steadily increasing, creating a clear need to adapt teaching methodologies to national educational realities. Teaching mathematics in English is particularly justified, as mathematical concepts and symbolic representations are universally shared across scientific communities, making the discipline an ideal platform for developing professional language proficiency without compromising conceptual understanding.

Theoretical background

Bilingual education is seen as the integration of content and language, where a foreign language becomes a tool for acquiring specialized knowledge. Modern research highlights various models of bilingual learning, but at the university level, the EMI model is considered the most effective. EMI involves teaching professional subjects in English without formally focusing on language goals [12; 15]. EMI is used in Europe, Asia, and South America, and experiences from some countries show that English is becoming the standard in many engineering programs [1; 7].

Language factors in mathematics learning are a special subject of research by scholars [4]. In mathematics education, EMI offers additional advantages. First, the universality of mathematical symbols helps students understand content even if their language skills are limited. Second, mathematical terminology is highly precise, and equivalents in different languages have clear meanings, which aids memory and natural vocabulary acquisition. Third, switching to another language system promotes analytical and critical thinking, as students must rethink familiar concepts and focus on logical connections instead of mechanically using formulas [2; 9; 11].

Ukrainian research on this topic is still fragmented and mostly focuses on specific aspects of foreign language mathematical training for engineers. The lack of a comprehensive concept for bilingual mathematics (engineering) education, national teaching methods, and didactic materials complicates the implementation of EMI courses [13; 14]. However, existing publications [3; 5] emphasize the urgent need to develop this area.

Organization of the EMI course and research methodology

At the National University "Zaporizhzhia Polytechnic", a course in higher mathematics has been taught in English since 2016 for students majoring in Power Engineering, Electrical Engineering, and Electrical Mechanics. This course is implemented as a full component of the educational program. Students in the English-speaking group follow the same curriculum as those in the Ukrainian-speaking groups. Groups are formed solely based on students' choice, and no selection based on language proficiency is applied. All students simultaneously take a course in English for Specifics Purposes (ESP), which ensures support for their language competencies.

During 2021–2024, 89 students participated in the study, including 29 enrolled in the EMI course and 60 studying in Ukrainian. Data were collected through Google Forms surveys and online questionnaires, which included various types of questions such as Likert scales, open-ended, and multiple-choice items. Statistical analysis involved comparison of final mathematics grades using the independent samples t-test. In addition, qualitative analysis was used to interpret students' motivations, challenges, and impressions.

The study is limited to a relatively small number of students from a single university. This is partly due to the consequences of the pandemic and the introduction of martial law in Ukraine. Nevertheless, the trend is clear, allowing us to assess the benefits, challenges, and cognitive effects of bilingual higher mathematics education.

Results and discussion

Student attitudes and main challenges. The survey conducted at the beginning of the course showed the following. The results demonstrated a high level of student awareness of bilingual education (over 92% of respondents were familiar with the concept) and a positive attitude toward the EMI mathematics course (about 84% supported the idea of a bilingual mathematics course). The majority of respondents (76%) believed that studying mathematical subjects in English broadens their professional prospects, promotes academic mobility, and increases competitiveness in the labor market. At the same time, only about one-third of students (38%) rated their initial English proficiency as sufficient for participating in an EMI course. However, later most respondents noted that language difficulties significantly decreased during the first few months.

Student motivation focuses on educational and professional opportunities (100% of bilingual group respondents), the desire to improve foreign language proficiency (65%), master subject-specific (mathematical) terminology (83%), and gain experience in intercultural communication.

At the end of the course, students' emotional feedback indicates that the English-medium mathematics course is perceived as engaging and useful (nearly 90%). Students highly value the opportunity to practice English-language mathematical discourse while solving problems, explaining methods, and participating in discussions

Alongside positive evaluations, students also note several challenges. The most frequently mentioned issue is the lack of English-language textbooks and teaching materials adapted to the Ukrainian mathematical tradition (82%). For example, the Ukrainian and Western European traditions differ significantly in their approaches to teaching topics related to function differentiation and the definite integral. Differences in notation, structure, and problem types make it difficult to use foreign resources without additional adaptation. There are also differences in basic school mathematics. In Ukrainian schools, considerable attention is devoted to studying solid geometry, logarithms, and trigonometry, while noticeably less emphasis is placed on combinatorics, statistics, financial calculations, working with graphical information, and the ability to formalize real-life problems (different balance between the theoretical and practical components). Therefore, we believe that it is necessary to develop specialized teaching materials that take into account the specifics of Ukrainian mathematical preparation while also meeting international standards. Relying solely on foreign textbooks is insufficient and may complicate the learning process. Thus, it is advisable to create adapted English-language manuals, glossaries, and online courses, at least during the initial stages of English-medium instruction.

Another challenge is the slower pace of instruction in a foreign language and, as a result, the possible lack of classroom hours needed to cover the mathematical material (49%). In addition, at the initial stages of bilingual instruction the instructor often needs to provide terminology in both languages and compile a glossary for each topic. As a result, within the scheduled classroom hours for the higher mathematics course, students in English-medium groups manage to cover a smaller amount of material than those studying in their native language. This may affect the completion of the curriculum. These reasons require the instructor to carefully select course materials. The issue of insufficient classroom hours can be partially addressed through blended learning, more intensive independent work, and the use of interactive platforms that help compensate for the slower pace of classroom instruction.

A comprehensive analysis shows that the success of bilingual mathematics instruction largely depends on the instructor's pedagogical expertise. English does not pose a barrier if the instructor possesses deep professional knowledge and can adapt the material to the students' pace and language characteristics. We agree with [8] and believe that a high level of methodological and subject-matter competence in a mathematics instructor can, to some extent, compensate for possible limitations in their foreign language proficiency. An important condition is collaboration between mathematics instructors and ESP teachers, as effective bilingual education requires an integrated approach that includes both mathematical and language components.

The impact of EMI instruction on the acquisition of mathematical content. A central question of this study was whether delivering a higher mathematics course in a foreign language has an impact on students' comprehension and mastery of the subject matter. Naturally, it is particularly important to ensure that students' learning is not adversely affected by instruction being delivered in a foreign language.

To address this question, we conducted a detailed analysis of students' assessment results in higher mathematics. The assessments were carried out at the end of the course using a standardized 0–100 point scale. Two distinct groups were examined: the experimental group, which participated in the EMI mathematics course, and the control group, which completed the traditional course in Ukrainian. To evaluate the potential effect of the language of instruction, we tested the hypothesis of equality of means between the two independent populations.

The experimental group consisted of 29 students who took the EMI course, while the control group included 60 students who studied in Ukrainian. The sample means were 72.70 and 71.61, respectively, with standard deviations of 6.28 and 3.44.

Given the difference in sample sizes and the fact that the sample variances were not substantially different ($1/2 < S1/S2 < 2$), a two-sample t-test with a two-sided critical region was applied. The empirical t-value (1.0545) was calculated using the Student's t-statistic. Since the p-value (0.3073) exceeds the significance level ($\alpha = 0.05$), we have no grounds to reject the null hypothesis that the means of the two groups are equal. This indicates that any observed differences in the scores are likely due to random variation rather than the language of instruction. The data do not contradict the null hypothesis that the means of the two samples are equal.

Therefore, it can be concluded that teaching higher mathematics in English does not adversely (negatively) affect students' mastery of the subject content. This finding aligns with previous research on the impact of bilingual programs on learning outcomes [6] and supports evidence on the effectiveness of bilingual instruction for engineering and technical students.

Thus, the results support the feasibility of implementing English-medium mathematics courses in technical universities, provided that a sufficient level of mathematical preparation is maintained and teaching materials are adapted to meet the needs of students with varying levels of language proficiency.

Cognitive effects of bilingual instruction in higher mathematics. The combination of the native language, English, and the language of mathematics creates a unique cognitive space that activates higher-order thinking. Switching the linguistic environment while studying mathematical concepts requires students to pay closer attention to the logical structure of the material, as familiar language patterns are no longer immediately apparent. Learning terminology in English forms new semantic connections, expands conceptual contexts, and deepens understanding by necessitating the integration of symbolic, verbal, and logical elements.

Formulas learned in isolation, like memorized fragments of text, are often forgotten, misunderstood, or altered by students. Learning through a foreign language forces students to pay closer attention to formulas and to engage more deeply with their meaning, since changing the language of instruction also changes the names and symbols of mathematical objects.

A simple example is the Ukrainian formula for calculating the area of a rectangle:

$$S = a \cdot b,$$

read as "*добуток сторін прямокутника* (a на b) (literal translation from Ukrainian: *the product of the sides of the rectangle (a times b)*). However, the English version of the same formula looks different, even though the concept remains unchanged:

$$A = l \cdot w,$$

read as "*length (l) times width (w)*". As we can see, both the sides of the rectangle and its area are denoted by different letters in the two languages, and the formulas are therefore read differently. Other examples of formulas and notational conventions can also be found, where the appearance and pronunciation differ between English and Ukrainian.

Formulas, notations, objects	Ukrainian	English
Hyperbolic functions	sh, ch, th, cth, arsh, arch, arth, arcth	sinh, cosh, tanh, coth, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, $\coth^{-1}$
Newton-Leibniz formula	$\int_a^b f(x)dx = F(b) - F(a)$	$\int_a^b f(x)dx = [F(x)]_a^b$
Geometric series	$\sum_{n=0}^{\infty} q^n = \frac{1}{1-q}, \quad \lvert q\rvert < 1$	$\sum_{n=0}^{\infty} r^n = \frac{1}{1-r}, \quad \lvert r\rvert < 1$
Area (volume) element in a multiple integral; region of integration in a definite multiple integral	$\iiint f(x;y;z)\ dx\ dy\ dz$ $\iint_D f(x;y)\ dx\ dy$	$\iiint f(x;y;z)\ dA$ $\iint_A f(x;y)\ dA$
Taylor series term (two variables)	$\frac{1}{n!}\left(\Delta x\cdot\frac{\partial}{\partial x}+\Delta y\cdot\frac{\partial}{\partial y}\right)^n f(a;b)$	$\frac{1}{n!}\left[\left(h\cdot\frac{\partial}{\partial x}+k\cdot\frac{\partial}{\partial y}\right)^n f\right]_{(a;b)}$
Field theory operators	grad f, div$\mathbf{A}$, rot$\mathbf{A}$, ∇u, rot grad f, div rot$\mathbf{A}$ In formulas (in textbooks), "verbal" operator notation is used most often.	∇f, $\nabla\cdot\mathbf{A}$, $\nabla\times\mathbf{A}$ (curl $\mathbf{A}$), $\nabla^2 u$, $\nabla\times(\nabla f)$, $\nabla\cdot(\nabla\times\mathbf{A})$ The formulas have an operator form; "verbal" operator names are used only in the text.
Quadratic surfaces	*однопорожнинний* (*двопорожнинний*) гіперболоїд [literal translation "hyperboloid of one (two) *cavities*"]	hyperboloid of one (two) *sheets*

Thus, using a foreign language in instruction prevents students from relying on memorized symbolic patterns. Instead, they must focus on understanding the meaning behind each symbol. This results in greater attention during classes and leads to a deeper comprehension of fundamental concepts.

In Ukrainian, the mathematical concepts "*область значень функції*", "*розмах (вибірки)*", "*точки, розташовані на одній прямій*", and "*множина покриття*" (in Bulgarian "*множество от стойности на функция*", "*размах (на разсейването)*", "*точки, принадлежащи на една права*", "*покритие*") are expressed by different terms. However, in English all of these correspond to the single term "*range*". There is no phonetic, etymological, or visual connection between the respective Ukrainian words; as a result, the relationships among these concepts may appear formal, artificial, or even nonexistent to students. When English is used as the language of instruction, students are more likely to perceive these concepts as manifestations of a common underlying idea, facilitating abstraction, transfer of knowledge, and the construction of more coherent mental models.

Studying higher mathematics in English can offer several cognitive advantages for students, not only in terms of conceptual integration but also in terms of algorithmic thinking. English mathematical discourse tends to favor concise, operator-based formulations and standardized terminology, which often results in definitions and statements that are more procedural and step-oriented. This stylistic tendency supports the development of algorithmic thinking – an important cognitive skill for later work in numerical methods, computational mathematics, and applied modeling, where problems are naturally expressed as sequences of operations rather than purely symbolic manipulations.

As an example, let us consider the definition of the limit of a function of two variables.

Typical of Ukrainian textbooks	Typical of American/British textbooks
Функція $f(x;y)$ має границю L при $(x;y) \to (a;b)$, якщо для довільного числа $\varepsilon > 0$ існує число $\delta > 0$ таке, що для всіх $(x;y)$, які задовольняють $0 < \sqrt{(x-a)^2+(y-b)^2} < \delta$, виконується $\lvert f(x;y) - L\rvert < \varepsilon$	Let $f(x,y)$ be a function defined on a neighborhood of $(a;b)$. We say that $\lim(x;y) \to (a;b) f(x;y) = L$ if for every $\varepsilon > 0$ there exists $\delta > 0$ such that whenever $0 < \sqrt{(x-a)^2+(y-b)^2} < \delta$ it follows that $\lvert f(x;y) - L\rvert < \varepsilon$

As we can see, the formulation in Ukrainian consists of a single long sentence with a complex grammatical structure and several embedded conditions. A student needs to decode the text in order to discern the algorithm for verifying the limit. In the English version, the structure is clearly visible: "if ... then ..." / "whenever ... it follows that ...". The operational sequence of actions is explicitly specified:

1) choose ε;
2) find the corresponding δ;
3) check the condition for $(x;y)$;
4) verify that $\lvert f - L\rvert < \varepsilon$.

Experience in English-medium instruction strengthens students' language competencies through the systematic use of mathematical discourse, which is typically inaccessible in traditional foreign-language courses. At the same time, mathematical symbolism acts as a cognitive bridge between linguistic systems, enabling students to construct meaning regardless of their level of English proficiency. Altogether, this fosters the development of analytical thinking, the ability to articulate arguments, and the capacity to compare and generalize mathematical approaches.

From a psychological perspective, bilingual instruction also shows a positive influence on students' mastery of mathematics. On the one hand, learners naturally experience communication and learning barriers, including language-related difficulties that arise when studying mathematics in a foreign language. However, when students overcome these psychological obstacles – provided that appropriate didactic, organizational, and psychological conditions are created – they develop essential emotional and volitional qualities needed for studying mathematics, such as readiness to face challenges, resilience to stress, and the ability to understand and accept alternative viewpoints.

By employing diverse approaches, bilingual instruction creates a motivating environment for students [10]. Therefore, EMI can positively influence many students' attitudes toward mathematics.

Conclusions

The study confirms that implementing an English-medium mathematics course in a technical university setting is both pedagogically feasible and academically effective. Students demonstrate positive attitudes toward bilingual instruction and clearly recognize its value for their professional development, mobility, and competitiveness. Despite initial language-related challenges, most learners adapt quickly, and their mathematical performance remains comparable to that of students studying in their native language. Statistical analysis of assessment results shows no significant difference between the EMI and non-EMI groups, indicating that learning mathematics through English does not hinder content mastery.

At the same time, successful implementation of such courses requires careful consideration of methodological and organizational factors. The lack of adapted English-language materials aligned with the Ukrainian mathematical tradition remains a significant barrier, highlighting the need for specialized textbooks, glossaries, and digital resources. Instructors' methodological expertise and cooperation between mathematics and ESP teachers are essential to maintaining a balanced pace of instruction and supporting students with varying levels of language proficiency.

Overall, the results demonstrate that EMI-course in mathematics promotes deeper cognitive engagement, enhances analytical and critical thinking, and enriches students' mathematical and linguistic competencies. With appropriate didactic support, bilingual mathematics instruction can become a valuable component of modern engineering education in Ukraine.

References

[1] J. Airey. "I don't teach language". The linguistic attitudes of physics lecturers in Sweden. *AILA Review*, 25(1) (2013), 64–79. ISSN 1461-0213, E-ISSN 1570-5595. https://doi.org/10.1075/aila.25.05air

[2] R. Barwell, J. Moschkovich, S. Staats. Teaching and learning mathematics in multilingual classrooms. Proceedings of the 32nd Conference of the International Group for the Psychology of Mathematics Education, July 17–21, Morelia, Mexico. Vol. 1 (2008), p. 202. ISBN 978-968-9020-06-6

[3] R. Bolitho, R. West. The internationalisation of Ukrainian universities: The English language dimension. Kyiv, Stal (2017). ISBN-978-617-676-123-5

[4] N. F. Ellerton, P. C. Clarkson. Language factors in mathematics teaching and learning. In A. J. Bishop, K. Clements, C. Keitel, J. Kilpatrick, & C. Laborde (Eds.), International handbook of mathematics education (Vol. 4, pp. 987–1033). Dordrecht, Springer (1996). ISBN 978-94-010-7155-0. https://doi.org/10.1007/978-94-009-1465-0_30

[5] B. A. Goodman. Implementing English as a medium of instruction in a Ukrainian University: Challenges, adjustments, and opportunities. *International Journal of Pedagogies and Learning*, 9(2) (2014), 130–141. IS sN 1833-4105. https://doi.org/10.1080/18334105.2014.11082026

[6] S. Jianhong, L. Junsheng, L. Hongjun, L. Qiming. Analysis of factors affecting the effectiveness of bilingual instruction. In 2010 International Conference on Educational and Information Technology (ICEIT 2010) (Vol. 2, pp. V2-412–V2-414). Chongqing, IEEE (2010). ISBN 978-1-4244-8033-3, E-ISBN 978-1-4244-8035-7 https://doi.org/10.1109/ICEIT.2010.5607604

[7] R. G. Klaassen. The international university curriculum: Challenges in English-medium engineering education (Doctoral dissertation). Technische Universiteit Delft (2001). ISBN 9051705689. https://doi.org/10.4233/uuid:dea78484-b8c2-40d0-9677-6a508878e3d9

[8] E. Kováčiková, J. Luprichová. CLIL as the vehicle of transition from mono- to bilingual instruction at Slovak universities. *Journal of Teaching English for Specific and Academic Purposes*, 11(3) (2023), 753–763. ISSN 2334-9182, E-ISSN 2334-9212.https://doi.org/10.22190/JTESAP231003056K

[9] C. Laborde. Language and mathematics. In P. Nesher & J. Kilpatrick (Eds.), Mathematics and cognition (p.p. 53-69). New York, Cambridge University Press (1990). ISBN 9521366089, 9521367875

[10] J. Novotná, M. Hofmannová. CLIL and mathematics education. (2000). Available from: https://www.researchgate.net/publication/228491266_CLIL_and_mathematics_education

[11] L. T. Prochazkova. Mathematics for language, language for mathematics. *European Journal of Science and Mathematics Education*, 1(1) (2013), 23–28. E-ISSN 2301-251X. https://doi.org/10.30935/scimath/9383

[12] A.-M. Sandstrom. English-taught Bachelor's programs in Europe. *International Higher Education*, (96) (2018), 12–13. ISSN 1084-0613. https://doi.org/10.6017/ihe.2019.96.10775

[13] N. Snizhko. Implementation of bilingual education in Ukrainian institutions of higher education. *Viae Educationis: Studies of Education and Didactics*, 2(3) (2023), 35–39. ISSN 2956-2856. https://doi.org/10.15804/ve.2023.03.04

[14] N. Snizhko. Model of Bilingual Mathematics Teaching at a Technical University. *Problems of Education*, 2(101) (2024), 44-57. ISSN 2710-3986. https://doi.org/10.52256/2710-3986.2-101.2024.03 (in Ukrainian)

[15] B. Wächter, F. Maiworm (Eds.). English-taught programmes in European higher education: The state of play in 2014. Bonn, LemmensMedien GmbH (2014). ISBN 978-3-86856-017-6