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# Psychological and Pedagogical Conditions of Bilingual Teaching Higher Mathematics at a Technical University

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***Abstract.*** *Bilingual education is understood as instruction delivered in a foreign language that functions as a tool for acquiring specialized knowledge. The paper examines psychological and pedagogical conditions for teaching higher mathematics in a technical university through a foreign language. It analyzes cognitive, motivational and intercultural factors, mechanisms of dynamic stereotype formation, interference and positive transfer, and substantiates the integrative, activity-based model of bilingual mathematics instruction.*
***Keywords:*** *bilingual instruction; higher mathematics; technical university.*

Bilingual education in higher school is interpreted as instruction delivered in a foreign language that serves not as an object of study, but as an instrument for acquiring professional and specialized knowledge. In this paper, bilingual education is

considered in the context of teaching higher mathematics at a technical university, where a foreign language (primarily English) becomes a means of mastering mathematical concepts, theories, and methods.

The implementation of bilingual teaching of mathematics requires the creation of specific psychological and pedagogical conditions [4]. Since the educational process unfolds in an artificially created foreign-language environment, the effectiveness of learning depends on the integration of subject and language components, students' cognitive readiness, motivational factors, and the professional competence of the teacher.

One of the key conditions for successful bilingual teaching of mathematics is its orientation toward the student's personality [3; 8]. The organization of instruction should take into account students' individual educational needs, motivation, cognitive interests, and emotional-volitional characteristics.

Mathematics as a discipline is based on logical consistency and systemic organization. However, in bilingual instruction, purely logical structuring is insufficient. The teacher must also consider psychological factors influencing knowledge acquisition in a foreign language: anxiety, fear of making mistakes, cognitive overload, and differences in linguistic background. The integration of subject content and language learning requires supportive pedagogical strategies that ensure holistic personal development [5].

At the same time, bilingual education stimulates students' autonomy [9]. The student becomes an active subject of the educational process who plans, regulates, and evaluates his or her own learning activity. Motivation plays a crucial role: success in mastering mathematical content and improving foreign language proficiency are mutually reinforcing goals.

Bilingual teaching of mathematics is not a mechanical translation of content from one language into another. It has a creative character. In the process of studying mathematics through a foreign language, students do not merely reproduce ready-made knowledge; they construct it independently [1].

Initially, students' speech activity may be reproductive. Gradually, however, it becomes productive: learners formulate definitions, justify solutions, interpret results, and build arguments in a foreign language. This transformation enhances intellectual flexibility, imagination, and analytical thinking.

The creative use of language in mathematical contexts promotes deeper conceptual understanding. When students reformulate known mathematical ideas in another linguistic code, they engage in cognitive restructuring, which strengthens comprehension and retention.

The effectiveness of bilingual mathematics instruction largely depends on the professional competence of the teacher. The teacher performs not only a didactic function but also a psychological and pedagogical one.

A competent teacher is able to:

– maintain students' motivation toward both mathematical and linguistic development;

– integrate subject and language objectives in each lesson;

– foresee and prevent negative language interference;

– organize corrective and compensatory work when necessary.

The teacher's task is to direct students' motivational activity simultaneously toward mastering mathematical content and improving proficiency in both the native and foreign languages. Thus, the educator acts as a mediator between two linguistic systems and one conceptual domain.

An important issue in bilingual education is language interference – deviations from the norms of one language caused by the influence of another [2]. In mathematics instruction, interference may manifest at phonetic, lexical, grammatical, or orthographic levels. If not addressed, it can complicate both foreign and native language development.

At the same time, bilingual instruction opens broad possibilities for positive transfer [7; 11]. This transfer may occur at several levels:

1) General learning strategies (cognitive, informational, collaborative).

2) Speech-thinking activity, including memory, perception, structuring, and verbal production.

3) Language system level, where similar linguistic structures facilitate acquisition (positive interference or transposition).

4) Mathematical thinking, as logical rigor, precision, and structured reasoning are reinforced through dual coding.

5) Personal qualities, such as perseverance, intellectual honesty, and creativity.

Mathematics, characterized by formalized syntax and internationally recognizable terminology (often of Latin origin), is particularly suitable for bilingual instruction. Its clarity and unambiguity reduce linguistic ambiguity and facilitate comprehension.

At the initial stage of bilingual mathematics teaching, additional time and specific methodological techniques are required to establish associative links between new foreign-language terms and previously formed mathematical concepts acquired in the native language.

This process leads to the duplication of language codes [10]: one concept receives two verbal designations (e.g., "derivative" – "похідна," "locus" – "геометричне місце точок"). As a result, a bilingual conceptual representation of mathematical knowledge is formed.

From the standpoint of cognitive psychology and neuropsychology, this can be explained through the formation of dynamic stereotypes – stable systems of neural connections regulating complex cognitive and speech actions. In bilingual education, previously formed native-language stereotypes are preserved, while new foreign-language codes are integrated into existing cognitive structures.

At advanced stages (parity model), when mathematics is taught almost entirely in a foreign language, basic linguistic stereotypes in the foreign language become automated. Further development concerns the subject domain: new mathematical concepts generate corresponding linguistic stereotypes. Thus, language and content development become interdependent processes.

Bilingual mathematics instruction reflects the activity-based nature of mathematical knowledge. Mathematics is not a static set of facts; it is the result of active cognitive activity.

In bilingual teaching, three interrelated components are integrated:

1) acquisition of ready-made knowledge (concepts, theorems, formulas);

2) mastery of methods of activity (problem-solving, modeling, reasoning, proving);

3) use of a foreign language as a cognitive tool, including work with authentic scientific sources and participation in professional communication.

The foreign language is not merely a communicative instrument but also a means of thinking. Reformulating mathematical ideas in another language activates deeper cognitive mechanisms and strengthens understanding.

The study of mathematics has significant educational and moral potential [6]. It cultivates logical rigor, clarity, objectivity, and intellectual honesty. Mathematical truth does not allow compromise; solutions must be justified and precise.

In solving mathematical problems, students develop perseverance, purposefulness, and creative initiative. These qualities extend beyond the subject domain and influence general intellectual and professional culture.

In a bilingual context, these traits are reinforced by the necessity to operate within two linguistic systems, which requires additional discipline, concentration, and flexibility.

Bilingual teaching of higher mathematics in a technical university represents an integrative pedagogical process in which a foreign language functions as a tool for acquiring specialized knowledge. Its effectiveness depends on a complex of psychological and pedagogical conditions: personality-oriented instruction, student autonomy, creative speech activity, teacher competence, management of interference and positive transfer, formation of double language coding and dynamic stereotypes, and implementation of an activity-based approach.

Such instruction not only enhances professional mathematical competence but also contributes to cognitive development, intercultural awareness, and the formation of intellectually mature and socially responsible specialists.

## References

1. Діяльнісні засади підготовки майбутніх компетентних фахівців в умовах сучасних викликів: монографія / за ред. О.А.Дубасенюк. Житомир : Вид-во ЖДУ ім. І.Франка, 2024. 366 с.

2. Крюкова Ю. Д. Міжмовна інтерференція та психологічні бар'єри у процесі вивчення іноземних мов у ЗВО: шляхи подолання. *Нова філологія*. 2022. № 85. С. 150-156.

3. Лук'янчук М. (Упровадження особисто орієнтованих технологій у педагогічний процес вищих навчальних закладів. *Knowledge, Education, Law, Management*. 2020. № 4 (32). Vol. 1. P.46-52.

4. Сніжко Н.В. Передумови та теоретичні основи моделювання білінгвального навчання математики майбутніх інженерів. *Strategic Directions for Developing Science and Education in Ukraine: scientific monograph. Ed. M. Filipovych*. Riga, Latvia : "Baltija Publishing", 2024. P. 196-223.

5. Сніжко Н.В. Спеціальні стратегії та прийоми навчальної діяльності при підготовці фахівців інженерних спеціальностей на білінгвальній основі. *Педагогічна Академія: наукові записки*. 2024. № 6.

6. Хінчин О. Я. Педагогічні статті. Про виховний ефект уроків математики. URL: http://ir.nmu.org.ua/handle/GenofondUA/31531.

7. Cree V., Macaulay C. Transfer of learning in professional and vocational education. London&NewYork : Routledge, 2000. 224 p.

8. Gurov S. Individualized education in the conditions of the polycultural environment of the educational institution. *Науковий вісник Мелітопольського державного педагогічного університету. Серія: Педагогіка*. 2021. №2 (27). С. 14-21.

9. Little D. Learner Autonomy: Definitions, Issues and Problems. Dublin : Authentik, 1991. 61 p.

10. Paivio A. Dual Coding Theory: Retrospect and Current Status. *Canadian Journal of Psychology/Revue Canadienne de Psychologie*.1991. № 45. P. 255-287.

11. Schunk D. Learning theories: An educational perspective (4th ed.). Upper Saddle River, NJ, USA: Pearson, 2004. 544 p.