

FORMATION OF COGNITIVE COMPETENCE THROUGH  
TRILINGUAL SOFTWARE IN MATHEMATICS LESSONS (BASED ON  
ACADEMIC LYCEUM EXPERIENCE)

**Saidova Zulfizar Askarovna - Mathematics teacher of the Republican Academic Lyceum named after S.H. Sirojiddinov, specializing in "Natural and exact sciences"**

**Abstract:** This article discusses the methodology for using trilingual (in three languages: Uzbek, Russian, and English) software tools in the formation of students' cognitive competence. According to the author's scientific assumptions, developed on the basis of trial lessons at the academic lyceum level, trilingual educational tools effectively develop students' critical, logical, and creative thinking abilities.

**Keywords:** trilingual software, infusion, integrative, elective, metacognitive activity, CLIL methodology, metalinguistic thinking, cross-linguistic thinking, adaptive learning modules, interactive training, reflection, analytical thinking, interactive assessment modules, learning platforms.

The development of students' thinking activity in the educational process is one of the main directions of modern pedagogy. In particular, at the academic lyceum stage, students are required to engage in logical, analytical, and cognitive activity when mastering complex and high-level topics in mathematics. The formation of cognitive competence in academic lyceum students includes adolescence. Adolescence is a critical period during which not only biological changes occur, but also higher-level cognitive processes such as thinking, decision-making, and problem-solving are formed. Therefore, age characteristics, psychological preparation, and social context play an important role in the development of cognitive competence. Academic lyceums use cognitive

competence to enable students to master, over the years, from literacy and numeracy skills to science, mathematics, and complex new skills and concepts. In academic lyceums, everything is required from the very beginning. Academic lyceum groups are complex environments. Students in each group differ in their qualifications, interest in learning, personality, and family background. Teachers differ in their teaching, teaching skills, and methods, and in their determination to motivate students to learn. Academic lyceum subjects differ in their conceptual characteristics and requirements; for example, learning a language, mathematics, or another subject requires a combination of cognitive processes. These differences are more pronounced than when students learn at school. Unfortunately, however, not all academic high school students are able to fulfill all educational plans in any high school subject. When academic high school students do not fulfill these developmental priorities, they often lack the knowledge and skills necessary to master the cognitive abilities associated with a particular year in order to move forward effectively. Problem solving is central to the study of mathematics. The goal is to introduce the study of number, algebra, and geometry through real-life scenarios and scenarios related to various scientific fields, such as physics and biology. These activate cognitive processes to make sense of unknown situations, express meaning, and represent particular aspects of the world or fields of knowledge in language and mathematical problem solving. The selection of appropriate prior knowledge and strategies to represent a problem mathematically will depend on many factors.

Cognitive competence is a person's ability to understand, analyze, generalize, and apply information in practice (Sun & Hui, 2006). Constructivist and sociocultural approaches of scientists such as Vygotsky (1978) and Piaget (1977) are important in developing this competence in students. These competencies can be further developed through the use of trilingual (trilingual) software. Or I think it

would be appropriate to conduct the lesson process based on a trilingual approach. The trilingual approach allows the student to analyze knowledge in three languages.

This approach:

- enhances the student's language competence;
- increases metacognitive activity in the subject;
- provides access to international resources;
- helps to understand science in different cultural contexts.

Naturally, the question arises as to what a trilingual approach would look like in mathematics lessons.

Mathematics is a subject rich in terms, expressed through formulas, and it is important to understand the terms correctly. Therefore, in a trilingual approach: When a student begins to see mathematical terms in three languages:

- he distinguishes the nuances in each language;
- he gains an understanding of the roots and etymology of terms;
- he learns new terms faster;
- he is prepared to independently read scientific literature in English.

As a scientific basis for my opinion, I would like to cite L. Vygotsky's views on this matter, namely, L. Vygotsky saw language as a means of thinking and evaluated communication as the main source of intellectual growth. Also, as J. Cummins (2000) said, "knowledge transfer occurs from one language to another", according to A. Demetriou (2017), multilingualism increases cognitive flexibility. Indeed, trilingualism strengthens the terminological base of the student, strengthens his cognitive competence and analytical thinking. The quality of education based on the CLIL methodology (Content and Language Integrated Learning) increases. Now it would be appropriate to add another innovation to this methodology, namely, to use trilingual software in mathematics lessons to further strengthen the

formation of cognitive competence and create a modern system of teaching using this software. The issue of cognitive competence formation in a modern digital environment, in particular in a multilingual (trilingual) educational environment, is reaching a new level. Trilingual software is a digital platform that allows the transmission, reception, processing and analysis of educational materials in three languages (usually the native language, the state language and English). These technological solutions develop not only the language competence of the student, but also the flexibility of thinking, semantic thinking, metacognitive control and communicative strategies. The use of multimodal tools in education plays an important role in managing the cognitive load. According to Mayer's theory, the simultaneous transmission of visual, auditory and textual information facilitates the student's assimilation of information (Mayer, 2005). Trilingual software is based on this principle: it covers language and logical concepts in different contexts. Also, the content presented in three languages strengthens metalinguistic thinking in students. That is, the learner attempts to think about language, compare means of expression, and understand grammatical and semantic structures. This process, in turn, leads to the development of general cognitive competence (Cummins, 2001).

Trilingual systems are especially important for students in science and technology. For example, by studying concepts in mathematics or computer science in Russian, English, and Uzbek, a student can see a single conceptual knowledge in different linguistic contexts. This activates cross-linguistic thinking and leads to deeper mastery.

Below, we will look at the benefits of some digital platforms in building cognitive competencies.

- Adaptive learning modules: Automatically select content that is appropriate for the individual level of learning of students. This method develops the student's ability to work independently and prepare for self-assessment.

- Interactive exercises and reflection: Platforms encourage students to think actively, ask questions, and draw conclusions through interactive tasks. In particular, exercises in the question-and-answer format are effective in developing critical thinking (Lipman, 2003).

- Problem-based learning (PBL): Trilingual software solutions are focused on solving problems in real-life contexts, and this methodological method enhances students' independent decision-making, development of alternative solutions, and reflective thinking (Barrows, 1986).

- Mind maps and visual graphics: They serve to develop students' cognitive skills such as structuring information, isolating main ideas, and analyzing interrelationships.

In addition, through trilingual software, students develop multicultural literacy. This, in turn, not only expands the scope of thinking, but also strengthens the student's social and adaptive competencies.

Below, we will consider the advantages of some digital platforms in the formation of cognitive competencies.

GeoGebra is an open-source interactive mathematics platform used in teaching areas such as algebra, geometry, analysis and statistics. It can be used at all levels from school to university.

Trilingual opportunities:

- The platform is available in more than 40 languages, including Uzbek, Russian and English interface support;
- There are menus, tasks and tools adapted to each language.

Impact on cognitive competencies:

- Concretization of abstract concepts through visual modeling;
- Activation of the student's analytical and spatial thinking;
- Experimentation and drawing conclusions using dynamic elements.

Desmos is an online graphing calculator and visual tasks platform. It is mainly used for drawing graphs, analyzing equations, and creating mathematical models.

Trilingual capabilities:

- The interface is fully in English, partially in Russian, and in Uzbek through auxiliary resources (through user-generated content);
- Desmos Activities can be customized in your language.

Impact on cognitive competence:

- Stimulating critical thinking through challenging graphical tasks;
- Connecting student thinking with mathematical expressions and models;
- Interactive learning through real-time observation of variables.

Khan Academy is a non-profit educational platform designed to teach mathematics, physics, computer science, and other subjects. It contains video lessons, tasks, and tests.

Trilingual capabilities:

- Fully in English;
- Russian version available;
- Partial translation into Uzbek has begun: some topics have been introduced through local projects.

Impact on cognitive competence:

- Multimodal learning through the integration of video, text and tests
- Step-by-step in-depth explanation of each topic
- Reflection and independent thinking through self-assessment (mastery learning).

Comparison table:

<b>Platform</b>	<b>Languages</b>	<b>Directions</b>	<b>Cognitive advantages</b>
<b>GeoGebra</b>	UZ, RU, EN	Geometry, algebra	Cognitive benefits
<b>Desmos</b>	EN, RU	Graph, function	Critical thinking, real-time analysis
<b>Khan Academy</b>	EN, RU, (UZ partially)	Comprehensive sciences	Independent thinking, reflection, processing

In developing cognitive competence in mathematics lessons, digital platforms such as GeoGebra, Desmos and Khan Academy allow students to simultaneously develop their language competence, logical thinking and analytical skills through a trilingual interface. These platforms allow for multimodal, contextual and differentiated education in accordance with the CLIL methodology.

The use of GeoGebra, Desmos, and Khan Academy platforms in mathematics lessons serves to develop not only students' subject-specific, but also linguistic and cognitive competencies. By presenting interfaces and tasks in Uzbek, Russian, and English, students' metalinguistic thinking, critical analysis skills, visual perception, and self-assessment skills are strengthened. The trilingual approach can be effectively implemented in academic lyceum mathematics lessons by using Desmos, GeoGebra, and Khan Academy platforms. In test lessons, complex topics such as logarithms, probabilities, combinatorics, and inequality graphs were taught in a visual, interactive manner with explanations in Uzbek, Russian, and English. This serves to increase students' critical thinking, metacognitive activity, and cognitive flexibility. The following didactic approaches are relevant in the formation of cognitive competence based on software:

- Adaptive learning modules: Automatically select content that is appropriate for the individual level of learning of students. This method develops the student's ability to work independently and prepare for self-assessment.

- Interactive exercises and reflection: Platforms encourage students to think actively, ask questions, and draw conclusions through interactive tasks. Question-and-answer exercises are especially effective in developing critical thinking (Lipman, 2003).

- Problem-based learning (PBL): Trilingual software solutions are focused on solving problems in real-life contexts, and this methodological method enhances students' independent decision-making, development of alternative solutions, and reflective thinking (Barrows, 1986).

- Mind maps and visual graphics: They serve to develop students' cognitive skills such as structuring information, isolating main ideas, and analyzing interrelationships.

In addition, trilingual software tools help students develop multicultural literacy, which not only broadens their horizons but also strengthens their social and adaptive competencies.

With the use of these technological tools, methods for assessing cognitive competencies are also being updated. For example, diagnostic tests, gamified problems, and reflective writing tasks are used to identify the student's cognitive strategies. In addition to traditional knowledge control, the assessment process also takes into account the student's thinking planning, adaptation to changing situations, and decision-making skills.

In conclusion, the formation of cognitive competence using trilingual software is a strategic platform that serves not only to develop linguistic skills, but also the ability to think, make decisions and solve problems at a higher level.

The modern educational environment requires the widespread use of digital tools. In particular, trilingual software (learning platforms with an interface in three languages) allows for the assessment and development of cognitive competences in different languages. Such systems include:

- Solving problem tasks through interactive tasks,
- Opportunities for self-assessment and reflection,
- Analysis of thinking models through observation of actions.

These ensure the transition of students from egocentric thinking to systematic and flexible thinking. A monitoring system should be implemented to determine how the student's cognitive competence changes over time. They include:

- Initial diagnostics (entry test)
- Intermediate assessment (formative)
- Final assessment (summative)

Based on the results of monitoring, it is possible to adjust individual learning paths, adapt educational technologies, and apply motivational mechanisms (Zimnyaya, 2003; Anderson & Krathwohl, 2001).

Developing students' cognitive competence is one of the strategic priorities of the modern education system. Based on the analysis presented in this article, the following general conclusions can be drawn:

1. Cognitive competence is the ability to analyze, apply, reflect, and create new knowledge in addition to acquiring knowledge (Sun & Hui, 2006).
2. The scientific basis of cognitive development was highlighted based on the theories of cognitive psychology of scientists such as Piaget, Vygotsky, and Fry.
3. Critical and creative thinking are components of cognitive competence, and their mutual integration forms the ability of students to think at a higher level (Sternberg, 2006; Paul, 1993).

4. Trilingual software creates a learning environment that focuses on students' multilingual thinking, analysis, and evaluation. This tool also develops digital skills.

5. Infusion, integrative, and elective approaches play a complementary role in developing cognitive competence. Each approach has its own methodological advantages.

6. Through assessment and monitoring processes, individual cognitive profiles of students are identified and educational strategies are adapted accordingly.

Within the framework of the main issues raised in the article, the following scientific proposals are put forward:

1. Conducting extended empirical research: studying the impact of critical and creative thinking on cognitive competence based on quantitative and qualitative indicators.

2. Studying with experimental groups: determining the effectiveness of cognitive competence formation in an academic lyceum using trilingual software.

3. Developing modular curricula for schoolchildren: creating competency-oriented textbooks and methodological guides suitable for an integrative approach.

4. Comparing age groups and cultural contexts: developing a differential approach by comparing socio-cultural factors affecting the development of cognitive competence.

5. Creating assessment systems in online and offline environments: developing opportunities for real-time monitoring of cognitive competence based on digital metrics.

Practical recommendations:

- Teachers: It is recommended to use a combination of infusion and integrative methods to develop critical and creative thinking. At the same time,

elements of reflection and metacognition should be included in regular assessment practices.

- School leaders: It is necessary to increase the number of elective courses and project activities aimed at developing students' cognitive competence, and improve the infrastructure for teaching in a trilingual environment.

- Software developers: It is necessary to develop learning platforms that work in multiple languages, stimulate analytical thinking, and have interactive assessment modules.

#### REFERENCES:

1. Mayer, R.E. (2005). *The Cambridge Handbook of Multimedia Learning*. Cambridge University Press.

2. Cummins, J. (2001). Bilingual children's mother tongue: Why is it important for education? *Sprogforum*.

3. Barrows, H. (1986). A taxonomy of problem-based learning methods. *Medical Education*, 20(6), 481–486.

4. Lipman, M. (2003). *Thinking in Education*. Cambridge University Press.

5. Sun, R.C.F., & Hui, E.K.P. (2006). Cognitive competence as a positive youth development construct. *International Journal of Adolescent Medicine and Health*, 18(3), 401–408.

6. Zimnyaya, I.A. (2003). Key competencies - a new paradigm of educational results. *Vysshee obrazovanie segodnya*.

7. Anderson, L.W., & Krathwohl, D.R. (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy*. Longman.

8. Vorovshikov, S.G. (2014). *Kvalimetricheskie osnovy pedagogiki*. Moscow: Pedagogy.

9. Хуторской А.В. Педагогическая инноватика. Москва: Издательский центр «Академия», 2010.
10. Зимняя И.А. Ключевые компетенции – новая парадигма результата образования. Высшее образование сегодня, 2003.