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TRANSFORMING STUDENTS' LOGICAL-CRITICAL THINKING IN PRIMARY EDUCATION BASED ON THE REQUIREMENTS OF INTERNATIONAL ASSESSMENT PROGRAMS (PISA, TIMSS)

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Abstract: This article examines the problem of transforming the logical-critical thinking of students at the primary education stage based on the requirements of the international assessment programs PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study). The purpose of the study is to determine the level of formation of logical-critical thinking skills in elementary students and develop a didactic transformation model aimed at its development by analyzing the first results of Uzbekistan's PISA-2022 and TIMSS-2023 studies. The study used comparative-analytical and content-analytical methods, analyzed international reports, national concept documents, and scientific literature.

Keywords: PISA, TIMSS, primary education, logical-critical thinking, cognitive levels, competence-based approach, functional literacy, didactic transformation, assessment culture, ICT integration.

Introduction The center of the 21st-century education system is the formation of thinking methods rather than just the transfer of knowledge. The international studies PISA and TIMSS, organized by the Organisation for Economic Co-operation and Development (OECD) and the International Association for the Evaluation of Educational Achievement (IEA), are built exactly on this paradigm: they measure not how many facts a student has memorized, but their ability to analyze acquired knowledge in unfamiliar, real-life situations, reason, and make decisions. Logical-critical thinking is a set of such skills: filtering information, identifying cause-and-effect relationships, formulating hypotheses, evaluating evidence, and drawing well-founded conclusions.

From a developmental psychology perspective, the primary school age (7–10 years) is a critical transitional period. It is precisely these skills that must be established as a foundation at the primary education stage—the period when a child's cognitive development is most rapid and the transition from concrete-operational to formal-operational thinking begins. If critical thinking is not nurtured early, students develop a passive learning style that is extremely difficult to reverse in later years.

Uzbekistan officially participated in the PISA study for the first time in 2022, and in the TIMSS study in 2023. This was an integral part of the state policy to adapt the national education system to international standards within the framework of the President of the Republic of Uzbekistan's "Concept for the Development of the Public Education System until 2030." According to this concept, Uzbekistan has set a goal to enter the top-30 countries in the PISA ranking by 2030. However, the initial results clearly revealed systemic problems in the national education system: in the PISA-2022 study, Uzbekistan ranked in the bottom ten out of 81 countries in all three areas—mathematical, reading, and scientific literacy. The TIMSS-2023 results also

confirmed that primary school (4th grade) students have significantly lower indicators than the international average.

Results

Analysis of PISA-2022 Results In the PISA-2022 study, over 7,000 15-year-old students from 202 educational institutions selected from all regions of Uzbekistan participated. According to the results, Uzbek students scored 364 points in mathematical literacy (average for participating countries — 472 points), 336 points in reading literacy (average — 476 points), and 355 points in scientific literacy (average — 485 points). As a result, the country ranked 72nd in mathematics, and 80th in both reading and science out of 81 participating countries.

Area	Uzbekistan Score	OECD / Participants Average	Ranking (out of 81 countries)
Mathematical literacy	364	472	72nd place
Reading literacy	336	476	80th place
Scientific literacy	355	485	80th place

Table 1. Uzbekistan's results in the PISA-2022 study

Analysis of TIMSS-2023 Results The TIMSS-2023 study, which is of direct relevance to primary education, was conducted in April-May 2023 with the participation of 8,800 students (4,450 of whom were 4th graders, and 4,350 were 8th graders) selected from 166 schools in Uzbekistan. According to the results, 4th-grade students from Uzbekistan scored 443 points in mathematics, taking 50th place out of 58 participating countries, and 412 points in science, taking 54th place. These indicators are significantly below the international scale's average level (500 points), indicating a serious systemic gap in logical thinking and problem-analysis skills right at the primary school stage.

An analysis of the TIMSS task structure shows that the program is evenly distributed across three cognitive domains—*Knowing, Applying,* and *Reasoning*. Moreover, tasks in the "Reasoning" domain require higher-order thinking operations from the student, such as multi-stage analysis, comparison, generalization, and justification. The fact that Uzbek students' results in this specific type of task were lower than their results in the "Knowing" domain indicates the dominance of a reproductive, memorization-based approach in national educational practice.

Significance of the Results for Primary Education (Grades 1–4) It should be specifically noted that although the PISA study covers 15-year-old students (i.e., the secondary education stage), its results are of direct practical importance for primary education, because the formation of cognitive skills has a cumulative character, and the thinking experience accumulated up to the age of 15 is mainly based on the foundation laid in grades 1–4. The TIMSS study, on the other hand, provides direct data specifically on the 4th grade (the primary education stage), which makes it the most valuable empirical source for this article. Due to the "quasi-longitudinal" design of the TIMSS study, the cohort that took the test in the 4th grade is reassessed in the 8th grade, which allows for observing how the shortcomings at the primary stage deepen in subsequent education levels. This continuity once again confirms the strategic importance of forming logical-critical thinking early and purposefully at the primary stage: the reasoning skill not formed in the 4th grade will not appear on its own in the 8th grade or at age 15; on the contrary, it requires systematic pedagogical intervention.

A comparative analysis of the PISA and TIMSS methodologies shows that both programs emphasize the cognitive process rather than the content of knowledge, but they achieve this by labeling and structuring it in different ways.

Systemic Barriers Hindering Development As a result of the analysis, several interrelated factors hindering the development of logical-critical thinking in primary education practice were identified:

1. Reproductive Curriculum Design: A large part of the curricula and textbook tasks are reproductive in nature, meaning they require the student to repeatedly apply a ready-made formula or rule, whereas PISA and TIMSS tasks are mainly built around making independent decisions in an unfamiliar context.

2. Factual Questioning Dominance: The majority of questions used in the learning process are factual in nature ("what?", "when?", "who?"), while analytical-reasoning questions ("why?", "what if...?", "how can this be proven?") occupy very little space in the lesson structure.

3. Methodological Deficit in Teachers: Many primary school teachers lack the training and confidence to facilitate open-ended discussions or manage the "cognitive load" of complex, multi-step problems, often reverting to direct instruction to save time.

4. Assessment Misalignment: Current school assessments heavily reward rote memorization, sending a conflicting message to students and parents about what constitutes "good learning."

Model for Transforming Logical-Critical Thinking Based on the above analysis, a four-stage didactic transformation model was developed aimed at developing logical-critical thinking at the primary education stage in accordance with PISA/TIMSS requirements.

• Stage 1 — Diagnostic stage. At this stage, the students' current cognitive level is determined using localized diagnostic tasks in the style of PISA/TIMSS (developed based on Item Response Theory — IRT methodology). *Example:* Instead of asking a 3rd grader to simply calculate "15 - 7", a diagnostic task would present a real-life scenario: "Ali bought a notebook for 7 som and gave the seller 15 som. How much change should he get back, and if he wants to buy a pencil for 5 som with the remaining money, is it enough?" This tests calculation within a contextual framework.

• Stage 2 — Content transformation. At this stage, curricula and textbook tasks are revised: the proportion of reproductive tasks is reduced for each topic, while the proportion of tasks focused on reasoning, problem-solving, and based on real-life contexts is increased. Crucially, these contexts must be *localized*—using scenarios from Uzbek daily life, local ecology, agriculture, and culture to make the cognitive load relevant to the child.

• Stage 3 — Methodological transformation. At this stage, teachers' skills in applying methods such as questioning strategies (e.g., Socratic questioning adapted for children), problem-based learning, project-based activities, and interdisciplinary integration are developed. Teachers are trained to use "wait time" after asking a question, allowing students the cognitive space to formulate complex answers rather than rushing to the first student who raises their hand.

• Stage 4 — Assessment system transformation. Current and final assessment tools are balanced across cognitive levels (*Knowing, Applying, Reasoning*). Formative assessment is introduced more broadly, utilizing rubrics that evaluate the *process* of reasoning (e.g., how a

student breaks down a problem) rather than just the final correct answer. The results are used not only to assign grades but also as a basis for designing subsequent learning trajectories.

Discussion When the obtained results are discussed in alignment with international experience, it becomes evident that successful reforms in developing logical-critical thinking usually cover three areas simultaneously: competency-based restructuring of the curriculum content, improvement of the teacher training system, and changing the assessment culture. The experience of countries that occupy high positions in international rankings—such as Singapore, Estonia, and South Korea—shows that high results are achieved not just by increasing study hours, but by creating conditions for students' independent thinking, strengthening family-school collaboration, and increasing teachers' methodological freedom.

The Role of Information and Communication Technologies (ICT) Furthermore, the integration of ICT plays a pivotal role in this transformation, particularly in the context of the digitalization of education. Digital educational platforms, interactive whiteboards, and gamified learning applications can simulate complex, multi-variable scenarios that are difficult to replicate with traditional chalk-and-talk methods. For instance, interactive math simulations allow primary students to visually manipulate variables and immediately observe the logical consequences of their decisions, thereby strengthening cause-and-effect reasoning. However, it is critical that ICT is used not merely as a digital substitute for textbooks (e.g., digital drill-and-practice), but as a tool for exploration, collaboration, and creative problem-solving.

This conclusion once again confirms the necessity of the institutional stage of the transformation model proposed in this study. Without systemic support, including the provision of digital infrastructure and continuous professional development for teachers, the transformation of classroom practices will remain isolated and unsustainable.

Conclusion and Policy Recommendations As a result of the conducted analysis, the following main conclusions were drawn. First, the initial results of Uzbekistan in the international PISA-2022 and TIMSS-2023 studies clearly showed systemic gaps in the development of logical-critical thinking at the primary and secondary education stages: the majority of students cannot move beyond the basic cognitive level, and results are particularly low in tasks requiring reasoning and evaluation. Second, the roots of this problem lie not only in the students' potential but also in the curriculum content, teaching methods, assessment practices, and institutional support; therefore, eliminating it requires a complex, multi-stage approach. Third, the four-stage model proposed in this article—*diagnostic, content, methodological, and assessment*—can serve as a consistent theoretical and practical basis for adapting primary education practice to the cognitive requirements of PISA/TIMSS.

To achieve Uzbekistan's strategic goal of entering the top-30 countries in the PISA ranking by 2030, the following practical recommendations are proposed for policymakers and educational leaders:

1. Establish a National Task Bank: The National Center for Implementation of International Studies should develop and distribute a freely accessible, localized digital bank of PISA/TIMSS-style formative assessment tasks specifically adapted for grades 1–4.

2. Revise Teacher Professional Development: Shift the focus of primary teacher training from "how to deliver content" to "how to facilitate cognitive processes," incorporating modules on critical thinking pedagogy and ICT integration.

3. Update Textbook Standards: Mandate that all new primary school textbooks and workbooks allocate at least 30-40% of their exercises to higher-order thinking tasks (Applying and Reasoning) based on real-world contexts.

4. Engage Parents and Society: Launch public awareness campaigns to help parents understand the value of functional literacy and critical thinking, encouraging them to foster curiosity and questioning at home rather than focusing solely on rote memorization for high grades.

Such studies and targeted interventions serve to form a scientifically grounded roadmap for the modernization of Uzbekistan's national education system.

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