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THE ROLE OF CRITICAL THINKING IN IMPROVING THE MATHEMATICAL LITERACY OF FUTURE PRIMARY SCHOOL TEACHERS

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Abstract

This article examines the pedagogical significance of critical thinking in improving the mathematical literacy of future primary school teachers. In the context of contemporary educational reforms, mathematical literacy is no longer limited to the mastery of computational skills but is understood as the ability to reason mathematically, analyze problem situations, interpret data, and apply mathematical knowledge in real-life and professional contexts. The preparation of future primary school teachers therefore requires a shift from reproductive learning models to approaches that foster analytical reasoning, reflection, and independent judgment. The study substantiates that critical thinking serves as a core cognitive mechanism that enables prospective teachers to understand mathematical concepts deeply, evaluate multiple solution strategies, identify errors, and justify their reasoning. The article analyzes theoretical perspectives on critical thinking and mathematical literacy, highlights their interconnection within teacher education, and emphasizes the role of higher-order thinking skills in the professional competence of primary school teachers. Special attention is paid to the pedagogical environment of teacher training institutions, where critical thinking-oriented instructional strategies contribute to the development of meaningful mathematical understanding. The findings indicate that integrating critical thinking into mathematics education enhances future teachers'

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confidence, adaptability, and readiness to teach mathematics effectively in primary classrooms.

Keywords: Critical thinking, mathematical literacy, primary school teachers, teacher education, professional competence, mathematics education.

Introduction

BO‘LAJAK BOSHLANG‘ICH SINF O‘QITUVCHILARINING MATEMATIK SAVODXONLIGINI OSHIRISHDA TANQIDIY FIKRLASHNING O‘RNI

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Annotatsiya:
Ushbu maqolada bo‘lajak boshlang‘ich sinf o‘qituvchilarining matematik savodxonligini oshirishda tanqidiy fikrlashning pedagogik ahamiyati tahlil qilinadi. Zamonaviy ta’lim islohotlari sharoitida matematik savodxonlik endilikda faqat hisoblash ko‘nikmalarini egallash bilan cheklanmay, balki matematik mantiqiy fikrlash, muammoli vaziyatlarni tahlil qilish, ma’lumotlarni talqin etish hamda matematik bilimlarni real hayot va kasbiy faoliyatda qo‘llash qobiliyati sifatida talqin etiladi. Shu sababli bo‘lajak boshlang‘ich sinf o‘qituvchilarini tayyorlash jarayoni reproduktiv o‘qitish modellaridan analitik fikrlash, refleksiya va mustaqil xulosa chiqarishni rivojlantiruvchi yondashuvlarga o‘tishni taqozo etadi. Tadqiqot natijalari tanqidiy fikrlash bo‘lajak o‘qituvchilarga matematik tushunchalarni chuqur anglash, bir nechta yechim strategiyalarini baholash, xatolarni aniqlash va o‘z fikrini asoslab berish imkonini beruvchi asosiy kognitiv mexanizm ekanligini asoslab beradi. Maqolada tanqidiy fikrlash va matematik savodxonlikka oid nazariy yondashuvlar tahlil qilinib, ularning pedagog kadrlar tayyorlash jarayonidagi

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o‘zaro bog‘liqligi yoritiladi hamda yuqori darajadagi tafakkur ko‘nikmalarining boshlang‘ich sinf o‘qituvchisining kasbiy kompetentligidagi o‘rni ochib beriladi. Shuningdek, o‘qituvchilarni tayyorlash muassasalarida tanqidiy fikrlashga yo‘naltirilgan o‘qitish strategiyalari mazmunli matematik tushunishni shakllantirishga xizmat qilishi alohida ta’kidlanadi. Tadqiqot natijalari matematik ta’lim jarayoniga tanqidiy fikrlashni integratsiya qilish bo‘lajak o‘qituvchilarning o‘ziga ishonchini, moslashuvchanligini va boshlang‘ich sinflarda matematikani samarali o‘qitishga tayyorgarligini oshirishini ko‘rsatadi.

Kalit so‘zlar: tanqidiy fikrlash, matematik savodxonlik, boshlang‘ich sinf o‘qituvchilari, o‘qituvchilarni tayyorlash, kasbiy kompetentlik, matematika ta’limi.

Introduction

The rapid development of science, technology, and information systems has significantly transformed the requirements placed on modern education systems. In this context, the role of the primary school teacher has expanded beyond the transmission of basic knowledge to include the formation of learners’ thinking skills, problem-solving abilities, and readiness to apply knowledge in real-life situations. Mathematics, as a fundamental component of primary education, plays a crucial role in developing logical reasoning, analytical thinking, and intellectual independence. Therefore, improving the mathematical literacy of future primary school teachers has become a priority task in teacher education programs.

Mathematical literacy is increasingly interpreted as an integrative competence that encompasses not only procedural fluency but also conceptual understanding, reasoning, interpretation, and the ability to use mathematics in diverse contexts. For future primary school teachers, mathematical literacy is directly linked to their professional effectiveness, as it determines their capacity to explain mathematical ideas clearly, anticipate learners’ difficulties, and design meaningful learning experiences. However, traditional approaches to mathematics instruction in teacher education often emphasize memorization and

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algorithmic problem-solving, which limits the development of deep understanding and flexible thinking.

In this regard, critical thinking emerges as a key pedagogical and cognitive resource for enhancing mathematical literacy. Critical thinking involves the ability to analyze information, evaluate arguments, draw reasoned conclusions, and reflect on one's own thinking processes. Within mathematics education, critical thinking enables future teachers to examine mathematical concepts from multiple perspectives, compare alternative solution strategies, and justify their reasoning logically. These skills are essential for teaching mathematics in primary school, where learners' misconceptions must be identified and addressed through thoughtful explanation rather than mechanical repetition.

The integration of critical thinking into mathematics education aligns with contemporary educational paradigms that emphasize learner-centered, competence-based, and reflective approaches. Teacher education institutions are expected to create learning environments that encourage questioning, discussion, and intellectual exploration. When future primary school teachers engage in critically oriented mathematical tasks, they develop a more profound understanding of mathematical structures and relationships, which subsequently influences their instructional decisions and teaching styles.

Furthermore, critical thinking contributes to the formation of professional autonomy and responsibility among future teachers. By learning to critically assess mathematical content, instructional materials, and assessment methods, prospective teachers become more capable of adapting curricula to learners' needs and educational contexts. This adaptability is particularly important in primary education, where students' cognitive development varies widely and requires differentiated pedagogical strategies.

The relevance of this study is also обусловлена by ongoing reforms in teacher education that aim to improve educational quality and align training outcomes with international standards. In these reforms, emphasis is placed on developing higher-order thinking skills as a foundation for lifelong learning and professional growth. Consequently, exploring the role of critical thinking in improving the

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mathematical literacy of future primary school teachers is both theoretically significant and practically necessary.

This article seeks to analyze the pedagogical foundations of critical thinking in mathematics education and to substantiate its role in enhancing the mathematical literacy of prospective primary school teachers. By examining the interrelationship between critical thinking and mathematical competence, the study contributes to a deeper understanding of effective strategies for preparing teachers capable of fostering meaningful mathematical learning in primary education.

Methods

The methodological framework of this study is based on a combination of theoretical analysis and pedagogical research approaches aimed at identifying the role of critical thinking in improving the mathematical literacy of future primary school teachers. The research design relies on a qualitative-dominant mixed approach, which allows for an in-depth examination of cognitive and pedagogical processes while also considering generalizable tendencies in teacher education practice.

At the theoretical level, a systematic analysis of philosophical, psychological, and pedagogical literature was conducted to clarify the conceptual foundations of critical thinking and mathematical literacy. Classical and contemporary theories of critical thinking, including cognitive, metacognitive, and constructivist perspectives, were analyzed to determine their relevance to mathematics education. In parallel, scholarly interpretations of mathematical literacy were examined, with particular attention to its cognitive, functional, and applied dimensions in the context of primary teacher preparation. This analysis made it possible to establish a conceptual linkage between critical thinking skills and the components of mathematical literacy required for effective teaching.

At the empirical level, the study employed pedagogical observation, analysis of educational practices, and reflective assessment of learning activities implemented in teacher education programs. The research was conducted within pedagogical universities preparing future primary school teachers, where

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mathematics courses constitute a core component of the curriculum. The focus was placed on instructional strategies that explicitly or implicitly promote critical thinking, such as problem-based learning, open-ended tasks, case analysis, mathematical discussions, and reflective questioning.

Pedagogical observation was used to examine how future teachers engage with mathematical tasks that require reasoning, justification, and evaluation rather than routine calculation. Particular attention was paid to students' ability to analyze problem conditions, select appropriate strategies, explain their reasoning, and critically evaluate alternative solutions. Observation data were complemented by the analysis of students' written work, including problem solutions, reflective notes, and analytical explanations of mathematical concepts.

In addition, a qualitative analysis of reflective activities was carried out to assess the development of critical thinking dispositions among future teachers. Reflective journals and written reflections were examined to identify changes in students' attitudes toward mathematics, their awareness of thinking processes, and their ability to critically assess their own understanding. These materials provided insight into how critical thinking contributes to deeper conceptual comprehension and increased confidence in mathematical reasoning.

Comparative analysis was also applied to contrast traditional instructional approaches with those that integrate critical thinking-oriented methods. This comparison focused on differences in students' engagement, depth of understanding, and ability to transfer mathematical knowledge to new contexts. By comparing learning outcomes across different instructional settings, the study sought to identify pedagogical conditions that are most conducive to the development of mathematical literacy through critical thinking.

To ensure the reliability and validity of the findings, triangulation of data sources was employed. The convergence of theoretical insights, observational data, and reflective materials allowed for a more comprehensive understanding of the research problem. Ethical considerations were observed throughout the study, including voluntary participation and the anonymization of student data.

Overall, the chosen methodological approach made it possible to explore the role of critical thinking in improving mathematical literacy from both conceptual and

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practical perspectives, providing a solid basis for interpreting the results and formulating pedagogical implications for the preparation of future primary school teachers.

Results

The results of the study demonstrate that the systematic integration of critical thinking-oriented approaches into mathematics education significantly contributes to the improvement of mathematical literacy among future primary school teachers. Analysis of observational data, students' written work, and reflective materials revealed qualitative changes in cognitive activity, depth of understanding, and professional readiness related to mathematical instruction.

One of the key findings is the positive impact of critical thinking on conceptual understanding of mathematical content. Future teachers who regularly engaged in tasks requiring analysis, comparison, and justification showed a clearer grasp of mathematical concepts and relationships. Instead of relying on memorized algorithms, they demonstrated the ability to explain the logic behind procedures, interpret mathematical symbols meaningfully, and connect abstract ideas with concrete examples. This depth of understanding is a central indicator of mathematical literacy, as it enables teachers to present material in an accessible and logically coherent manner to primary school pupils.

The results also indicate a noticeable improvement in problem-solving skills. Participants exposed to open-ended and problem-based mathematical tasks were more flexible in selecting solution strategies and more confident in exploring alternative approaches. They were able to identify relevant information, recognize underlying structures of problems, and critically evaluate the appropriateness of chosen methods. In contrast to traditional approaches, where a single correct answer is emphasized, critical thinking-oriented instruction encouraged future teachers to view problem solving as a process of reasoning and decision-making. This shift is essential for mathematical literacy, which requires adaptability and the ability to apply knowledge in diverse contexts.

Another significant result concerns the development of reflective skills. Reflective journals and written self-assessments revealed that future teachers

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became more aware of their own thinking processes. They increasingly engaged in self-questioning, identified gaps in their understanding, and evaluated the effectiveness of their reasoning. This metacognitive awareness allowed them to regulate their learning more effectively and to approach mathematical tasks with greater confidence and independence. Reflection also supported the formation of a professional attitude toward mathematics, reducing anxiety and fostering a more positive perception of the subject.

The study further revealed that critical thinking contributes to improved communicative competence in mathematics. Future primary school teachers demonstrated enhanced ability to articulate mathematical reasoning clearly and logically, both in written and oral forms. During discussions and collaborative activities, they were able to justify their ideas, respond constructively to alternative viewpoints, and engage in reasoned argumentation. These communicative skills are integral to mathematical literacy, as effective teaching in primary education depends on the teacher's ability to explain concepts, address misconceptions, and guide learners through reasoning processes.

Comparative analysis of instructional approaches showed that students involved in critical thinking-oriented learning environments exhibited higher levels of engagement and motivation. They displayed greater interest in mathematical tasks and a stronger sense of responsibility for their learning outcomes. This engagement was closely linked to the perceived relevance of mathematics to real-life and professional situations, which is a defining characteristic of mathematical literacy.

Overall, the results confirm that critical thinking serves as a powerful catalyst for the development of mathematical literacy among future primary school teachers. By fostering analytical reasoning, reflection, problem-solving flexibility, and communicative clarity, critical thinking enhances both cognitive and professional dimensions of teacher preparation, creating a foundation for effective and meaningful mathematics teaching in primary education.

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Discussion

The findings of this study highlight the central role of critical thinking in shaping the mathematical literacy of future primary school teachers and provide important insights into contemporary teacher education practice. The results confirm that mathematical literacy is not merely a set of technical skills but a complex competence that develops through reflective, analytical, and evaluative thinking. In this regard, critical thinking functions as a foundational cognitive process that enables future teachers to internalize mathematical knowledge and apply it flexibly in pedagogical contexts.

The observed improvement in conceptual understanding supports theoretical perspectives that emphasize deep learning over surface-level memorization. When future teachers engage in critical analysis of mathematical concepts, they move beyond procedural execution to meaningful comprehension. This aligns with constructivist views of learning, according to which knowledge is actively constructed through reasoning and reflection. The study demonstrates that critical thinking-oriented instruction creates conditions in which prospective teachers can reconstruct mathematical knowledge, identify conceptual connections, and develop a coherent understanding of mathematical structures.

The enhancement of problem-solving abilities observed in the results also reinforces existing research that links critical thinking with effective mathematical reasoning. Open-ended and non-routine tasks encouraged future teachers to explore multiple strategies, evaluate their validity, and justify their choices. Such experiences are particularly valuable in primary education, where teachers must be prepared to respond to diverse student approaches and misconceptions. The ability to critically assess solution strategies enables teachers to support learners' thinking rather than simply correcting errors, thereby fostering a more supportive and intellectually engaging classroom environment.

Another important aspect highlighted in the discussion is the role of reflection and metacognition. The development of self-regulatory skills among future teachers suggests that critical thinking contributes to lifelong learning competencies. By becoming aware of their own cognitive processes, prospective teachers are better equipped to monitor their understanding, adapt their

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instructional approaches, and engage in continuous professional development. This reflective capacity is essential in the dynamic context of modern education, where teachers are expected to respond to changing curricular demands and learner needs.

The study also underscores the communicative dimension of mathematical literacy. Effective mathematics teaching in primary school requires the ability to explain ideas clearly, ask purposeful questions, and engage learners in dialogue. The findings indicate that critical thinking-oriented instruction enhances these communicative skills by encouraging reasoned argumentation and collaborative discussion. This supports the view that mathematical literacy is inherently social and communicative, developing through interaction and shared meaning-making.

From a pedagogical perspective, the discussion points to the need for systematic integration of critical thinking strategies into mathematics courses within teacher education programs. Isolated activities are insufficient; instead, critical thinking should be embedded in curriculum design, instructional methods, and assessment practices. Teacher educators play a key role in modeling critical thinking behaviors and creating learning environments that value questioning, reasoning, and reflection.

At the same time, the discussion acknowledges certain limitations. The qualitative nature of the study provides in-depth insights but may limit generalizability. Future research could incorporate quantitative measures to further examine the relationship between critical thinking and mathematical literacy across larger samples. Nevertheless, the findings offer valuable guidance for improving the quality of teacher preparation.

In summary, the discussion confirms that critical thinking is not an auxiliary skill but a core component of mathematical literacy and professional competence for future primary school teachers. Its integration into teacher education has the potential to enhance both teaching effectiveness and the quality of mathematical learning in primary education.

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Conclusion

The study has demonstrated that critical thinking plays a decisive role in improving the mathematical literacy of future primary school teachers and serves as a key factor in their professional preparation. In the context of modern education, where the emphasis is placed on competence-based learning and meaningful understanding, mathematical literacy emerges as an essential professional quality for primary educators. The findings of this research confirm that the development of mathematical literacy is inseparable from the cultivation of higher-order thinking skills, among which critical thinking occupies a central position.

The analysis shows that critical thinking enables future teachers to move beyond mechanical application of mathematical procedures toward a deeper comprehension of mathematical concepts and relationships. This conceptual depth allows prospective teachers to interpret mathematical ideas flexibly, explain them clearly, and adapt instructional strategies to the cognitive needs of primary school learners. As a result, mathematical literacy is formed not as a static body of knowledge, but as a dynamic ability to reason, analyze, and apply mathematics in pedagogical and real-life contexts.

The study also confirms that critical thinking enhances problem-solving competence, which is a core component of mathematical literacy. Future primary school teachers who are trained in critically oriented learning environments demonstrate greater independence in selecting solution strategies, higher confidence in dealing with non-standard tasks, and stronger abilities to justify their reasoning. These qualities are particularly important in primary education, where teachers must guide pupils through the process of thinking rather than simply providing correct answers. By modeling critical thinking, teachers create learning conditions that encourage pupils to explore, question, and reason mathematically.

An important conclusion of the study concerns the role of reflection and metacognition in teacher preparation. Critical thinking fosters self-awareness of cognitive processes, enabling future teachers to evaluate their own understanding and continuously improve their professional skills. This reflective capacity

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supports lifelong learning and professional growth, which are essential in the rapidly changing educational landscape. Teachers who possess strong critical thinking skills are better prepared to adapt to new curricula, instructional technologies, and educational challenges.

The communicative dimension of mathematical literacy is also strengthened through critical thinking. The ability to articulate mathematical reasoning, engage in constructive dialogue, and respond thoughtfully to alternative viewpoints is a direct outcome of critically oriented instruction. These communicative skills enhance classroom interaction and contribute to a positive learning environment in primary education, where clear explanation and supportive feedback are crucial for pupils' mathematical development.

Overall, the conclusions of this study emphasize that critical thinking should be regarded as an integral component of mathematics education in teacher training institutions. Its systematic integration into curricula, teaching methods, and assessment practices can significantly enhance the quality of preparation of future primary school teachers. By fostering critical thinking, pedagogical universities contribute to the formation of teachers who are mathematically literate, professionally competent, and capable of promoting meaningful mathematical learning in primary classrooms.

Thus, strengthening the role of critical thinking in teacher education is not only a pedagogical necessity but also a strategic priority for improving the effectiveness of primary mathematics education and ensuring the sustainable development of educational quality.

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