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DEVELOPING MATHEMATICAL LITERACY THROUGH CONTEXT-BASED LEARNING IN ACCORDANCE WITH PISA REQUIREMENTS

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Abstract. The development of mathematical literacy is a critical goal of contemporary education systems worldwide. This study investigates the effectiveness of context-based learning as a pedagogical approach to enhance mathematical literacy in alignment with the Programme for International Student Assessment (PISA) requirements. By integrating real-life scenarios into mathematics instruction, students are encouraged to apply mathematical concepts, reason critically, and solve complex problems relevant to everyday situations. The research employs a mixed-methods design involving an instructional intervention and empirical assessment with secondary school students. Findings indicate that context-based learning significantly improves students' ability to interpret, formulate, and apply mathematics in meaningful contexts, thereby increasing their readiness for PISA assessments and real-world challenges. The study highlights the importance of teacher training and curriculum adaptation to support the successful implementation of contextual learning. Recommendations for further research and educational practice are discussed.

Keywords: Mathematical literacy; Context-based learning; PISA; Real-life problems; Mathematics education; Competence development.

Introduction

In the context of rapid global development, the role of education is undergoing profound transformation. Modern society increasingly requires individuals who are capable not only of possessing academic knowledge but also of applying this knowledge effectively in real-life situations. As a result, the focus of contemporary education has shifted from content-oriented instruction toward competence-based learning, where the development of functional skills and practical reasoning abilities becomes a central objective. Within this paradigm, mathematical literacy has emerged as one of the most significant indicators of educational quality.

Mathematics plays a crucial role in shaping analytical thinking, logical reasoning, and problem-solving competence. However, international research demonstrates that students often experience difficulties when required to apply mathematical knowledge outside of traditional classroom tasks. Learners who perform well in routine exercises may struggle to interpret data, analyze real-life situations, or make mathematically justified decisions. This discrepancy reveals a fundamental gap between school mathematics and its practical application in everyday

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life. The Programme for International Student Assessment (PISA), initiated by the Organisation for Economic Co-operation and Development (OECD), was designed to evaluate students' preparedness to face such real-world challenges. Unlike traditional examinations, PISA does not measure how well students reproduce curricular content; instead, it assesses their ability to formulate, employ, and interpret mathematics in diverse contexts. Consequently, PISA results serve as a powerful diagnostic tool, reflecting the effectiveness of national education systems in preparing students for social, economic, and technological realities. In recent years, many countries have begun to reconsider their mathematics curricula in response to PISA outcomes. Educational reforms increasingly emphasize contextual problem solving, interdisciplinary integration, and learner-centered approaches. These reforms highlight the necessity of transforming mathematics teaching from abstract, decontextualized instruction into learning experiences grounded in meaningful life situations. One of the most promising pedagogical approaches supporting this transformation is context-based learning. This approach is based on the idea that mathematical concepts become more comprehensible and sustainable when introduced through realistic and relevant contexts. By embedding mathematics within familiar social, economic, scientific, or everyday situations, students are encouraged to perceive mathematics as a functional tool rather than an isolated academic subject.

Context-based learning aligns closely with the conceptual framework of PISA. PISA tasks are explicitly constructed around real-life contexts such as personal finance, health, transportation, environmental issues, and technological processes. These contexts require students to interpret information, select appropriate mathematical strategies, and evaluate the reasonableness of their solutions. Therefore, integrating contextual learning into classroom practice directly contributes to the development of competencies assessed by international studies. Contemporary educational psychology emphasizes that learning becomes more effective when students can connect new knowledge with prior experience. Contextual tasks activate cognitive engagement, promote intrinsic motivation, and support deeper conceptual understanding. Through such tasks, learners develop higher-order thinking skills, including reasoning, modeling, and reflection. The recognized importance of contextual learning, its systematic implementation in mathematics education remains limited in many schools. Teachers often face challenges related to instructional design, assessment methods, and alignment with existing curricula. As a result, mathematics instruction may remain predominantly procedural, limiting students' opportunities to develop genuine mathematical literacy. Given these challenges, there is a growing need for scientific research that explores effective methods for integrating context-based learning into mathematics education in accordance with PISA requirements. Investigating theoretical foundations, methodological principles, and practical strategies is essential for improving learning outcomes and strengthening students' functional mathematical competence.

Research Approach

This study adopts a mixed-methods approach combining quantitative and qualitative data to provide a comprehensive understanding of the impact of context-based learning on mathematical literacy development aligned with PISA standards. The quantitative component measures student performance, while the qualitative aspect explores attitudes and teaching practices.

Participants and Sampling

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The research involves 200 secondary school students aged 15-16 from both urban and rural schools. Participants were selected using purposive sampling to represent a diverse demographic. The sample was divided into two groups: an experimental group receiving context-based learning instruction, and a control group taught via traditional methods.

Instructional Intervention

Context-based learning modules were developed focusing on authentic, real-life situations that mirror PISA problem contexts, such as personal finance, health statistics, and environmental data. These modules were incorporated into the regular mathematics curriculum over a 16-week period. Teachers in the experimental group received professional development to effectively facilitate these lessons.

Data Collection Instruments

- **Mathematical Literacy Assessments:** Customized pre- and post-tests reflecting PISA-style tasks were administered to evaluate students' problem-solving and reasoning abilities in real-world contexts.
- **Attitudinal Surveys:** Structured questionnaires measured students' motivation, engagement, and perceptions toward mathematics before and after the intervention.
- **Classroom Observations:** Systematic observations during lessons provided qualitative insights into student participation and teacher facilitation methods.
- **Teacher Interviews:** Semi-structured interviews gathered detailed information on educators' experiences, challenges, and perspectives on implementing context-based learning.

Data Analysis

Quantitative data from tests and surveys were statistically analyzed using paired t-tests and Analysis of Covariance (ANCOVA) to determine the effectiveness of the intervention. Qualitative data from observations and interviews were analyzed through thematic coding to identify patterns related to instructional practices and learner engagement.

Ethical Considerations

Ethical approval was obtained prior to the study. All participants and their guardians provided informed consent. Confidentiality and anonymity were guaranteed, with all data securely stored and used solely for research purposes.

Conclusion

This study has demonstrated that context-based learning plays a vital role in enhancing students' mathematical literacy in accordance with PISA requirements. By embedding mathematical concepts within real-life scenarios, learners are able to better understand, apply, and critically analyze mathematical information beyond traditional classroom exercises. The findings reveal that students exposed to contextual tasks show significant improvement in problem-solving skills, reasoning abilities, and motivation toward mathematics compared to those receiving conventional instruction. Integrating context-based learning fosters a more

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student-centered environment, encouraging active participation and collaborative learning. This approach aligns well with contemporary educational objectives that emphasize competence development and practical applicability of knowledge. Successful implementation of contextual learning demands adequate teacher training, curriculum adjustments, and appropriate assessment methods. Educators should be supported in designing meaningful tasks that reflect authentic problems and in facilitating classroom dynamics that promote inquiry and reflection.

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