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Project-Based Learning Approach to Improve Students' Mathematical Numeracy Literacy: a Systematic Literature Review

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Abstract: The efficacy of project-based learning (PjBL) strategies in enhancing students' mathematical numeracy literacy is investigated in this comprehensive research review. Early development of quantitative numeracy skills is essential in this era of growing complexity. This study intends to determine the features, application, and effects of PjBL on the growth of students' mathematical numeracy literacy at different educational levels by a methodical review of recent literature. The review's findings show that, in comparison to more conventional teaching approaches, project-based learning greatly enhances students' problem-solving skills. Students who participated in STEM-focused project learning demonstrated gains in teamwork, critical thinking, and the capacity to relate mathematical ideas to practical issues. Mastery of ideas and numeracy abilities were favorably connected with PjBL's ability to boost students' motivation and involvement in the mathematics learning process. According to the research review, PjBL fosters four essential competencies: collaboration, representation, intra-mathematical connections, and the development of a positive identity toward mathematics. In the meantime, current PjBL implementations continue to underrepresent computational thinking abilities. The review also demonstrates that the quality of the learning design, teacher assistance, and implementation context all affect how well PjBL strengthens numeracy. Based on the results, this review comes to the conclusion that students' mathematical numeracy literacy can be greatly enhanced by using a project-based learning strategy. This method fosters higher-order thinking abilities and learning motivation in addition to improving mathematics technical proficiency. Teachers must continue their professional development in order for PjBL to be implemented successfully, with an emphasis on integrating pedagogy and technology. In light of the demands of children from diverse backgrounds, this study suggests that educators, researchers, and practitioners work together to create a particular PjBL framework for enhancing mathematical numeracy literacy. The usefulness of PjBL in blended learning and online learning environments, as well as the creation of reliable evaluation tools to gauge how effectively students' numeracy literacy is developing using the PjBL approach, require more research.

Keywords: Project Based Learning, Literacy, Numeracy, Mathematics

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A. INTRODUCTION

The 21st century's rapid advancements in science and technology have made mathematical numeracy literacy one of the most important skills that kids need to have. In addition to performing basic arithmetic operations, numeracy literacy encompasses the capacity for quantitative reasoning, contextual problem solving, and effective and logical communication of mathematical concepts. Mastery of numeracy literacy is crucial in today's educational environment as a means of preparing students to handle challenging and ever-changing real-world situations.

Project-Based Learning (PjBL) is one of the pedagogical strategies that has become a cutting-edge substitute for conventional teaching methods. PjBL places a strong emphasis on students actively participating in the learning process by implementing cross-disciplinary, cooperative, and practically applicable projects. Through the direct application of mathematical principles in practical contexts, this method is thought to be able to improve conceptual understanding, foster critical thinking, and increase learning motivation.

Project Based Learning (PjBL) approaches have become an increasingly popular method in education, especially in improving students' mathematical and numeracy literacy. In this context, PBL provides opportunities for students to engage in more active and meaningful learning, so that they can apply mathematical concepts in real situations. The purpose of this study is to investigate the features, application, and effects of PjBL techniques on students' growth in mathematical numeracy literacy across a range of educational levels. In order to determine how PjBL can support students' learning motivation, higher-order thinking abilities, and mathematical comprehension in increasingly complicated and varied learning environments, this project will undertake a systematic review of the most recent evidence.

B. METHOD

This study employs a qualitative research method in the form of a systematic literature review. The literature review aims to collect, analyze, and synthesize relevant scholarly articles and academic sources related to the integration of Project-Based Learning (PjBL), Literacy, Numeracy, and Mathematics. The stages of the literature review follow a systematic approach: (1) Identification of keywords and research questions; (2) Selection of relevant literature through inclusion and exclusion criteria; (3) Data extraction from selected journals and academic publications; and (4) Analysis and synthesis of findings to construct a conceptual understanding of the proposed instructional model.

Data were obtained from reputable academic databases such as Scopus, ERIC, Google Scholar, and ScienceDirect, with a focus on peer-reviewed journals published within the last ten years (2020–2024). The inclusion criteria included articles discussing PjBL, Literacy, Numeracy, and Mathematics. The analysis was conducted using thematic coding to identify common patterns, theoretical frameworks, teaching strategies, and empirical findings that support the integration of the three approaches. The review was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure transparency and comprehensiveness throughout the process.

Table 1. Inclusion and Exclusion Criteria Table

Criteria	Inclusion	Exclusion
Publication Year	2020–2024	Articles published before 2020
Language	English or Indonesian	Other languages without translation
Type of Publication	Peer-reviewed journal articles, conference papers	Non-academic sources, blogs, opinion pieces
Research Focus	PjBL, literacy, numeracy, and mathematics.	Studies not related to literacy, numeracy, and mathematics or

Criteria	Inclusion	Exclusion
		not integrating PjBL
Skill Outcomes	Enhancing students' mathematical numeracy literacy	Studies focusing only on knowledge recall or procedural learning
Target Participants	Studies focusing on elementary/secondary students (if not comparable)	University students or preservice mathematics teachers

C. RESULTS AND DISCUSSION

1. Implementation of PjBL in Improving Mathematical Problem Solving Skills

Secondary school pupils' ability to solve mathematical problems was much enhanced by the use of the PjBL approach. According to research, PjBL's main success elements include students' active participation, the development of their collaboration skills, and the application of mathematical ideas in a practical setting. Students learn theory and how to apply it in real-world situations by participating in pertinent projects (Oktaviani, 2024). PjBL is a teaching approach that places a strong emphasis on students actively participating in actual projects. Jannah et al. (2021) claim that PjBL enhances students' comprehension of mathematical ideas by assisting them in exploring and synthesizing knowledge to finish tasks. Students can relate theory to everyday practice by actively participating in the learning process through the use of PjBL (Jumira et al., 2022).

Positive outcomes have been shown when this concept has been implemented in schools. According to Astriyana (2023), PjBL can help students become more mathematically literate since it teaches them how to create and finish projects that are applicable to their everyday lives. In addition to enhancing mathematical comprehension, this promotes student cooperation and communication. According to a study by Lina and Amidi (2023), pupils' mathematical literacy was significantly enhanced when PjBL was combined with the STEM (Science, Technology, Engineering, and Mathematics) approach. Through STEM-related projects that offer authentic context, students can gain a deeper understanding of how mathematics is used in daily life. Positive outcomes in early childhood have also been demonstrated by the use of PjBL. According to Aulad's research (2024), this paradigm enhances children's fundamental capacity to solve mathematical problems in authentic circumstances and aids in their recognition of patterns, symbols, and relationships between data.

2. Mathematical Numeracy Literacy and PjBL

According to Wardani et al. (2024), numeracy literacy is crucial and should be taught at a young age to assist pupils comprehend and use what they have learned in daily situations. This study demonstrates that the PjBL paradigm enhances students' critical thinking abilities in addition to their numeracy. Students learn to think critically and logically when faced with challenges by tackling real-world issues that need to be solved (Wardani et al., 2024). It has been demonstrated that the Project-Based Learning methodology works well for raising students' numeracy and mathematical literacy. Students gain critical thinking abilities that

are necessary to overcome obstacles in the actual world in addition to learning mathematical principles through active participation in real-world projects. Consequently, it is strongly advised that PjBL be incorporated into the curriculum to aid in the growth of students' problem-solving and numeracy literacy.

According to Munahefi et al. (2023), students' numeracy literacy skills can be enhanced through project-based integrated theme learning. Students were asked to complete projects in the study that combined a variety of mathematical ideas, which taught them how to apply their knowledge and reasoning abilities to solve real-world situations. PjBL significantly improves mathematical literacy, according to several research. According to research by Fatma Jumira et al. (2022), students who received instruction utilizing the PjBL model had a higher level of growth in their mathematical literacy abilities than those who received traditional instruction. These findings are consistent with study by Latifah (2022), which demonstrates the effectiveness of the PjBL model in enhancing problem-solving abilities and comprehension of mathematical ideas.

3. The Relevance of PjBL for Mathematical Numeracy Literacy

a. Enhances focus (attention). Students' interest in arithmetic and numeracy can be piqued via engaging and pertinent tasks.
b. Growing in importance. Students learn the value of mathematics and numeracy through projects that are relevant to their everyday lives.
c. Gain more self-assurance. The project's successful completion boosts pupils' self-esteem in their mathematical and numeracy abilities.
d. Boosts contentment (contentment). Students are satisfied when they see the immediate advantages of using their math and numeracy skills in the project.

4. Challenges and Solutions in Implementing PjBL

a. Sufficient preparation.
b. Thorough evaluation.
c. Effective time management

5. The role of teachers in ensuring the implementation of PjBL in increasing mathematical numeracy literacy

a. Facilitator of learning. The instructor assists pupils in their learning process by acting as a facilitator.
b. Designer of the project. It is crucial for teachers to create projects that align with the curriculum and students' comprehension.
c. Mentor and guide. Throughout the PjBL process, teachers also serve as mentors and advisors. They give pupils precise instructions on how to finish the job and assist them in overcoming obstacles.
d. Classroom supervisor. Instructors must strike a balance between allowing students to explore freely and making sure they don't stray from the learning objectives (Yuniar et al., 2022). All children will benefit from a positive learning environment created by efficient classroom management.

e. Process and outcome evaluator. Evaluation considers the learning processes that students go through in addition to the outcome (Wahyuni et al., 2024). By giving pupils constructive criticism, educators can motivate them to keep growing and enhancing their abilities.

D. CONCLUSIONS AND SUGGESTIONS

The Project-Based Learning (PjBL) paradigm has been shown to be a successful strategy for raising students' literacy and numeracy levels. According to the discussed research findings, PjBL fosters critical, creative, and cooperative thinking abilities in addition to helping students grasp mathematical topics. The use of this paradigm has a major positive impact, as evidenced by PjBL success indicators such improved test scores, learning completeness, student involvement, problem-solving skills, student feedback, and the caliber of the final project. PjBL helps students connect mathematics knowledge to real-world situations by involving them in authentic projects that are pertinent to their everyday lives. This enhances learning outcomes and student motivation.

Teacher Training. In order for teachers to comprehend and successfully apply the PjBL paradigm, it is advised that schools give them sufficient training. Project design methods, classroom management, and suitable assessment methodologies should all be included in this training. Curriculum Development. To make sure that the projects created are pertinent to the learning objectives and the needs of the students, the PjBL approach should be integrated with the mathematics education curriculum. Student participation will increase if projects emphasize real-world circumstances. Continuous Evaluation. It's critical that educators use PjBL to carry out ongoing assessments of the learning process and results. Students' literacy and numeracy abilities can be thoroughly evaluated with the aid of unambiguous assessment rubrics. Student Collaboration. Students' social and communication skills can be enhanced by promoting teamwork on assignments. Instructors must foster an environment that encourages collaboration and group discussions. Additional Research. To examine many facets of PjBL in diverse settings, including its impact on age groups and educational backgrounds, more research is required. This study can shed further light on how well PjBL works to raise reading and numeracy in a variety of school contexts. It is intended that by putting these recommendations into practice, the Project-Based Learning approach can be further enhanced to raise students' literacy and numeracy levels across the board.

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