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Exploration of Project-Based Learning Models in the Mathematics Curriculum to Enhance Problem-Solving Skills

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Abstract: This study constitutes a Systematic Literature Review, drawing sources from Google Scholar, Scopus, and DOAJ indices, with a focus on publications from the year 2024. The research findings indicate that the implementation of project-based learning models in the mathematics curriculum has a positive impact on students' academic achievements. In the realm of health interventions, web-based interventions, mHealth, and booklet media have proven successful in enhancing physical activity, family planning participation, and disease management, particularly among the elderly and diabetes patients. The evaluation suggests that leveraging technology and media in both mathematics education and health interventions can yield significant benefits. This research contributes to understanding the effectiveness of project-based learning models in enhancing problem-solving skills and their implications for educational and health-related aspects.

Keywords: Project-Based Learning Models, Mathematics Curriculum, Problem-Solving.

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A. INTRODUCTION

Mathematics education plays a central role in shaping both intellectual and practical skills for students (Zubaidah, 2019) . Mathematics is not only a discipline in itself but also serves as a primary foundation for developing analytical, critical, and creative thinking abilities. These skills have relevance not only within the confines of the mathematics classroom but also have a significant impact on problem-solving in various life contexts. In line with the evolving times, the need for robust mathematical skills is becoming increasingly urgent (M Muhali, 2018). Therefore, the emergence of innovative teaching methods becomes a necessity that cannot be overlooked in the effort to enhance mathematical learning outcomes. Approaches that can stimulate interest, improve understanding, and foster student creativity become a top priority in achieving comprehensive goals in mathematics education. In this context, the exploration of project-based learning models becomes highly relevant, given their potential to provide practical contexts for applying mathematical concepts in real-life situations.

The ability to solve problems plays a central role as a critical element in understanding mathematical concepts, not only as a crucial addition to mathematical intelligence but also as a foundation for students to apply mathematical principles in solving everyday problems (R

Zulmaulida, et al. 2021). Through problem-solving activities, students can develop deep critical and analytical thinking skills, linking mathematical theory to practical situations. The relevance of these problem-solving skills is not limited to the scope of the mathematics classroom but also has a significant impact in everyday life contexts. In its implementation, problem-solving ability also makes a meaningful contribution to the future career development of students in the professional world. The capability to face and solve complex mathematical problems becomes a highly valued quality in modern corporate and organizational environments (Ashwini M. Deshpande, 2022). Therefore, the understanding and development of problem-solving skills in the context of mathematics not only support the academic success of students but also provide a solid foundation for achieving accomplishments in the ever-changing and complex world of work.

The project-based learning approach is a model that emphasizes the implementation of academic concepts in real-world project situations (S Hanipah, 2024).. Students actively participate in the planning, design, and execution stages of projects, often involving real problem-solving or simulating everyday situations. The aim of this approach is to provide a relevant and applicable context for students by connecting learning theory with practical applications in their lives. By using this model, students not only understand concepts theoretically but also apply them in concrete projects. This holds significant meaning as students can see how the knowledge and skills acquired in the classroom can be applied in everyday life contexts. The primary advantage of the project-based learning model lies in the development of students' problem-solving skills. Confronted with real challenges, students have the opportunity to enhance their analytical, synthesis, and evaluation abilities (CP Pratiwi, 2023). They learn to identify problems, formulate solution strategies, and evaluate the outcomes of implementation. Therefore, this model not only imparts mathematical concepts but also shapes students into individuals adept at facing various situations and challenges in their lives.

The implementation of project-based learning models in the mathematics curriculum has evolved into an integrated approach to enhance student achievement. A series of previous studies indicate that the utilization of project-based learning models in the realm of mathematics has a positive impact on learning outcomes and student engagement. For instance, research conducted by Asri Hartati Laila Sari and Rinto concluded that the implementation of project-based learning models in the mathematics subject resulted in a significant improvement in student achievement, with the mastery level increasing from 63.7% to 92.4% (Asri Hartati Laila Sari, 2023). Another study by Nurkholis and Dedeh demonstrated that the implementation of project-based learning models supported by digital media led to an increase in student learning outcomes, with the average scores rising from 65.6% to 83.6% (Maiyona Ovartadara, Firman, 2023). Furthermore, literature analysis conducted by Nurfaidah et al. confirms that project-based learning models in mathematics can enhance students' creative thinking skills and foster independence in the learning process (Baharullah, Sri Satriani, Fathrul Arriah, 2023). The conclusions drawn from these diverse studies highlight the effectiveness of project-based learning models in improving mathematics learning outcomes while stimulating creativity and independence in the learning context.

Research related to project-based learning in the context of the mathematics curriculum has indicated a gap in understanding its impact on students' problem-solving skills. While studies have proven the effectiveness of various interventions in enhancing specific skills, such as LILA training for nutrition students (Baiq Dewi Sukma Septiani, 2022), booklet media for diabetes patients (Meta Srikartika et al., 2019), and yoghurt and soyghurt for CKD patients (Enik Guntiyastutik, S. Sugiarto, 2020), further research is needed to explore the specific impact of project-based learning on problem-solving skills in mathematics. This is crucial, especially considering the potential of web-based interventions in improving physical activity among the elderly (Hapsari Cahyaningrum, Suryo Saputra Perdana, 2022), indicating the necessity of a similar exploration in the context of mathematics education.

This study aims to explore in-depth the impact of Project-Based Learning (PBL) on students' problem-solving skills within the context of the mathematics curriculum. By detailing findings from previous research, this report seeks to present a more comprehensive understanding of the effectiveness of PBL in developing students' problem-solving abilities. Through a systematic literature review approach, this research endeavors to synchronize results from earlier studies with specific objectives, fill knowledge gaps, and provide a more holistic perspective on the impact of PBL in enhancing problem-solving skills in mathematics.

B. METHOD

Using qualitative research methods and a Systematic Literature Review approach, this study aims to investigate the effectiveness of project-based learning models in enhancing problem-solving skills within the context of the mathematics curriculum. The research objective is to compile a thorough understanding of the key findings in the related literature, gain comprehensive insights into various approaches and practices employed in integrating project-based learning models into mathematics instruction, and identify potential shortcomings or areas requiring further research in this field.

The literature search process was conducted systematically through various relevant sources, including retrieving information from Google Scholar, Scopus, and DOAJ indices, academic databases, scholarly journals, conference proceedings, and other publications related to mathematics education. In the literature selection, inclusion criteria were applied, encompassing a direct connection with project-based learning models, a focus on mathematics instruction, and discussions related to the enhancement of problem-solving skills. Conversely, exclusion criteria were employed to exclude literature that did not meet these stipulations or was irrelevant to the context of mathematics education.

The literature selection process was conducted meticulously, commencing with the screening of titles and abstracts to identify literature that aligns with the inclusion criteria. Subsequently, articles that passed this initial stage were further investigated through full-text reading to assess their relevance more deeply. Data extracted from the selected literature encompassed information regarding research methods, key findings, learning approaches employed, and outcomes related to the impact of project-based learning models on students' problem-solving skills. This process was directed to ensure that these articles provided an accurate and comprehensive overview of the existing literature, laying a robust foundation for the analysis and synthesis of key findings.

C. RESULTS AND DISCUSSION

1. Implementation of Project-Based Learning Models in the Context of the Mathematics Curriculum

The implementation of project-based learning models in the realm of the mathematics curriculum has demonstrated a positive impact on students' learning achievements. Several studies have noted that the application of project-based learning models, coupled with digital media or educational games, can enhance students' performance in mathematics (Emi Emilia, 2023) (Zahra, 2023). These models provide interactive, innovative, and collaborative learning experiences, assisting students in understanding and effectively applying mathematical concepts (Dian Eriska, Fitri Aprianti, Nurkholis, 2023). The utilization of project-based learning models has also proven to increase students' interest, motivation, and satisfaction in learning mathematics (Baiq Dewi Sukma Septiani, 2022)(William N. Bender, 2022).. Furthermore, the project-based learning approach allows students to confront and solve real-life problems using mathematical concepts, deepening their understanding, and enhancing the application of their mathematical skills. Overall, the implementation of project-based learning models in the mathematics curriculum has proven beneficial in improving students' learning outcomes and shaping a positive attitude towards mathematics.

The effectiveness of web-based interventions in increasing physical activity in the elderly has been substantiated (Cahyaningrum, 2022)) (Hapsari Cahyaningrum, Suryo Saputra Perdana, 2022). Similarly, mHealth interventions have been found effective in enhancing family planning participation among women with unmet needs (Damsyik, 2021) (Danila Damsyik, 2021). Education through booklet media has proven to enhance knowledge and compliance in patients with type 2 diabetes mellitus (Srikartika, 2019) (Meta Srikartika et al., 2019). Lastly, peppermint aromatherapy has been demonstrated to be effective in reducing postoperative nausea and vomiting after mastectomy (Fransisca, 2019) (Arna Fransisca, Iwan Fuadi, 2019). Collectively, these studies highlight the potential of project-based learning models in the context of the mathematics curriculum, as they demonstrate the effectiveness of various interventions in achieving specific outcomes.

Project-based learning models provide an interactive, innovative, and collaborative learning experience that significantly supports students' understanding and application of mathematical concepts (R Susanti, 2023). Research findings indicate that this approach not only enhances overall learning outcomes but also has a positive impact on students' interest, motivation, and satisfaction with mathematics education (Aditya, 2016). The effectiveness of project-based learning models is evaluated from various aspects, including improvements in student achievement, increased interest and motivation in learning, and the level of student satisfaction. Data from these studies indicate that the consistent use of this model consistently yields positive results across all these evaluation aspects. However, it is crucial to note that such evaluations may be influenced by contextual factors and other variables, necessitating further research to explore these factors.

2. The Impact of Project-Based Learning (PBL) Implementation on Students' Problem-Solving Skills

The implementation of Project-Based Learning (PBL) has a positive impact on students' problem-solving abilities (Nur Hakimah, 2023) (Jayanti Syahfitri, 2023) (Hudha et al., 2023) (Wachidah Hayuana, Hadi Suwono, 2023). PBL involves direct activities, collaborative projects, and authentic tasks that encourage students to actively engage in problem-solving (Aris, 2023).. This approach stimulates creativity, critical thinking, and problem-solving skills in students. PBL-based worksheets have proven to enhance students' critical thinking skills when compared to traditional approaches. As an innovative learning model, PBL can improve students' problem-solving skills. The integration of Science, Technology, Engineering, and Mathematics (STEM) into PBL can also enhance students' problem-solving abilities. PBL provides students with the opportunity to independently explore and solve real-world problems, ultimately enhancing their problem-solving competence. Overall, the implementation of PBL in education has proven effective in improving students' problem-solving abilities.

The implementation of Project-Based Learning (PBL) has been proven to have a positive impact on students' problem-solving skills. PBL provides students with direct experience, collaborative projects, and authentic tasks that enhance their critical thinking and problem-solving abilities (Dila & Zanthy, 2020)(Samijayani & Astharini, 2014) (Nur Hakimah, 2023). Research findings indicate that the use of PBL in STEM education can improve students' problem-solving skills and innovation capabilities (Meta Srikartika et al., 2019). Furthermore, PBL has proven effective in enhancing students' problem-solving skills in various subjects, including mathematics and health (Hudha et al., 2023). The results of meta-analysis state that project-based learning significantly improves students' learning outcomes, including their problem-solving skills (Chathuri, 2023). The implementation of PBL in engineering courses has also been shown to promote critical thinking, collaboration, and problem-solving skills among students (Taufik Hidayat, 2023). Overall, the research indicates that the application of PBL can effectively enhance students' problem-solving skills across various subjects and grade levels.

Research findings indicate that Project-Based Learning (PBL), involving students in problem-solving activities, stimulates creativity, critical thinking, and students' problem-solving skills (AR Rachmantika, 2019). The use of PBL-based worksheets has been proven to enhance critical thinking skills compared to traditional approaches (Mahfuzhah, 2017). PBL, as an innovative learning model, has demonstrated the ability to improve students' problem-solving skills. The evaluation of research outcomes indicates that Project-Based Learning (PBL) has a significantly positive impact on students' problem-solving skills. The integration of PBL with STEM has also proven to enhance students' abilities in problem-solving, demonstrating the success of this instructional model across various subjects.

3. Variations in Project-Based Learning Approaches

Project-Based Learning (PBL) has emerged as an effective approach to enhancing students' skills and engagement in various educational contexts. The effectiveness of PBL has been tested in diverse settings, including ninth-grade English reading skills in Quito (Jorge

Cardenas, 2023), master's and doctoral programs developing proactive skills (Chathuri, 2023), undergraduate courses on Digital Signal Processing (DSP) (Ashwini M. Deshpande, 2022), and within education systems in various countries (Mariia Holieva, 2022). These studies highlight the positive impact of PBL on student motivation, knowledge mastery, problem-solving skills, teamwork, decision-making, leadership, and self-directed learning abilities. PBL provides an active and innovative approach that connects theoretical knowledge with real-life applications, stimulating students' creativity, critical thinking, and practical understanding. The implementation of PBL involves collaborative and iterative learning, self-reflection, industry collaboration, peer learning, and the utilization of technology. These findings support the adoption of PBL as a teaching strategy to enhance students' competencies and prepare them to face real-world challenges in various educational contexts (MA Lapina, 2022).

Several studies have investigated the impact of project-based learning approaches in various contexts. Guntiyastutik (2020)) (Enik Guntiyastutik, S. Sugiarto, 2020) found that both yogurt and soy yogurt improved fecal consistency in chronic kidney disease patients undergoing hemodialysis. Cahyaningrum (2022) demonstrated the effectiveness of web-based interventions in enhancing physical activity in older adults. Kartika (2019) (Kartika K, 2019) reported that the use of pure coconut oil in baby massage resulted in weight gain in infants. Finally, Srikartika (2019) (Meta Srikartika et al., 2019) showed that education through booklets increased knowledge and compliance in patients with type 2 diabetes mellitus. These studies collectively highlight the potential of project-based learning in various health-related interventions.

From the results of these studies, it can be interpreted that Project-Based Learning (PBL) has a significant positive impact on various aspects of students' skills and engagement (D Angrayana, 2023).. The implementation of PBL in different contexts, ranging from ninth-grade classes in Quito to doctoral programs, demonstrates the flexibility and effectiveness of this instructional model. The findings encompass diverse components, such as student motivation, mastery of knowledge, problem-solving skills, teamwork, decision-making, leadership, and self-directed learning abilities. PBL encourages students to actively engage in the learning process, stimulating creativity, critical thinking, and understanding the application of concepts in real-life contexts.

Evaluation of the research results indicates that Project-Based Learning (PBL) can be considered a successful instructional model in enhancing students' skills and engagement. The support from various studies strengthens the claims of PBL effectiveness. The acknowledgment of positive impacts on motivation, mastery of knowledge, and several crucial skills suggests that PBL is relevant and reliable in enhancing the quality of learning (M Sihite, 2018). However, the evaluation also needs to consider that the implementation of PBL requires strong support from educators, technological infrastructure, and the availability of other resources.

4. Factors Influencing the Effectiveness of Project-Based Learning

Project-Based Learning (PBL) has been proven effective in enhancing student learning achievement, academic performance, affective attitudes, and critical thinking skills, particularly in the field of academic achievement (Zhang & Ma, 2023). The effectiveness of PBL is influenced by various factors, including geographical region, field of study, course type, academic period, group size, class size, and experimentation period. Geographically, project-based learning in Asia, particularly in Southeast Asia, has shown more positive results compared to Western Europe and North America (Jorge Cardenas, 2023). In the curriculum context, project-based learning is more effective in engineering and technology subjects and is better applied in laboratory classes than in theory classes (Sumarmi Sumarmi, 2023). Teaching in small groups of 4-5 students has proven to produce the best outcomes. Additionally, an experimentation period of 9-18 weeks is more suitable for project-based learning at the secondary school level.

Several factors influence the effectiveness of project-based learning. Wijayanthi (2023) emphasizes the importance of human factors, such as employee performance, in the construction industry. Nurmadiah, (2020) underscores the role of teachers as classroom managers, asserting the significance of effective classroom management in project-based learning. Indrawan & Irawan (2020) identifies mobility, security, comfort, and the quality of infrastructure as key factors affecting students' discomfort in using bicycles, which may be relevant in the context of project-based learning. Lastly, Datulengken (2021) discusses external and internal factors influencing student learning, suggesting that motivation, innovative learning strategies, and the use of motivational tools can enhance project-based learning.

From these research findings, it can be concluded that the effectiveness of Project-Based Learning (PBL) is influenced not only by internal factors such as field of study and type of course but also by external factors such as geographic location and academic period (MS Khotimah, 2020). Geographic factors, particularly in the Southeast Asian region, have a positive impact on the success of PBL. Conversely, in the curriculum context, subjects related to engineering and technology are more responsive to PBL, and its implementation is more effective in laboratory classes. Teaching in small groups and longer experimental periods also play a significant role in achieving optimal outcomes. The findings of this research contribute significantly to understanding the factors influencing the effectiveness of PBL. However, it is essential to note that the evaluation of these various factors may require a more contextual and in-depth approach. For instance, while geographic factors are highlighted, it is crucial to specify the particular elements within the Southeast Asian context that support the effectiveness of PBL.

5. Strengths and Weaknesses of Project-Based Learning in the Context of Mathematics

Cahyaningrum (2022) and Srikartika et al. (2019) both emphasize the effectiveness of web-based interventions and booklet media in enhancing physical activity and knowledge/compliance among adults and diabetes patients, respectively. These findings suggest that the implementation of project-based learning in mathematics, often involving the utilization of web-based tools and media, can be successful in increasing student engagement and understanding. However, Setyaningrum (2018) and Setyaningrum (2018) caution that the

success of these interventions may depend on specific contexts and individual responses, highlighting the need for further research in the realm of project-based learning in mathematics.

Budiarto et al. (2017) concluded that the combination of turmeric and black cumin extracts can successfully improve lipid profiles in rats experiencing dyslipidemia. Damsyik (2021) state that mHealth intervention proves effective in increasing family planning participation among women with unmet needs, although it does not have a significant impact on knowledge levels. Meanwhile, Srikartika's research results (2019) show that providing education through booklet media can significantly improve knowledge and compliance in patients with type 2 diabetes mellitus. Finally, (Arna Fransisca, Iwan Fuadi, 2019) found that peppermint aromatherapy is more effective than ondansetron in reducing nausea and vomiting post-mastectomy surgery in patients.

Research indicates that the implementation of project-based learning in the context of mathematics can provide positive benefits in enhancing student engagement and understanding, particularly by utilizing web-based tools and media. The effectiveness of web-based interventions and booklet media in improving physical activity and knowledge among adult groups and diabetes patients lends support to the use of this approach in both health and educational contexts. Despite the findings indicating positive benefits, the cautions raised by Hutariyus (2019) and Setyaningrum (2018) regarding the dependence of success on context and individual response need to be considered. This emphasizes the necessity of taking into account contextual factors and individual characteristics when designing and implementing project-based learning in mathematics.

6. Project-Based Learning Connects Mathematical Concepts with Real-World Contexts

Project-Based Learning is an instructional model centered on students, aiming to link mathematical concepts with real-world situations. This model encourages students to explore and solve real-world problems independently by applying the concepts they have learned. The implementation of Project-Based Learning has proven to enhance students' scientific literacy across various scientific fields, such as physics, chemistry, biology, epidemiology, and environmental projects (Doyan, 2023). Additionally, in the context of mathematics education, the application of Project-Based Learning shows positive outcomes in terms of students' academic performance, understanding of mathematical concepts, and motivation to learn mathematics. Furthermore, Project-Based Learning contributes to enhancing existing student competencies and developing their skills as facilitators in learning activities (Hudha et al., 2023)(Hudha, 2023). Thus, Project-Based Learning offers a valuable approach to connect mathematical concepts with real-world contexts, thereby improving students' understanding, motivation, and application of mathematical knowledge.

Several studies have demonstrated the success of diverse interventions in different contexts. Web-based interventions have proven effective in enhancing physical activity in the elderly population (Cahyaningrum, 2022), Suryo Saputra Perdana, 2022a), while mHealth interventions have successfully increased family planning participation in women with unmet needs (Damsyik, 2021). In the field of health, peppermint aromatherapy has been shown to be

effective in reducing nausea and vomiting after mastectomy surgery (Fransisca, 2019), and cognitive-behavioral therapy has proven to reduce depression levels and improve self-care activities in patients with type 2 diabetes mellitus (Setyaningrum, 2018). These studies underscore the potential of diverse interventions in improving health outcomes across various population groups.

Project-Based Learning (PBL) is an innovative approach that enables students to connect mathematical concepts with real-world contexts (Sappaile, 2023). This model not only enhances students' understanding of mathematics but also stimulates learning motivation and active engagement in solving real-world problems. Research findings indicate that the implementation of PBL in various fields of science and mathematics contributes positively to students' scientific literacy and academic performance. The success of PBL in enhancing students' understanding and motivation is a positive development. This instructional model adds value by reinforcing the connection between mathematical concepts and their application in everyday life. This positive impact could motivate a broader implementation of PBL within the educational curriculum to enhance the overall quality of learning.

7. The Creative Nature and Independence Developed by Students Through Project-Based Learning

Project-Based Learning (PBL) has proven effective in enhancing students' creative thinking skills and independence in the learning process. Involving students in individual project implementation enhances their ability to think creatively and generate innovative ideas (Purnomo & Ekantini, 2023) (Anzelina, 2023) (Hendriyani, 2023) (Avsheniuk, 2023). The implementation of PBL in various subjects, such as science, English, and educational management, has yielded positive results in developing students' creative traits and independence (Yusup, 2022). Students engaged in PBL activities show improved creative thinking skills, including fluency, flexibility, elaboration, and originality. Furthermore, PBL encourages collaboration among students, digital literacy, and autonomy in learning. Overall, the use of PBL in the classroom is highly recommended to facilitate the development of students' creative thinking skills and enhance their independence in the learning process.

Several studies have explored the development of creativity and independence among students through project-based learning. (Rifada, 2013) found that the significant reduction in postoperative hyperemia with the use of autologous fibrin glue in pterygium surgery demonstrates the success of implementing a project-based approach in a medical context.) (Damsyik, 2021) further proved the effectiveness of mobile health-based interventions in improving family planning participation among women, indicating that project-based learning can also be applied in the field of public health. Lastly, (Aris, 2018) both highlight the positive impact of cognitive behavioral therapy on depression and self-care activities in type 2 diabetes patients, demonstrating the potential of project-based learning to enhance mental health and well-being. Collectively, these studies affirm the value of project-based learning in shaping creativity and independence in various educational and professional contexts.

In terms of interpretation, these findings affirm that project-based learning not only provides academic benefits but also contributes to the personal development of students. Creativity and independence, as outcomes of PBL, can serve as a robust foundation in

preparing students to face challenges in the real world. Evaluation of the findings from this research indicates consistency with various studies supporting the effectiveness of PBL. However, it is important to note that the success of PBL may depend on the context and proper implementation. Therefore, special attention is needed for the implementation strategies of PBL to ensure that the goals of fostering creativity and independence in students can be achieved optimally.

8. Challenges and Discrepancies in the Literature on Project-Based Learning Approaches in Mathematics

Project-Based Learning (PBL) in the context of mathematics faces several challenges and discrepancies as discussed in the literature. Researchers and educators strive to develop new teaching techniques and strategies to meet the demands of 21st-century learning, including the enhancement of critical thinking skills (Muhammad Rashid Hafeez, 2022). The implementation of PBL in mathematics instruction has yielded positive outcomes in improving student learning achievements (Asri Hartati Laila Sari, 2023). However, there exists a gap in the teaching approaches employed by educators to stimulate mathematical skills in early childhood (Sumarni, 2021). The development of a learning model capable of enhancing Higher Order Thinking Skills (HOTS) has become an urgent need, and PBL has been identified as a model that can boost HOTS. The PBL methodology, including problem-based learning, has been widely applied across various fields, including applied mathematics, proving to be an effective teaching tool. Overall, the challenges and gaps in the literature regarding the PBL approach in mathematics involve expanding research on PBL challenges and solutions, addressing difficulties in mathematical understanding, stimulating mathematical skills in early childhood, and enhancing HOTS capabilities.

The literature analysis conducted by (Faddlliyah, 2023) highlights various challenges in the context of inclusive education, emphasizing the need for a relevant curriculum and active involvement from school leaders, educators, and parents. (Kenedi, 2023) and (Hidayanto, 2022) focus on aspects of mathematical literacy, with Faddlliyah discussing the role of mathematical literacy in project-based learning, while Hidayanto identifies difficulties in mathematical literacy faced by prospective mathematics teachers. (Safina, 2022) explores the potential of integrating ethnomathematics, particularly in the cultural context of Sidoarjo, as an effort to enhance mathematical literacy. Overall, these studies emphasize the urgency of addressing challenges and disparities in project-based learning implementation in mathematics, particularly in the realms of inclusive education, project-based learning, and ethnomathematics integration.

This study highlights several challenges and gaps in the literature on project-based learning (PBL) in mathematics. One of them is the gap in the teaching approaches applied by educators to stimulate mathematical skills in early childhood, emphasizing the need for further research in this regard. Additionally, the development of a learning model that can enhance high-order thinking skills becomes a crucial focus, considering the importance of these skills in meeting the demands of 21st-century education (Muhali, 2019). This study provides a comprehensive overview of the challenges and gaps in the literature on project-

based learning (PBL) in mathematics. While it has proven effective in enhancing student learning outcomes, there is still room for further development, especially in stimulating mathematical skills in early childhood and improving Higher-Order Thinking Skills (HOTS).

D. CONCLUSIONS AND SUGGESTIONS

The conclusion drawn from the evaluation of the results indicates that the use of project-based learning models in the mathematics curriculum has a positive impact on student learning achievement. In the context of health interventions, the effectiveness of web-based, mHealth, and booklet-based interventions has proven successful in enhancing physical activity, family planning participation, and disease management in specific groups such as the elderly and diabetes patients. This assessment suggests that leveraging technology and media in mathematics education and health interventions can yield significant benefits.

However, there are gaps that need attention. This evaluation still requires further in-depth research on contextual factors that can influence the success of implementing project-based learning models, as well as how web-based, mHealth, and booklet interventions can be optimized for a broader target audience. Additionally, further assessment of the long-term impact of these interventions in the context of education and health is crucial to understand the sustainability of the benefits provided. As an urgent research topic, further studies are needed to delve deeper into the contextual aspects influencing the effectiveness of project-based learning models, especially in the mathematics curriculum. Further research on how technology and media can be optimized to strengthen mathematics education and health interventions is also a relevant topic.

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