

Project-Based Learning and Interactive Media as Strategies for Enhancing Student Participation in Mathematics Learning

Munawarah^{1*}, Khairina Mukhlisoh², Salamah³

^{1,2,3} PGMI, UIN Antasari Banjarmasin, Indonesia

ARTICLE INFO

Article history:

Received : 2025-11-15

Revised : 2025-11-29

Accepted : 2025-12-25

Publishs : 2025-12-25

Kata Kunci:

Partisipasi siswa; Project-Based Learning; media interaktif; pembelajaran matematika; kajian literatur kualitatif

Keywords:

Student participation;
Project-Based Learning;
interactive media;
mathematics learning;
qualitative literature review

ABSTRAK

Rendahnya partisipasi siswa masih menjadi permasalahan yang sering dijumpai dalam pembelajaran matematika, khususnya ketika proses pembelajaran didominasi oleh pendekatan yang berpusat pada guru dan bersifat abstrak. Keterlibatan siswa yang terbatas tidak hanya menghambat pemahaman konsep, tetapi juga menurunkan motivasi dan kebermaknaan pengalaman belajar. Artikel ini bertujuan untuk menganalisis secara kualitatif peran Project-Based Learning (PjBL) dan media interaktif sebagai strategi pembelajaran dalam meningkatkan partisipasi siswa pada pembelajaran matematika. Penelitian ini menggunakan pendekatan kualitatif berbasis kajian literatur dengan mensintesis temuan-temuan dari artikel ilmiah nasional dan internasional yang dipublikasikan dalam lima tahun terakhir. Data dianalisis menggunakan teknik *content analysis* untuk mengidentifikasi tema, pola, dan hubungan konseptual yang berkaitan dengan partisipasi siswa, penerapan Project-Based Learning, dan penggunaan media interaktif dalam pembelajaran matematika. Hasil kajian menunjukkan bahwa Project-Based Learning berfungsi sebagai kerangka pedagogis yang mendorong keterlibatan aktif siswa melalui aktivitas belajar yang kontekstual, kolaboratif, dan berorientasi pada pemecahan masalah. Sementara itu, media interaktif berperan sebagai strategi pendukung yang memperkuat keterlibatan kognitif dan afektif siswa melalui visualisasi, interaksi, dan peningkatan minat belajar. Integrasi Project-Based Learning dan media interaktif membentuk strategi pembelajaran yang saling melengkapi dalam meningkatkan partisipasi siswa secara kognitif, afektif, dan sosial. Kajian ini memberikan kontribusi

konseptual bagi pengembangan strategi pembelajaran matematika yang lebih partisipatif serta implikasi pedagogis bagi pendidik dalam merancang pembelajaran yang bermakna dan berorientasi pada keterlibatan aktif siswa.

ABSTRACT

Low levels of student participation continue to be a persistent challenge in mathematics learning, particularly when teacher-centered and abstract instructional approaches dominate. Limited student engagement not only constrains conceptual understanding but also reduces motivation and meaningful learning experiences. This article aims to qualitatively analyze the roles of Project-Based Learning (PBL) and interactive media as pedagogical strategies for enhancing student participation in mathematics learning. Employing a qualitative literature-based approach, this study synthesizes findings from relevant national and international scholarly articles published within the last five years. Data were analyzed using content analysis to identify recurring themes, patterns, and conceptual relationships related to student participation, Project-Based Learning, and the use of interactive media in mathematics instruction. Project-Based Learning serves as a pedagogical framework that fosters active participation through contextual, collaborative, and problem-oriented learning activities. Meanwhile, interactive media serve as strategic supports that enhance cognitive and affective engagement by facilitating visualization, interaction, and sustained student interest. The integration of Project-Based Learning and interactive media forms a complementary instructional strategy that supports student participation across cognitive, affective, and social dimensions. This study makes a conceptual contribution to mathematics education by offering an integrative perspective on how these strategies foster more participatory and meaningful learning environments in mathematics.

1. INTRODUCTION

Mathematics learning plays a fundamental role in developing students' logical thinking, analytical reasoning, and problem-solving skills, which are essential for academic success and everyday life. However, numerous studies have reported that student participation in mathematics learning remains relatively low. Limited participation, reflected in minimal involvement in questioning, discussion, and collaborative problem-solving, has been associated with superficial conceptual understanding and reduced learning motivation (Maamin et al.,

* Corresponding Author: First Author: munawarah112004@gmail.com

2021; Subagyo et al., 2025). This condition indicates that effective mathematics learning is not solely determined by content mastery but is also strongly influenced by the extent to which students actively engage in the learning process.

Previous research suggests that low levels of student participation are closely related to the dominance of teacher-centered instructional approaches and abstract modes of content delivery. When learning activities primarily focus on the one-way transmission of knowledge, students tend to assume passive roles, resulting in limited opportunities for them to construct their own mathematical understanding independently (Rani et al., 2021). In contrast, student participation serves as a critical indicator of cognitive, affective, and social engagement, directly contributing to meaningful learning experiences in mathematics (Maamin et al., 2021). Therefore, enhancing student participation should be regarded as a strategic objective in the development of effective mathematics instruction.

To address this challenge, the literature increasingly highlights the importance of instructional strategies that actively involve students in contextual and meaningful learning activities. One widely discussed approach is Project-Based Learning (PBL). PBL positions students at the center of the learning process by engaging them in project-oriented activities that emphasize problem-solving, collaboration, and learner autonomy (Anggraini & Wulandari, 2020; Khairullina & Prastowo, 2024). Several studies indicate that PBL has the potential to enhance student participation by encouraging active involvement in planning, implementing, and reflecting on learning tasks (Ramadhan & Hindun, 2023). In mathematics learning, PBL enables students to connect abstract concepts with real-world contexts, thereby fostering deeper engagement and understanding.

Nevertheless, Project-Based Learning enhances student participation most effectively when supported by instructional strategies that facilitate conceptual understanding and sustain student engagement. In this regard, interactive media play an important pedagogical role in supporting mathematics learning. Interactive media, encompassing both digital and non-digital forms, facilitate two-way interaction between students and learning materials, thereby increasing attention, motivation, and active engagement (Mayer, 2024; Smith et al., 2022). Previous studies have also demonstrated that interactive media facilitate the visualization of abstract mathematical concepts and help mitigate learning difficulties by making content more accessible and engaging (Khairullina & Prastowo, 2024).

Although numerous studies have examined Project-Based Learning and interactive media independently, research that conceptualizes both approaches as an integrated instructional strategy for enhancing student participation in mathematics learning remains limited. Existing studies often address PBL as a learning model and interactive media as instructional tools without explicitly exploring their synergistic potential. Conceptually, Project-Based Learning can be understood as a pedagogical framework that structures student-centered learning activities, while interactive media function as facilitators that strengthen cognitive and affective engagement throughout the learning process. Integrating these two approaches may therefore provide a more comprehensive strategy for fostering active student participation in mathematics learning.

Based on this gap, this article aims to qualitatively analyze the roles of Project-Based Learning and interactive media as instructional strategies for enhancing student participation in mathematics learning. Drawing on a synthesis of relevant national and international studies published within the last five years, this conceptual review seeks to provide a comprehensive understanding of how the integration of PBL and interactive media can support cognitive, affective, and social dimensions of student participation. The findings of this study contribute theoretically to the mathematics education literature by offering an integrative perspective on

participatory learning strategies and providing pedagogical insights for designing more engaging and meaningful mathematics learning environments.

2. METHOD

This study employed a qualitative literature-based approach with a descriptive–analytical orientation. The primary purpose of this approach was to synthesize and interpret existing scholarly evidence related to Project-Based Learning (PBL), interactive media, and student participation in mathematics learning. Rather than generating primary empirical data, the study focused on developing a conceptual understanding of how these instructional strategies function in enhancing student participation.

The data sources consisted of peer-reviewed national and international journal articles relevant to the topic of student participation, Project-Based Learning, interactive media, and mathematics learning. The study conducted literature searches using academic databases such as Google Scholar and other reputable education journal portals. To ensure the relevance and timeliness of the analysis, this study included articles published within the last five years. The selection criteria emphasized studies that explicitly discussed instructional strategies, student engagement or participation, and mathematics learning contexts. The study excluded articles that did not meet these criteria from the analysis.

The literature search process was conducted systematically in several stages. First, the study utilized relevant keywords, including student participation, Project-Based Learning, interactive media, and mathematics learning, to identify potential sources. Second, the researchers screened the retrieved articles by reviewing their titles and abstracts to assess relevance to the research focus. Third, the study conducted a full-text review to ensure that the selected articles provided substantive insights into the roles of Project-Based Learning and interactive media in promoting student participation. This screening process yielded a final set of articles that served as the analytical basis for the study.

The study analyzed the data using a content analysis approach by examining the selected articles to identify recurring themes, patterns, and conceptual relationships related to student participation and instructional strategies in mathematics learning. The analysis focused on extracting key concepts, pedagogical mechanisms, and reported outcomes associated with the use of Project-Based Learning and interactive media. The study then compared and synthesized these findings to develop an integrative conceptual understanding of how both approaches enhance student participation across cognitive, affective, and social dimensions.

To ensure the trustworthiness of the analysis, the study included only articles from reputable academic sources and examined conceptual consistency across studies to strengthen the credibility of the findings. In addition, the study employed multiple sources for analytical triangulation, thereby reducing potential bias and enhancing the validity of the conceptual synthesis.

Given its exclusive reliance on existing literature, the findings provide conceptual insights rather than empirical generalizations; however, the methodological approach offers a robust foundation for understanding the strategic integration of Project-Based Learning and interactive media, as well as for guiding future empirical research.

3. RESULT AND DISCUSSION

a. Result

Based on an in-depth qualitative synthesis of the reviewed literature, this study identified four significant integrative findings concerning student participation in mathematics learning and the strategic roles of Project-Based Learning (PBL) and interactive media. The study elaborates each finding to demonstrate conceptual depth and theoretical relevance.

1) Student Participation as a Multidimensional Construct in Mathematics Learning

The literature consistently conceptualizes student participation in mathematics learning as a multidimensional construct encompassing cognitive, affective, and social dimensions (Fredricks et al., 2004; Maamin et al., 2021). Cognitive participation refers to students' active engagement in reasoning, problem-solving, and conceptual understanding of mathematical ideas. Affective participation involves students' motivation, interest, and emotional responses toward learning tasks, while social participation reflects interaction, communication, and collaboration with peers and teachers during the learning process. This multidimensional perspective suggests that participation extends beyond observable behaviors and includes internal cognitive and emotional engagement.

Several studies indicate that low student participation in mathematics learning often results from instructional practices that emphasize abstract explanations and a teacher-centered approach to knowledge transmission (Rani et al., 2021; Subagyo et al., 2025). In such contexts, students tend to assume passive roles, limiting opportunities for meaningful interaction and reflective thinking. As a result, participation often becomes mere compliance rather than active engagement, which undermines conceptual understanding and learning motivation.

Conversely, learning environments that emphasize interaction, collaboration, and contextualized tasks are reported to foster higher levels of participation across cognitive, affective, and social dimensions (Maamin et al., 2021; Maghfiroh & Mahmudah, 2025). When students are encouraged to engage in discussion, explore multiple solution strategies, and communicate their reasoning, participation becomes a central mechanism for knowledge construction rather than a peripheral activity. These findings underscore the importance of viewing participation as a core pedagogical objective, rather than a secondary instructional outcome.

Taken together, the literature suggests that enhancing student participation in mathematics learning requires instructional strategies that intentionally address its multidimensional nature. Strategies that focus solely on cognitive engagement without considering emotional and social aspects may yield limited outcomes. Therefore, an integrative instructional approach is needed to support sustained and meaningful student participation.

2) Project-Based Learning as a Mechanism for Activating Student Participation

The synthesis of literature suggests that Project-Based Learning serves as a mechanism for engaging students in structured, student-centered learning experiences. PBL emphasizes authentic projects that require learners to engage in planning, inquiry, collaboration, and reflection, positioning students as active agents in the learning process (Anggraini & Wulandari, 2020; Blumenfeld et al., 1991). This approach contrasts sharply with traditional instructional models that prioritize content delivery over student engagement.

From a cognitive perspective, PBL enhances participation by engaging students in higher-order thinking and problem-solving activities that are embedded in meaningful contexts (Ramadhan & Hindun, 2023). Students are encouraged to analyze problems, apply mathematical concepts, and evaluate solutions, thereby fostering deeper conceptual understanding. Such engagement supports cognitive participation by requiring sustained attention and active reasoning throughout the learning process.

In addition to cognitive engagement, PBL promotes social participation through collaborative project work. The reviewed studies emphasize that group-based projects create opportunities for peer interaction, discussion, and shared responsibility for learning outcomes (Haluti et al., 2022). These collaborative processes encourage students to articulate their

thinking, negotiate meaning, and learn from one another, thereby strengthening social dimensions of participation.

Furthermore, PBL contributes to affective participation by enhancing students' motivation and sense of ownership over their Learning. Projects perceived as relevant and meaningful tend to enhance students' intrinsic motivation and emotional investment in learning activities (Blumenfeld et al., 1991). As a result, Project-Based Learning not only activates participation but also sustains it by aligning learning tasks with students' interests and real-world experiences.

3) Interactive Media as a Facilitator of Cognitive and Affective Engagement

Another significant finding from the literature concerns the strategic role of interactive media in facilitating student participation in mathematics learning. Interactive media, including digital applications, simulations, visual representations, and concrete manipulatives, enable students to interact directly with mathematical content, thereby supporting active engagement (Mayer, 2024; Rani et al., 2021). These media provide alternative pathways for understanding abstract concepts that may be difficult to grasp through verbal explanation alone.

From a cognitive standpoint, interactive media enhance participation by supporting visualization, exploration, and conceptual clarity. Mayer, (2024) multimedia learning theory suggests that well-designed interactive media reduce cognitive load and facilitate deeper processing of information. Studies reviewed in this analysis indicate that students are more likely to engage cognitively when they can manipulate objects, observe dynamic representations, and explore mathematical relationships through interactive tools (Asiya et al., 2024).

Regarding affective engagement, interactive media widely enhance students' interest, attention, and enjoyment in mathematics learning (Khairullina & Prastowo, 2024). The interactive nature of these media can transform learning experiences from passive reception into active exploration, which positively influences students' attitudes toward mathematics. Increased affective participation, in turn, supports sustained engagement and willingness to participate in learning activities.

Moreover, interactive media can lower affective barriers such as anxiety and lack of confidence, which often inhibit student participation in mathematics learning. By providing immediate feedback and opportunities for experimentation, interactive media create a supportive learning environment that encourages students to participate without fear of failure. These findings suggest that interactive media serve as facilitators that strengthen both cognitive and emotional dimensions of participation.

4) Integrating Project-Based Learning and Interactive Media as an Instructional Strategy

A central integrative finding of this study is that Project-Based Learning and interactive media are most effective when implemented as complementary instructional strategies rather than as isolated approaches. The literature indicates that PBL provides the pedagogical structure for student-centered Learning, while interactive media enhance the quality of engagement within that structure (Blumenfeld et al., 1991; Mayer, 2024). This integration creates a cohesive instructional strategy that supports active participation throughout the learning process.

Within this integrated framework, Project-Based Learning organizes mathematics learning around meaningful projects that require sustained participation, collaboration, and problem-solving. Interactive media, in turn, function as enabling tools that support students' cognitive processing and affective engagement during project activities. For example,

interactive visualizations and digital tools can help students explore mathematical concepts more deeply while working on projects, thereby enhancing both understanding and motivation.

The synthesis of studies suggests that integrating PBL and interactive media supports student participation across cognitive, affective, and social dimensions simultaneously (Khairullina & Prastowo, 2024). Problem-oriented project tasks and interactive exploration strengthen cognitive participation, while engaging and meaningful learning experiences enhance affective participation. Collaborative project work, supported by interactive tools, fosters social participation.

Overall, this integrative strategy highlights the importance of viewing instructional approaches as interconnected components within a broader pedagogical ecosystem. Rather than treating Project-Based Learning and interactive media as separate instructional choices, the literature suggests that their integration provides a more comprehensive and effective strategy for enhancing student participation in mathematics learning.

The expanded findings demonstrate that student participation in mathematics learning is a complex and multidimensional construct that requires intentional instructional design. Project-Based Learning activates participation through meaningful, collaborative, and problem-oriented learning structures, while interactive media facilitates cognitive and affective engagement by enhancing visualization, interaction, and motivation. When integrated, these strategies form a cohesive instructional approach that promotes active, sustained, and meaningful student participation across multiple dimensions of Learning.

b. Discussion

This discussion interprets the findings by situating them within existing theoretical perspectives and prior empirical research on student participation, Project-Based Learning, and interactive media in mathematics education. Rather than reiterating the results, this section critically examines how and why the identified strategies function to enhance student participation and what these findings contribute to the broader literature.

1) Student Participation as a Central Goal in Mathematics Learning

The finding that student participation is a multidimensional construct encompassing cognitive, affective, and social dimensions reinforces established engagement theories in educational research (Fredricks et al., 2004). In mathematics learning, participation extends beyond observable behaviors such as answering questions or completing tasks and reflects deeper cognitive involvement, emotional investment, and social interaction. This interpretation aligns with prior studies that emphasize the importance of meaningful mathematics learning, which occurs when students are actively engaged in reasoning, problem-solving, and communication processes (Maamin et al., 2021).

Compared to traditional teacher-centered approaches, which often prioritize procedural fluency and content coverage, participatory learning environments offer students more opportunities to collaboratively construct mathematical understanding (Rani et al., 2021). The present findings extend this perspective by highlighting participation as a strategic instructional outcome rather than a secondary by-product of teaching methods. This conceptualization shifts the focus of mathematics instruction from delivering content to designing learning experiences that actively involve students in the learning process.

Furthermore, the multidimensional view of participation helps explain why instructional interventions that address only one aspect of engagement often yield limited effects. For example, cognitively demanding tasks without affective support may overwhelm students, while motivational strategies without meaningful cognitive challenges may result in superficial

engagement. Therefore, participation represents an integrated construct that requires balanced instructional strategies.

2) Project-Based Learning and Its Pedagogical Mechanisms

The discussion of Project-Based Learning as a mechanism for activating student participation aligns with constructivist and socio-constructivist learning theories, which emphasize Learning as an active and socially mediated process (Blumenfeld et al., 1991; Khairullina & Prastowo, 2024; Saputra, 2022). By engaging students in authentic projects, PBL encourages them to take ownership of their Learning, collaborate with peers, and apply mathematical concepts to meaningful contexts. These features explain why PBL consistently promotes higher levels of cognitive and social engagement.

Compared with conventional instructional models, PBL offers a more participatory structure by embedding Learning within problem-oriented activities that require sustained engagement. Previous studies have reported similar findings, indicating that PBL supports higher-order thinking and collaborative Learning in mathematics classrooms (Haluti et al., 2022; Ramadhan & Hindun, 2023). The present study complements this literature by emphasizing participation as a central outcome of PBL rather than focusing solely on academic achievement.

However, the findings also suggest that PBL alone may not fully address affective barriers to participation, such as anxiety or lack of confidence in mathematics learning. Without appropriate instructional supports, some students may struggle to engage effectively in project-based activities. This limitation highlights the importance of integrating complementary strategies that can enhance students' emotional engagement and conceptual understanding during PBL implementation.

3) The Role of Interactive Media in Enhancing Engagement

The discussion of interactive media as facilitators of cognitive and affective engagement is consistent with multimedia learning theory, which posits that well-designed instructional media can support deeper understanding by integrating visual, verbal, and interactive elements (Mayer, 2009). Interactive media help bridge the gap between abstract mathematical concepts and students' concrete experiences, thereby supporting cognitive participation.

Comparatively, traditional instructional tools that rely heavily on static representations may limit students' opportunities to explore and manipulate mathematical ideas. In contrast, interactive media enable dynamic exploration, immediate feedback, and multiple representations, which have been shown to enhance students' motivation and interest in mathematics learning (Khairullina & Prastowo, 2024). These findings align with prior research demonstrating that interactive media can reduce cognitive load and increase affective engagement.

Importantly, interactive media also play a role in reducing affective barriers such as mathematics anxiety. By providing a supportive and exploratory learning environment, interactive media encourages students to participate without fear of making mistakes. This affective support is critical in mathematics learning, where negative emotions can significantly inhibit participation. Accordingly, interactive media extend beyond instructional aids and serve as strategic components that shape students' engagement.

4) Integrating Project-Based Learning and Interactive Media: A Strategic Perspective

A key contribution of this study lies in its integrative discussion of Project-Based Learning and interactive media as complementary instructional strategies. While previous studies have often examined these approaches independently, the present findings suggest that

their integration offers a more comprehensive strategy for enhancing student participation in mathematics learning. From a pedagogical standpoint, PBL provides the structural framework for participatory Learning, whereas interactive media enhance the quality and sustainability of engagement within that framework.

In comparison, instructional approaches that rely solely on PBL may struggle to support students' conceptual understanding and emotional engagement, particularly when the mathematical content is highly abstract. Similarly, the use of interactive media without a coherent pedagogical framework may result in fragmented or superficial engagement. Integrating PBL and interactive media addresses these limitations by combining structured, project-oriented Learning with interactive and supportive instructional tools.

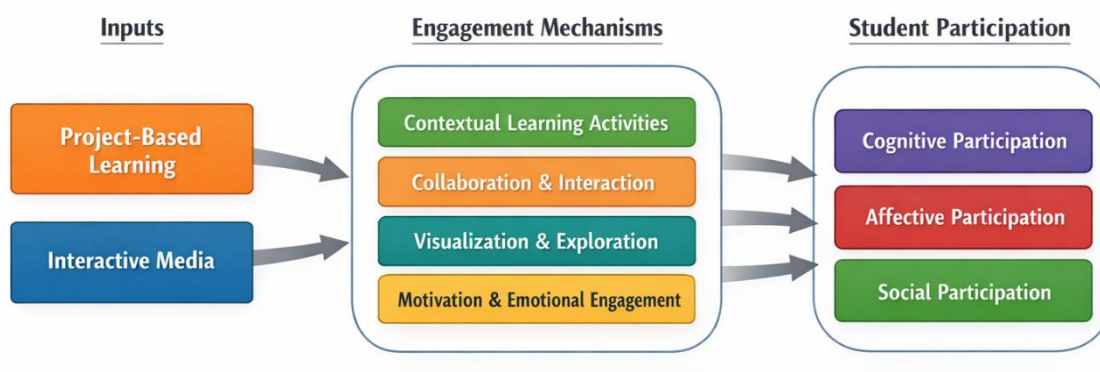


Figure 1. Conceptual Framework of Project-Based Learning and Interactive Media as Strategies for Enhancing Student Participation in Mathematics Learning

This integrative strategy supports participation across cognitive, affective, and social dimensions simultaneously. Problem-oriented projects and interactive exploration strengthen cognitive engagement, while meaningful and motivating Learning experiences enhance affective engagement. Collaborative project work, supported by interactive tools, fosters social engagement. From a theoretical perspective, this integration reflects a systems-oriented view of instruction, in which multiple pedagogical components interact to support meaningful Learning.

5) Implications for Theory and Research

The discussion of these findings contributes theoretically to the literature on mathematics education by reinforcing the importance of viewing participation as a central instructional objective. By conceptualizing Project-Based Learning and interactive media as integrated strategies, this study extends existing research that has often treated instructional models and media as separate entities. This integrative perspective offers a more comprehensive understanding of how instructional strategies can support student engagement and participation.

Furthermore, the findings underscore the need for future research to empirically investigate the proposed integrative strategy in various mathematics learning contexts. While this study provides a conceptual foundation, empirical studies are needed to explore how the integration of PBL and interactive media influences participation across different student populations and instructional settings. Such research could further refine the theoretical framework and inform evidence-based instructional design.

4. CONCLUSION

This study concludes that student participation in mathematics learning is a multidimensional construct encompassing cognitive, affective, and social dimensions that require deliberate instructional attention. The findings of this qualitative literature-based analysis indicate that Project-Based Learning and interactive media are most effective when conceptualized as complementary instructional strategies rather than isolated approaches. Project-Based Learning provides a pedagogical structure that promotes active, collaborative, and problem-oriented Learning, while interactive media function as enabling supports that enhance visualization, motivation, and emotional engagement. When integrated, these strategies activate key engagement mechanisms that foster meaningful and sustained student participation in mathematics learning.

From a theoretical perspective, this study contributes an integrative conceptual framework that clarifies how Project-Based Learning and interactive media interact to enhance student participation. By synthesizing existing literature, the framework advances understanding of participatory instructional design in mathematics education and highlights the importance of strategic integration between pedagogical approaches and learning media. Despite its reliance on secondary data, this study provides a foundation for future empirical research and offers conceptual guidance for educators and researchers in designing more participatory mathematics learning environments.

5. REFERENCES

- Anggraini, P. D., & Wulandari, S. S. (2020). Analisis Penggunaan Model Pembelajaran Project Based Learning Dalam Peningkatan Keaktifan Siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, 9(2), 292–299. <https://doi.org/10.26740/jpap.v9n2.p292-299>
- Asiya, S., Umam, K., Suhardi, A., & Arpilleda, A. J. (2024). Development and Utilization of Domino Card Media in Thematic Learning of Mathematics for Elementary School Students. *Al-Adzka: Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah*, 14(2), 176–188. <https://doi.org/10.18592/aladzkapgmi.v14i2.13951>
- Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, 26(3–4), 369–398. <https://doi.org/10.1080/00461520.1991.9653139>
- Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research*, 74(1), 59–109. <https://doi.org/10.3102/00346543074001059>
- Haluti, A., Uno, H. B., Abbas, N., Djakaria, I., Badu, S. Q., Arwildayanto, A., & Djafri, N. (2022). Implementation of Teacher-Made Mathematics Learning Media on Integer Counting Operations. *British Journal of Teacher Education and Pedagogy*, 1(2), 36–44. <https://doi.org/10.32996/bjtep.2022.1.2.4>
- Khairullina, A., & Prastowo, A. (2024). Implementation of ICT-Based Problem-Based Learning Model to Improve Higher Order Thinking Skills in IPAS Learning in Madrasah Ibtidaiyah. *Al-Adzka: Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah*, 14(2), 151–161. <https://doi.org/10.18592/aladzkapgmi.v14i2.13282>

- Maamin, M., Maat, S. M., & H. Iksan, Z. (2021). The Influence of Student Engagement on Mathematical Achievement among Secondary School Students. *Mathematics*, 10(1), 41. <https://doi.org/10.3390/math10010041>
- Maghfiroh, I. A., & Mahmudah, N. (2025). Teacher Professionalism in Primary Education: An Integrative Framework of Relational Practice, Professional Development, and Instructional Leadership. *Journal of Elementary Education Research and Practice*, 1(3), 157–166. <https://doi.org/10.70376/tp5ds084>
- Mayer, R. E. (2024). The Past, Present, and Future of the Cognitive Theory of Multimedia Learning. *Educational Psychology Review*, 36(1), 8. <https://doi.org/10.1007/s10648-023-09842-1>
- Ramadhan, E. H., & Hindun, H. (2023). Penerapan Model Pembelajaran Berbasis Proyek untuk Membantu Siswa Berpikir Kreatif. *Protasis: Jurnal Bahasa, Sastra, Budaya, Dan Pengajarannya*, 2(2), 43–54. <https://doi.org/10.55606/protasis.v2i2.98>
- Rani, P. R., Lestari, A., Mutmainah, F., Ishak, K. A., Delima, R., Siregar, P. S., & Marta, E. (2021). Pengaruh Metode PJBL Terhadap Hasil Belajar Matematika di Sekolah Dasar. *Journal for Lesson and Learning Studies*, 4(2), 264–270. <https://doi.org/10.23887/jlls.v4i2.34570>
- Saputra, H. (2022). Improving Mathematics Problem-Solving Ability With Problem-Based Learning in V Grade Students. *Al-Adzka: Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah*, 12(1), 28. <https://doi.org/10.18592/aladzkapgmi.v12i1.6401>
- Smith, K., Maynard, N., Berry, A., Stephenson, T., Spiteri, T., Corrigan, D., Mansfield, J., Ellerton, P., & Smith, T. (2022). Principles of Problem-Based Learning (PBL) in STEM Education: Using Expert Wisdom and Research to Frame Educational Practice. *Education Sciences*, 12(10), 728. <https://doi.org/10.3390/educsci12100728>
- Subagyo, R. A., Harsono, H., & Rahmawati, L. E. (2025). Pengaruh Partisipasi Pembelajaran Matematika terhadap Kemampuan Pemecahan Masalah Siswa Kelas Atas Sekolah Dasar. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 9(3), 711–721. <https://doi.org/10.31004/obsesi.v9i3.6945>