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Project-Based Learning Based on Mastery Learning to Improve Continuous Numeracy Literacy in High School Students: Literature Review

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ABSTRACT

The low numeracy literacy of high school students is an important challenge in 21st century education, especially in the implementation of the Independent Curriculum which emphasizes meaningful and sustainable learning. This study aims to explore the potential of integrating *Project Based Learning* (PjBL) and *Mastery Learning* as an innovative approach to improve students' numeracy literacy. The research was conducted through a narrative literature study by searching through articles from Google Scholar, Scopus, ERIC, and DOAJ databases. The inclusion criteria include articles published between 2013–2024, relevant to the topic, and in the form of scientific journals or accredited proceedings. The results of the study show that PjBL provides a contextual learning experience that improves the understanding of numerical concepts applicatively. Meanwhile, Mastery Learning ensures the completeness of each numeracy indicator through a gradual and evaluative approach. The integration of these two approaches creates active, structured, and adaptive learning to students' learning needs. The implications of these findings show that an integrative approach can support the transformation of numeracy learning in the context of the Independent Curriculum. The study also recommends the development of teaching tools and teacher training to effectively implement integrative models. In conclusion, the integration of PjBL and Mastery Learning is a promising strategy in improving numeracy literacy in a sustainable manner at the secondary education level. This finding provides a significant scientific contribution by offering an integrative approach between Project Based Learning and Mastery Learning as a numeracy learning model that has not been systematically explored in the context of the Independent Curriculum, thus opening up new space for more contextual, structured, and sustainable pedagogical innovation at the secondary education level.

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1. INTRODUCTION

In the 21st century learning era, numeracy literacy skills are a basic competency that is not only important in mathematics lessons, but also in daily life. Numeracy literacy includes the ability to understand, interpret, and use number-based information in a variety of contexts. This is important because learners are faced with the realities of life full of data, graphs, and quantitative problems that require a functional mathematical understanding. Numeracy literacy is part of quantitative literacy, which means the ability to use mathematics effectively in daily life (Masood & Hoda, 2014). In addition, according to Adams (2020) Numeracy literacy allows students to become critical citizens and be able to make data-driven decisions. Therefore, this ability is a major target in modern learning that emphasizes high-level thinking skills. In the global context, numeracy literacy is also an indicator of the quality of a nation's education through international assessments such as PISA. Developed countries continue to strengthen curricula that emphasize numeracy literacy as the foundation of scientific and logical thinking. Therefore, 21st century education requires the integration of learning approaches that are able to grow these abilities in depth and sustainably.

In line with these developments, the Independent Curriculum in Indonesia places numeracy literacy as one of the main focuses of cross-disciplinary learning. This curriculum is designed to provide space for students to develop numeracy competencies through contextual, meaningful, and student-centered learning. The government through the National Assessment policy also emphasizes the importance of mastering numeracy literacy as the main indicator of education quality. This shows that learning is not enough to emphasize memorization of formulas, but needs to be directed at understanding concepts and applying them in real-life situations. Learning will be more effective if it is associated with social context and meaningful activities that are in accordance with the student's zone of proximal development (Cooper & Lavie, 2021). Meaningful learning can be achieved through an approach that allows students to build their own knowledge through exploration and interaction (Bers et al., 2014). Therefore, numeracy literacy is not only a learning goal, but also a foundation for building a sustainable scientific way of thinking. In the Independent Curriculum, a project-centered approach and learning completeness are highly recommended to accommodate these needs. Learning strategies are needed that are able to answer these challenges, one of which is the integration of Project Based Learning based on Mastery Learning (Saad & and Zainudin, 2024).

The problem of low numeracy literacy among high school students is a serious challenge in the world of Indonesian education. The results of international surveys such as PISA (Programme for International Student Assessment) consistently show that the numeracy ability of Indonesian students is below the OECD average. Many students have difficulty understanding basic math concepts and applying them in real-life contexts. This shows that mathematics learning in schools is still procedural and lacks emphasis on conceptual understanding and application. Numeracy literacy is not just a matter of arithmetic, but includes mathematical reasoning, communication, and problem-solving (Masood & Hoda, 2014). This low ability can also be attributed to a learning approach that still focuses on teachers and lacks context. In addition, students are often not given the opportunity to explore real issues that are challenging and relevant to their lives. This leads to a lack of interest, motivation, and meaningful connections between the subject matter and the real world. Therefore, changes in learning strategies are needed that are able to build numeracy literacy in a more contextual and in-depth manner.

At the national level, the results of the National Assessment also show that the majority of high school students have not reached an adequate level of numeracy competence. Many students are unable to interpret data, read graphs, or solve problems based on mathematical logic. In fact, this ability is very important for rational decision-making in today's information age. Individuals who do not have numeracy skills will experience obstacles in personal, work, and civic life (Huang et al., 2017). Low numeracy literacy has an impact on low productive participation in a society that is increasingly data- and technology-based (Braun & Huwer, 2022). In the context of high school, low numeracy literacy is also an indicator that learning has not been able to achieve educational goals optimally. The disparity between students' cognitive achievement and the demands of the curriculum indicates the need for evaluation of the learning methods used. In addition, this problem is also related to the lack of personalization of learning according to the needs and abilities of students. Therefore, it is necessary to apply an approach that emphasizes active student involvement, learning completeness, and connection with the real world, in order to build sustainable numeracy literacy.

One of the innovative approaches that has great potential in improving the quality of learning is *Project Based Learning* (PjBL). PjBL encourages students to learn through in-depth investigation of real issues or challenges relevant to their lives. This model places students as active subjects in the learning process, thus encouraging them to think critically, creatively, and collaboratively. An authentic and complex project-based learning approach, which results in real products and provides meaningful learning experiences (Conde et al., 2020). Through the project, students learn to integrate various concepts, especially in the context of numeracy that requires cross-topic understanding and practical application. In addition, this approach is able to increase student motivation because they find learning more relevant and engaging. In the context of numeracy literacy, PjBL helps students relate mathematical concepts to real situations such as financial management, planning, and data analysis. This is crucial in shaping 21st-century skills that rely not only on memorizing formulas, but also on the ability to apply them contextually. Therefore, PjBL is considered effective in building sustainable numeracy literacy.

On the other hand, *Mastery Learning* also offers extraordinary potential in ensuring students' completeness of the targeted competencies. This approach emphasizes that each student has the opportunity to achieve full mastery of a material, with a learning pace tailored to their needs. With the principle that all students can learn well if given the right time and assistance. *Mastery Learning* creates a space for more equitable and personalized learning. *Mastery Learning* can significantly improve learning outcomes because it allows students not to move on to the next material before actually understanding the previous material (Aurelia & Prasetya, 2023). *Mastery Learning* not only improves cognitive outcomes, but also builds students' confidence and positive perception of learning (Bao & Hosseini, 2021). When combined with PjBL, this approach can provide a strong structure in ensuring that each student is not only involved in the project, but also truly understands the concepts contained in it. In the context of numeracy literacy, Mastery Learning ensures that students master basic numeracy skills before solving complex problems in projects. The combination of these two approaches opens up opportunities to create an active, contextual, and adaptive learning process to the needs of students. Therefore, the integration of PjBL and Mastery Learning is a potential strategy to overcome low numeracy literacy and create transformative learning at the high school level.

Literature review has an important role in strengthening the theoretical and practical basis for the implementation of a learning approach, including the integration between *Project Based Learning* (PjBL) and *Mastery Learning*. Both are approaches that have been proven individually to improve the quality of learning, but their integration has not been extensively studied in depth in the context of numeracy literacy. A literature study is needed to identify how the combination of these two approaches can complement each other, especially in improving student engagement and learning completeness. A good literature review is not just about collecting references, but also compiling an intellectual map that shows trends, gaps, and new directions in research (Lyon & Magana, 2020). Meanwhile Pattaro (2016) emphasizes that a systematic review of the literature can build a solid conceptual foundation for the development of more innovative learning strategies. In this case, the integration of PjBL and

Mastery Learning requires a comprehensive understanding of the syntax, objectives, and learning outcomes from various perspectives. Literature studies can also uncover implementation constraints, evaluation approaches, and best practices from previous research. Thus, this study not only serves as a theoretical foundation, but also as a practical reference for educators and researchers in designing relevant learning models. Therefore, efforts to integrate PjBL and Mastery Learning need to begin with a strong and systematic literature review.

Furthermore, examining the integration of PjBL and Mastery Learning through literature study can bridge the gap between theory and practice in the world of education. Many teachers have applied these two approaches separately, but not many have understood their synergistic potential within one integrated learning framework. By tracing the results of previous research, we can understand how this integration affects the achievement of numeracy literacy, especially in high school students. In addition, the literature study allows for the identification of key elements that must be considered in designing project-based learning while maintaining the completeness of the material. A comprehensive literature review helps readers understand the complexity of an issue and presents new insights for scientific development (Curasma et al., 2021). While Education et al. (2018) states that *integrative literature review* can produce new models or frameworks that are more relevant to contemporary learning challenges. In this context, the combination of 21st century skills-oriented PjBL with Mastery Learning that focuses on mastering basic concepts can form a holistic learning model. Therefore, a structured literature study can be the basis for the development of new learning models or frameworks that are more adaptive and applicative. This is very important to strengthen the strategy of increasing numeracy literacy in a sustainable manner in the context of the Independent Curriculum in Indonesia.

Although many studies have proven the effectiveness of *Project Based Learning* in improving 21st-century skills, such as collaboration, creativity, and problem-solving, few have specifically linked it to the continuous improvement of numeracy literacy. Existing research generally focuses on affective and motivational aspects, not on the completeness of a deep understanding of numerical concepts. On the other hand, *Mastery Learning* is known to be able to ensure complete mastery of the material by students, but tends to be less associated with meaningful and applicable learning contexts such as in PjBL. In other words, these approaches are often studied separately, rather than as an integrated model that complements each other. According to Furi et al., (2018) The integration between project-oriented and completion-based learning approaches can result in more optimal learning outcomes. However, research that tests such integration, especially in the context of numeracy literacy of high school students in Indonesia, is still very limited. In addition, there have not been many studies that discuss how these two approaches can be applied synergistically within the framework of the Independent Curriculum. In fact, the combination of the two has the potential to strengthen conceptual understanding as well as critical thinking skills in real contexts. Therefore, it is necessary to explore the literature that examines in depth the integration of PjBL and Mastery Learning in an effort to answer the challenge of low numeracy literacy of students.

In addition to the limited number of studies that integrate PjBL and Mastery Learning, there is still a gap in terms of developing a systematic conceptual and operational framework in its implementation. Most studies only emphasize the final outcome, without comprehensively examining the learning process, from project planning, formative assessment, to remediation strategies in Mastery Learning. The effectiveness of learning is influenced by instructional design that pays attention to the sequence of learning stages and the significance of the learning assignment (Creswell, 2012). Meanwhile, Rivera & Becker (2008) emphasizing the importance of *constructive alignment*, which is the alignment between objectives, learning activities, and evaluation in creating effective learning. Unfortunately, this gap is rarely discussed in the existing literature, resulting in a lack of reference for teachers in implementing the integrated learning model appropriately. In addition, there has not been a literature study that specifically examines this integrative model for the purpose of improving numeracy literacy in a sustainable manner, not just a momentary improvement. This indicates the need for a literature review that compiles concept maps, implementation strategies, and indicators of success from the merger of the two approaches. By identifying these gaps, literature research can contribute to the development of

learning models that are responsive to the challenges of numeracy learning in secondary schools. Therefore, this research is directed to fill this gap while enriching theoretical and practical insights in the field of numeracy learning innovation.

This research offers novelty through the integration of two complementary learning approaches, namely *Project Based Learning* and *Mastery Learning*, in the context of continuous improvement of numeracy literacy in high school students. Most previous studies have only examined the effectiveness of each approach separately, without examining the synergies between the two in a single integrated learning model. The novelty of this research lies in the design of a conceptual framework that combines the advantages of PjBL that is oriented to the real-world context with Mastery Learning that focuses on learning completeness. According to Abrami et al. (2008) Effective learning occurs when students engage in authentic tasks and are provided with appropriate support until they master the targeted skills. Moreover Adler & Kim (2017) emphasizes that gradual and systematic mastery is necessary to form deep and continuous learning. By combining these two approaches, students not only actively build knowledge through projects, but also ensure that they master the concepts of numeracy thoroughly before moving on to the next stage. This integrative model has not been studied specifically, especially in the context of numeracy literacy and its implementation in the Independent Curriculum. Therefore, this research contributes to the development of numeracy-based learning theory and practice in a more contextual and adaptive manner. This novelty also paves the way for teachers to develop innovative learning models based on real needs in the classroom.

Another novelty of this research is the focus on sustainable development of numeracy literacy, not just short-term improvement or academic results. The PjBL-Mastery Learning approach is designed not only to improve momentary achievements, but also to form logical, critical, and reflective thinking habits in the long run. This is in line with a transformative educational approach that emphasizes the development of long-term competencies and the sustainability of lifelong learning. Meaningful learning must involve critical reflection and transformation of students' perspectives on the material and themselves (Anderson, 2016). Continuous learning occurs when students have a deep understanding that can be applied in a variety of situations. This research offers a framework that allows such processes to occur through the integration of real projects and thorough learning. Thus, this research not only provides a solution to low numeracy literacy, but also provides a new direction in the development of a more holistic learning model. This novelty is expected to enrich the educational literature and become a strategic reference for teachers, curriculum developers, and education researchers. Thus, this research occupies an important position in efforts to answer the challenges of 21st century education in an innovative and evidence-based manner.

Various previous studies have shown that *the Project Based Learning* (PjBL) approach is effective in improving students' 21st century skills, including in the aspect of numeracy. For example, research by Setiani & Rochmiyati (2025) shows that PjBL can improve understanding of mathematical concepts and problem-solving abilities through students' active involvement in real projects. The implementation of PjBL in mathematics subjects has a positive impact on students' motivation and learning independence. Where meaningful learning occurs through social interaction and contextual experiences. Meanwhile, it emphasizes the importance of concrete experiences in building students' cognitive structures. However, although many research results show the effectiveness of PjBL, most have not explicitly measured the completeness of mastery of concepts or integrated remedial strategies for students who are left behind. This is a weakness that can be covered through a more systematic *Mastery Learning* approach in ensuring that all students achieve mastery of the material. Therefore, further study is needed on the potential integration of these two complementary approaches. Literature studies are important to analyze how the results of previous research can be summarized and developed into a more comprehensive numeracy learning model.

On the other hand, research on *Mastery Learning* also shows a significant impact on the achievement of learning outcomes, especially in improving mastery of basic mathematics materials. Research by Adolphus (2011) states that *Mastery Learning* enables all students to succeed in learning if given the appropriate time and assistance. This strategy is able to reduce the achievement gap between

students, especially in mathematics subjects that require gradual understanding. It is this approach that emphasizes positive reinforcement and gradual training to achieve mastery. Learning theory Aziz et al. (2018) It also supports the idea that effective learning should follow a clear and systematic hierarchy of goals. However, studies on *Mastery Learning* are generally classical and lack the context of problem-based learning or real projects. This is an opportunity to expand the effectiveness of *Mastery Learning* through integration with PjBL that is more contextual and applicative. To date, few studies have examined the synergy between the two approaches, especially in the context of sustainable numeracy literacy in high school students. Therefore, it is important to compile a literature study that reconstructs previous findings and addresses gaps in the development of holistic and innovative numeracy learning models.

The integration of Project Based Learning (PjBL) and Mastery Learning in the context of improving numeracy literacy is a relatively new topic and has not been explored in depth in educational studies, especially at the secondary school level. Most studies so far have only focused on the effectiveness of each approach separately—PjBL in the context of meaningful and context-based learning, and Mastery Learning in ensuring complete mastery of the material. In fact, when these two approaches are combined, there is great potential for synergy: PjBL can encourage active involvement and the development of 21st-century skills, while Mastery Learning ensures that each student masters numeracy concepts before moving on to more complex project stages. However, this integration is still minimally discussed in the literature, both in terms of implementation design, learning syntax, and empirical studies of its effectiveness in the context of national curricula such as the Merdeka Curriculum in Indonesia.

In addition, the strength of this article lies in its focus on the development of sustainable numeracy literacy, not just temporary improvements that are often sporadic or responsive to momentary assessments. The emphasis on reflective, logical, and critical thinking habits in the long term is in line with the principles of transformative education. However, this article is still at the conceptual level; there has been no empirical trial or development of a concrete model that has been tested for its effectiveness in the field. This is a gap as well as a great opportunity for further research, especially through a design-based research or research and development approach that is able to produce tested learning products. Thus, this article provides a strong theoretical foundation, but still requires continuation in the form of empirical validation to truly realize its practical contribution in improving student numeracy sustainably.

This study aims to examine the integration of *Project Based Learning* and *Mastery Learning* in improving sustainable numeracy literacy in high school students through literature studies. This integration is expected to be able to combine the advantages of contextual project-based learning with a systematic approach to learning completion. The main objective of this research is to build a conceptual framework for numeracy learning that is relevant to the Independent Curriculum and the needs of the 21st century. Learning strategies should be designed to ensure thorough mastery of the material. Meanwhile, Almarzuqi & Mat (2024) states that effective learning should be oriented towards the development of higher-level thinking. The contribution of this research lies in the synthesis of innovative learning theories and practices that can be used as a reference for teachers and researchers. The results of the study are expected to provide direction in the development of adaptive and applicable numeracy teaching tools. This research also contributes to answering the literature gap related to the integration of the two approaches in the context of mathematics education. Thus, this research is strategic both from a theoretical and practical perspective.

2. METHODS

This study uses a *narrative literature review* approach to present a comprehensive understanding related to the integration of PjBL and Mastery Learning. This approach was chosen because of its flexibility in synthesizing findings without strict protocol restrictions. Literature reviews are conducted systematically through Google Scholar, Scopus, ERIC, and DOAJ databases. The article search process uses the keywords "Project Based Learning", "Mastery Learning", "numeracy literacy", "SMA", and

"sustainable learning". Theories put forward Kratochvíl (2017) emphasizes the importance of a bibliographic structure that connects key concepts in the literature review. In addition, it underscores the importance of intellectual maps to identify research trends and gaps. The search began in August 2024 and was completed in March 2025 to ensure the coverage of the latest literature. All articles found are organized and recorded in a search table for easy tracking. The clarity of this search process is maintained so that the research has high transparency and replication.

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Cruz Castro et al. (2021) About Literature Selection in Systematic Studies. Inclusion-exclusion criteria should be established before the main search. Out of approximately 135 initial articles, 62 articles were selected based on relevant abstracts. The next stage involves reading the full text to filter down to 41 main articles. Each article that passed was analyzed and data was taken according to the criteria. The final number of articles reflects the balance between broad coverage and depth of analysis.

The analysis technique used in this study is thematic analysis. Thematic analysis allows researchers to identify and categorize the main themes of each article. According to Anwar et al. (2022) Thematic analysis is effective for exploring patterns of meaning in qualitative data. Moreover Isti'ana (2024) stated that the integration of critical methods strengthens the validity of findings in the literature review. The findings are categorized into three main themes: the effectiveness of the model, implementation strategies, and the impact on numeracy literacy. Each theme is described narratively based on the synthesis of the findings of various studies. An article selection flow chart is included to provide a visualization of the filtering process. The results of the analysis are then synthesized in the form of a comprehensive thematic summary. This approach ensures that the recommendations of the PjBL-Mastery Learning model are based on strong empirical evidence.

3. FINDINGS AND DISCUSSION

Findings

a. Sustainable Numeracy Literacy in High School Students

Numeracy literacy is an individual's ability to understand, use, and interpret numbers and mathematical data in various life contexts. Within the framework *PISA* defines numeracy literacy as the capacity to formulate, apply, and interpret mathematics in a variety of situations. This includes mathematical reasoning and the use of mathematical concepts, procedures, facts, and tools to explain and predict phenomena. Numeracy literacy is not limited to numeracy skills, but it also includes an understanding of data-based information, graphs, and other visual representations. Numeracy literacy is an essential part of the literacy of modern society to participate in social, economic, and political life (Annas et al., 2024). In the context of education, this ability is essential to equip students to think logically and make informed decisions. Therefore, numeracy literacy is one of the main competencies in the Independent Curriculum. A strong understanding of the definition of numeracy literacy is the basis for designing relevant and meaningful learning.

The numeracy literacy indicator refers to the aspects of ability that students must have in using mathematics functionally. Indicators of numeracy literacy include the ability to calculate, understand number concepts, apply mathematical operations, and interpret data and information in the form of tables or graphs. Meanwhile, the OECD through PISA identifies three levels of numeracy ability: reproduction (using basic concepts), connection (connecting between concepts), and reflection (solving new problems with creativity). These indicators also include skills in contextual problem-solving,

mathematical reasoning, and communicating quantitatively. According to Khan et al. (2017) Students must be able to develop mathematical communication, reasoning, problem-solving, and interconnectedness and representation skills. With this indicator, teachers can comprehensively assess not only the results of the calculation, but also the students' thinking process. Understanding these indicators is important as a basis for evaluating and developing learning interventions. Therefore, numeracy literacy must be measured holistically and contextually, not just from written test results.

Sustainable numeracy literacy refers to consistent, progressive, and integrated learning efforts to grow students' numeracy skills in the long term. This approach emphasizes that the development of numeracy cannot be achieved in just one phase of learning, but needs to be built gradually and systematically. Continuous learning is a process that emphasizes formative assessment, feedback, and reflective learning (Aurelia & Prasetya, 2023). In the context of the Independent Curriculum, continuous numeracy literacy is integrated into various subjects and learning projects. This is in line with *the Project Based Learning* approach that facilitates the application of mathematical concepts in real life in a sustainable manner. In addition, *the principle of Mastery Learning* also supports gradual numeracy learning and accommodates individual needs. Students need to achieve full mastery before moving on to the next material to ensure continuity of understanding. Therefore, a learning model that combines PjBL and Mastery Learning has great potential in supporting sustainable numeracy literacy.

Improving numeracy literacy at the high school level faces a number of complex challenges, both from the aspects of students, teachers, and curriculum. One of the main challenges is the low motivation and confidence of students in understanding mathematical concepts. In addition, there are still many teachers who have not fully adopted the contextual and project-based learning approach. Limited resources, such as learning media and teacher training, are also significant obstacles. Teacher quality and teaching strategies have the greatest influence on the achievement of student learning outcomes (Saipon & Sumantri, 2023). The dense curriculum and exam pressure also make teachers more focused on cognitive achievement than conceptual comprehension and numeracy applications. In addition, the lack of a reflective culture in the learning process hinders students' ability to relate mathematics to everyday life. Socio-economic factors and an unsupportive learning environment also exacerbate inequality in numeracy literacy. Therefore, innovative learning strategies and continuous support systems are needed to address these challenges.

Although the challenges are great, there are many opportunities to improve the numeracy literacy of high school students through learning innovations and progressive education policies. The *Project Based Learning approach* provides space for students to develop their understanding of numeracy through relevant contextual projects. On the other hand, *Mastery Learning* ensures that each student achieves mastery before going further. When students are given enough time and help, almost all can achieve mastery of concepts (Afamasaga-Fuata'i, 2008). The government through the Independent Curriculum also encourages the integration of cross-disciplinary numeracy as part of the Pancasila student profile. In addition, the development of digital technology can be used to present data, mathematical visualizations, and simulations that make it easier to understand numeracy. Collaboration between teachers is also a great opportunity to share strategies and best practices in teaching numeracy. Increasing teacher capacity through practice-based training is a key factor in the success of numeracy learning. By strategically utilizing these opportunities, students' numeracy literacy can be significantly and sustainably improved.

b. Model Project Based Learning (PjBL)

Project Based Learning (PjBL) is a student-centered learning approach through active involvement in real and meaningful projects. PjBL is a learning model that uses projects as the core of the learning process to achieve deep understanding (Setiani & Rochmiyati, 2025). The main characteristics of PjBL include the existence of real problems, active student involvement, real product results, and the existence of a reflection process. In PjBL, students are encouraged to design, research, analyze, and present solutions to problems related to daily life. This is in line with constructivist theory which emphasizes that effective learning occurs through social interaction and contextual engagement (Deen

& Smith, 2006). PjBL emphasizes independent learning, collaboration, and cross-disciplinary use of knowledge. Learning becomes more meaningful because students are involved in the process of building their own knowledge. Therefore, PjBL is one of the most suitable approaches in improving 21st century skills, including numeracy literacy.

The application of PjBL in mathematics learning requires systematic stages or syntax so that learning goals are optimally achieved. According to Sholihah & Afriansyah (2017) The general stages in PjBL include: (1) determining basic questions, (2) project planning, (3) preparing schedules, (4) monitoring project progress, (5) assessing results, and (6) evaluating learning experiences. In the context of math learning, basic questions should be designed to bring out critical thinking and numerical problem-solving skills. Projects can be contextual problem solving, data analysis, or product creation based on mathematical calculations. Teachers play the role of facilitators who guide the students' exploration process. A learning structure like this is able to increase student motivation and learning achievement (Apriandi, 2012). This syntax also facilitates the natural integration of numeracy concepts in real problem solving. With a clear and flexible structure, PjBL is an effective strategy in literacy-based mathematics learning.

Various studies show that PjBL contributes positively to strengthening students' numeracy literacy. This model allows students to understand numeracy concepts through concrete and applicative learning experiences. PjBL encourages higher cognitive engagement and provides real context for math mastery (Da Costa et al., 2014). Numeracy literacy not only develops from the ability to calculate, but also from the ability to think logically and interpret data. PjBL provides a space for students to explore numbers, tables, graphs, and data-driven situations directly. In addition, this approach hones mathematical communication skills as students are asked to explain and account for their solutions. Research results by Apiati et al. (2024) concludes that students who study with PjBL show significant improvements in their understanding of mathematical concepts and their application in real life. Therefore, PjBL is considered effective in forming functional and sustainable numeracy competencies. The impact is not only on cognitive aspects, but also affective aspects such as attitudes towards mathematics.

A number of national and international studies have proven the effectiveness of PjBL in mathematics learning at the high school level. High school students who participate in project-based learning show improved high-level thinking skills, including numeracy literacy. In Indonesia, the application of PjBL in mathematics improves the learning outcomes and critical thinking skills of high school students. The effectiveness of PjBL is also strengthened by findings from Aksu & Koruklu (2015) which reveals that PjBL can significantly increase students' interest and understanding of mathematical concepts. One of the strengths of this approach is its ability to build connections between math material and students' real lives. In the context of the Independent Curriculum, this model is in line with the principle of differentiated learning and the formation of Pancasila student profiles. According to Reju & Jita (2018) Active involvement in projects makes students feel like they have a meaningful learning experience. These studies confirm that PjBL is a viable and effective strategy to implement in high school. This empirical support is an important foundation in the development of innovative learning models based on numeracy literacy.

Based on the literature study conducted, the integration of PjBL in mathematics learning provides many benefits for improving the quality of learning in schools. Teachers need to adopt the role of facilitators who guide students to explore mathematical ideas in the context of real projects. This is in line with the opinion Ahmad et al. (2008) which states that teachers play the role of cognitive companions in PjBL. High school students will be more motivated when they see the direct relevance between mathematics and daily life. However, the implementation of PjBL also requires effective time planning and classroom management. According to Jang et al. (2020) Authentic learning experiences build meaning and reinforce long-term understanding. Therefore, schools need to provide support both in the form of teacher training and curriculum flexibility. With consistent implementation, PjBL can be a strategic means to strengthen numeracy literacy and form students who are ready to face the

challenges of the 21st century. Strengthening this practice also opens up opportunities to develop more collaborative, contextual, and meaningful learning models.

c. Strategi Mastery Learning

Mastery Learning is a learning approach that emphasizes achieving full mastery of basic competencies before students move on to the next material. All students can achieve high learning outcomes if given enough time and assistance. The main principle in Mastery Learning is individualized learning, with an adjusted learning pace. This learning is designed systematically with stages of material delivery, formative assessment, and remedies. Nurtanto & Sofyan (2015) adding that this approach is effective in improving learning outcomes because it provides continuous feedback. Another principle is the emphasis on achieving learning objectives, not on comparisons between students. This model also supports differentiated learning that suits the needs and potential of students. With these principles, Mastery Learning provides a strong foundation in improving the quality of learning, especially in subjects such as mathematics that demand completeness of concepts.

In the context of numeracy literacy, Mastery Learning is particularly relevant because it emphasizes mastering basic concepts before moving into higher-level thinking skills. Numeracy requires a deep understanding of numbers, mathematical operations, and application in real-life contexts. Through formative assessments and structured remediation, students can correct conceptual errors early. A model that provides opportunities for students with low abilities to systematically catch up (Vioreza et al., 2023). In practice, teachers use diagnostic questions to identify students' initial understanding and provide interventions as needed. This approach also encourages students' self-reflection on their numeracy learning progress. Teaching strategies that focus on completeness increase the effectiveness of knowledge transfer to a real context. Therefore, Mastery Learning can be used as a sustainable and meaningful numeracy learning framework.

One of the main advantages of Mastery Learning is its ability to guarantee the completeness of each basic competency before moving on to new material. This is very important in mathematics learning which is hierarchical and interconnected between topics. With the completeness of basic concepts, students are better prepared to face numeracy challenges at a higher level. The difference in student learning outcomes is more influenced by the available learning time than by the innate ability (Cavey & Berenson, 2005). Mastery Learning provides additional time for students who require repetition and deeper understanding. Additionally, this approach reduces academic anxiety because students are given the opportunity to correct mistakes without penalty. The evaluation system in Mastery Learning focuses more on learning than mere assessment. Thus, this approach provides quality assurance of learning outcomes through a complete understanding, not just procedural mastery.

Various studies show that Mastery Learning is effective in improving the learning outcomes of middle school students, including in the context of numeracy. Provides a significant improvement in academic achievement in various subjects, especially mathematics. In Indonesia Anderson (2016) found that the application of Mastery Learning in high school increased learning completeness by up to 85% in algebraic topics. An approach that encourages learning independence and improves student motivation. These studies reinforce the evidence that the provision of appropriate additional and remedial learning time can lead to more even outcomes. In addition, this approach is very suitable to be applied in classrooms with a diversity of students' abilities. Mastery Learning helps create a more equitable and inclusive education system (Suhendro & Syaefudin, 2020). Therefore, its implementation at the intermediate level is very relevant to improve the quality of competency-based learning.

d. Integration of PjBL and Mastery Learning

The integration between Project Based Learning (PjBL) and Mastery Learning in learning has been widely discussed in the literature as a holistic approach that encourages active engagement and the achievement of learning completeness. This integrative model generally compiles the PjBL syntax flexibly while maintaining the principle of completeness from Mastery Learning. PjBL can be

strengthened through formative and remedial evaluation elements which are the core of Mastery Learning. One of the models developed is the "PjBL-Mastery Cycle", where each project ends with a thorough evaluation and reflection. Strengthening core competencies before proceeding with the next project to ensure long-term success. The literature also shows that this integration can be adapted to the context of the classroom and subjects, especially mathematics. Models like this provide a structure for students to build understanding progressively through project-based activities. With this integrative approach, learning becomes more adaptive, meaningful, and measurable.

Theoretical support for the integration of PjBL and Mastery Learning can be found in constructivism theory and differential learning theory. Learning is most effective when students are in the zone of proximal development, which can be achieved through guided contextual projects and structured interventions. This theory underlies the importance of a combination of authentic activities (PjBL) and appropriate learning aids (Mastery Learning). Gradual mastery is necessary to form a permanent learning response. This integration emphasizes the importance of meaningful, individual, and participatory learning. By combining open exploration and thoroughness monitoring, students get a rich and immersive learning experience. This approach allows teachers to design learning that is not only active but also well-structured. Therefore, these theories are an important foundation in the development of integrative learning models oriented towards numeracy literacy.

The integration of PjBL and Mastery Learning in numeracy learning provides several significant advantages. PjBL allows students to apply mathematical concepts in a real context, while Mastery Learning guarantees that each concept is understood completely. A combination of active strategies and differential approaches like this can improve the effectiveness of overall learning (Umar et al., 2023). Another advantage is the increased motivation of students because they feel they have succeeded in mastering the material gradually and relevantly. This is very important in numeracy learning which requires logical and applicative understanding. This integration also encourages a more personalized approach to learning, allowing students to learn at their own pace. An effective approach to encourage mathematical problem-solving and improve students' resilience in the face of learning difficulties. Thus, this integration supports the development of sustainable and in-depth numeracy literacy.

Several empirical studies have shown positive results from the application of the integration of PjBL and Mastery Learning in the context of mathematics learning. This integrative model increases students' average numeracy scores by 20% compared to conventional models (Braniwati, 2025). Students who learn with an integrative approach show improved critical thinking skills and conceptual understanding of mathematics. This integration helps to lower the failure rate of students in understanding the concepts of fractions and algebra. In the study, the evaluation and remedial cycles after the project made students more aware of their weaknesses and progress. The synergy of these two approaches creates a learning environment conducive to all ability levels. The findings suggest that this integrative application is relevant and effective, especially in high schools with higher levels of material complexity. Therefore, this integrative approach is worthy of being used as a strategic alternative to strengthen numeracy learning.

Although the Project Based Learning (PjBL) and Mastery Learning approaches have great potential in improving numeracy literacy, both are not free from implementation and pedagogical limitations. PjBL, for example, tends to require more time and resources, which are often difficult to meet in schools with limited facilities and teacher training. The flexible nature of PjBL can also cause ambiguity in achieving competencies if not balanced with structured supervision and evaluation. On the other hand, Mastery Learning, although it guarantees learning completion, is prone to causing stagnation in learning groups due to differences in speed between students, and risks ignoring aspects of creativity and exploration that are important in context-based numeracy learning. The integration of the two approaches also faces conceptual challenges, especially in aligning the open nature of PjBL with the tiered structure of Mastery Learning that demands sequence and completion. Without a clear mechanism, this integrative model has the potential to be inconsistent in practice.

Regarding the measurement of numeracy literacy success, this article has not provided a synthesis of operational indicators that can be measured quantitatively or qualitatively. Although the levels of

reproduction, connection, and reflection of PISA and indicators such as numeracy, understanding concepts, and interpreting data are mentioned, it is not explained how these indicators are converted into valid and reliable assessment instruments. Without structured measurement standards, it is difficult to compare the effectiveness of approaches or to map students' numeracy achievements longitudinally. The implication for the development of science is the urgent need to develop a holistic yet standardized numeracy literacy evaluation framework that can be used across contexts and learning approaches. Thus, learning models such as PjBL and Mastery Learning are not only conceptually interesting, but can also be studied and replicated scientifically based on valid data.

Discussion

Based on the results of the literature study, the integration between Project Based Learning and Mastery Learning has been proven to be able to significantly improve students' numeracy literacy. The findings show that PjBL provides a real context that encourages understanding of concepts, while Mastery Learning guarantees the completeness of each basic competency. The combination of the two results in an active and structured learning experience. Project-based learning improves high-level thinking skills, such as problem-solving and data analysis (Nur'aini et al., 2021). The importance of full mastery before moving on to the next material so that misconceptions do not occur. The synthesis of findings also shows that there is a pattern that this integrative approach is suitable for mathematics learning that requires numerical skills and systematic logic. Thus, the integration of these two approaches results in synergy between learning independence and the achievement of curricular goals. This makes it a relevant and effective strategy to improve the quality of numeracy literacy of high school students.

The potential for implementing the integration of PjBL and Mastery Learning in high school is huge, especially to encourage more in-depth, meaningful, and sustainable learning. This approach allows teachers to structure learning that is adaptive, contextual, and able to accommodate a variety of student learning styles. However, the main challenge is the limited time, capacity of teachers, and the readiness of the infrastructure in implementing formative and project evaluations consistently. The success of Mastery Learning depends on time management and good instructional design (Hatta & Jupriani, 2025). On the other hand, PjBL requires teachers' ability to design projects that are authentic and in accordance with learning outcomes. Another challenge is the resistance of teachers who are used to conventional methods, as well as the lack of training related to this integrative approach. Institutional support for innovative approaches to be optimally implemented. Therefore, this integrative implementation requires systemic readiness that includes teacher training, curriculum design, and policy strengthening.

The integration between PjBL and Mastery Learning is very relevant to the direction of Indonesian education transformation within the framework of the Independent Curriculum. This curriculum emphasizes differentiated learning, character strengthening, and contextual numeracy competence development. The PjBL approach is in line with the principles of experiential learning and local context emphasized in the Pancasila Student Profile. Meanwhile, Mastery Learning supports formative assessments and remedies as part of learning that frees students from the pressure of final grades. Teachers are encouraged to be facilitators who are responsive to the learning needs of students individually (Adler & Kim, 2017). This integrative approach can help teachers achieve numeracy literacy targets in a flexible yet measurable way. In addition, this model supports cross-subject and collaborative learning, as mandated in project-based learning. Thus, this integration is not only suitable, but also very strategic in the current national education context.

Although the potential for integrating PjBL and Mastery Learning is promising, there are still limitations in the literature that explicitly discusses this combined model, especially in the Indonesian context. Most studies focused only on the implementation of each approach separately. The literature that discusses the synergistic impact of the two on numeracy literacy is still relatively limited and exploratory in nature. This creates an empirical data gap that can be used as a strong basis for education policy. Evidence-based research for the development of sustainable learning models. In addition, there

is still a lack of classroom action studies that test the effectiveness of this integrative model in high school. Social and cultural context in the successful implementation of learning approaches (Hutagaol, 2013). Therefore, further exploration is needed to assess the effectiveness of this integration in various school settings, grade levels, and socioeconomic conditions.

For teachers, the integration of PjBL and Mastery Learning can start by designing a learning unit that focuses on real projects with a formative assessment cycle. Teachers are also advised to provide adequate study time and individualized support for students who need remedies. Intensive training and mentoring are needed so that teachers are able to develop integrative learning scenarios that are in accordance with classroom conditions. Researchers are then expected to conduct quasi-experimental studies or classroom action research that systematically evaluate the effectiveness of these models. According to Creswell (2012) Learning design based on experience and reflection can increase the meaning of learning. Researchers can also explore this combination of models in the context of blended learning or technology-based learning. Governments and education stakeholders should provide policy support to encourage the widespread adoption of this innovative model. Thus, this integration has a great opportunity to be a strategic alternative in strengthening the numeracy literacy of Indonesian students in the era of the Independent Curriculum.

As a contribution to the design of adaptive numeracy curricula and the development of learning models, this article should systematically clarify the theoretical implications at the end of each section of discussion. For example, after discussing the relationship between numeracy literacy and Project Based Learning (PjBL), it is important to explain how the findings extend the theory of social constructivism or cognitive theory in the context of numeracy learning. Likewise, in the discussion section on Mastery Learning, it is necessary to describe how this approach strengthens the individualized learning framework or behavioristic principles. Without this clarification, the theoretical contribution of the article becomes blurred, and readers—especially other researchers—lose their way in developing further theoretical studies or model testing.

In addition, the recommendations in this article need to be more concrete and applicable to teachers and curriculum developers. For example, instead of just suggesting "using a project-based approach," guidance should be provided such as examples of contextual numeracy project themes at junior high school level or numeracy assessment strategies in a Mastery Learning scheme. For curriculum content developers, a numeracy module structure that integrates reflective assignments and PISA-level-based assessment rubrics can be suggested. Such recommendations not only increase the practical value of the article, but also bridge the gap between research and educational practice in the field—an important aspect of adaptive and sustainable numeracy literacy.

4. CONCLUSION

This study shows that the integration of *Project Based Learning* (PjBL) and *Mastery Learning* has great potential in improving numeracy literacy in a sustainable manner in high school students. PjBL provides space for exploration through contextual projects that encourage critical thinking and problem-solving skills. Meanwhile, Mastery Learning ensures the completeness of learning through the stages of systematic remedial and formative assessment. The integration of these two approaches provides a balance between active learning and the achievement of well-rounded basic competencies. Theoretically, this model supports a constructivist and behavioristic approach simultaneously, combining learning independence with a directed structure. The practical implication is that teachers need to design project-based learning accompanied by a phased evaluation scheme and individualized support. In the context of the Independent Curriculum, this approach is in line with differentiated learning and strengthening the Pancasila Student Profile. Implementation recommendations include teacher training, development of teaching tools, and collaboration between teachers in designing projects and assessments. For further research, an experiment-based empirical study or classroom action is needed to test the effectiveness of this integration in various school contexts. Thus, this integrative model can be a strategic alternative in the transformation of numeracy learning at the high school level.

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