JPPIPA 11(9) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Role of Teachers as Motivators and Facilitators in Strengthening Numeracy Literacy

Sakerani[1*], Andi Arifuddin Iskandar[2], Bambang Ismaya[3], St. Rahmah[3]

[1]Universitas Lampung Mangkurat, Banjarmasin, Indonesia.
[2]Universitas Patompo Makassar, Makassar, Indonesia.
[3]Universitas Singaperbangsa Karawang, Karawang, Indonesia.
[3]Universitas Islam Negeri Antasari Banjarmasin, Banjarmasin, Indonesia.

Received: July 8, 2025
Revised: September 18, 2025
Accepted: September 25, 2025
Published: September 30, 2025

Corresponding Author:
Abduloh
abdulah@staff.unsika.ac.id

DOI: 10.29303/jppipa.v11i9.12069

Abstract: This study aims to analyze the implementation of a numeracy literacy habituation program in schools using a descriptive qualitative research method through library research. The main focus of this study is to understand various aspects that influence the success of the numeracy literacy program, including reading habituation, educational games, the provision of supporting facilities such as reading corners and educational posters, and the socialization of the program through In-House Training for teachers. Data was obtained from relevant literature sources that examine the numeracy literacy habituation program as well as best practices in its application in schools. The results of the study indicate that reading habituation and educational games can significantly improve students' literacy and numeracy skills. Additionally, strengthening teachers' capacity through continuous training is essential to ensure effective implementation. The use of supporting facilities, such as varied reading corners and informative educational posters, strengthens numeracy literacy learning outside the classroom. This study also emphasizes the important role of parents and the community in supporting the success of this program. By involving various stakeholders, it is hoped that the numeracy literacy program can be optimally implemented to enhance students' competencies in both fields.

Keywords: Educational games; Numeracy literacy program; Reading habituation; Teacher capacity building

Introduction

Amid global advancements and rapid digital transformation, literacy and numeracy have become key pillars in the modern education system (Solissa et al., 2023). Literacy is no longer limited to the basic skills of reading and writing; it encompasses the ability to understand and interpret information deeply, as well as the ability to critically evaluate the meaning of texts and contexts. Critical thinking skills developed through literacy allow individuals to make wiser and more objective decisions in various situations (Higgins et al., 2005). Meanwhile, numeracy requires more than just the ability to count numbers (Ali et al., 2024; Suryono et al., 2023; Wantu et al., 2024). It involves mathematical analysis skills and their application in solving real-life problems, as well as understanding the increasingly complex phenomena of the world. Numeracy also involves applying mathematical concepts to recognize patterns, make predictions, and support problem-solving processes based on data. These two competencies are essential in preparing a generation that is capable of surviving and thriving in an ever-evolving and challenging world.

Literacy and numeracy skills are key to facing the challenges of the 21st century, which demands higher-level thinking and the ability to innovate in addressing the increasingly complex problems of the world (Putra et al., 2023; Negara et al., 2024; Noh et al., 2014). In a world that is interconnected and driven by data, skills to

How to Cite:
Sakerani, S., Iskandar, A. A., Ismaya, B., & Rahmah, S. (2025). The Role of Teachers as Motivators and Facilitators in Strengthening Numeracy Literacy. *Jurnal Penelitian Pendidikan IPA*, *11*(9), 90–99. https://doi.org/10.29303/jppipa.v11i9.12069

analyze, verify information, and perform relevant mathematical reasoning are essential qualities for generating intelligent and innovative solutions. In Indonesia, the low levels of literacy and numeracy among students remain a significant issue. Based on the Programme for International Student Assessment (PISA) survey results, Indonesian students' performance in these two fields is far below the global average. This condition highlights a gap that needs to be immediately addressed within the education system, emphasizing the importance of reforms focused on improving the quality of learning at every education level. Efforts to tackle this issue require a substantial improvement in educators' capacity, particularly in optimizing the role of teachers as a vital part of the success of the education process (Timperley & Alton-Lee, 2008).

Reading, as an integral part of literacy, is a key factor in determining the progress of education. Educational success cannot only be seen from the number of students who achieve high grades but also from how much interest in reading exists among students. According to the 2018 Programme for International Student Assessment (PISA) results, Indonesia ranked among the bottom 10 out of 79 participating countries (Dewanto et al., 2023; Elfira & Santosa, 2023; Zulkifli et al., 2022; Zulyusri et al., 2023). The average reading score of Indonesian students was recorded as 80 points below the average of OECD countries. Additionally, Indonesia still lags behind students in ASEAN countries, with average scores in reading, mathematics, and science each lower by 42 points, 52 points, and 37 points compared to the average student scores in ASEAN. The low literacy skills have significant negative impacts on children's development and their future prospects. This issue was further exacerbated by complaints from parents regarding disrupted learning during the pandemic, which resulted in a decline in students' literacy and numeracy competencies. According to the UNESCO report titled The Social and Economic Impact of Illiteracy, published in 2010, low literacy levels can lead to a loss of productivity, high healthcare costs, and a decrease in the quality of education both at the individual and societal levels (Timperley & Alton-Lee, 2008; Asnur et al., 2024). Low literacy levels also limit advocacy rights and social-political participation. Societies with low literacy often exhibit poor awareness regarding food hygiene, frequent malnutrition issues, and are exposed to high-risk behaviors related to sexual health. This ultimately leads to higher rates of sexually transmitted diseases, pregnancies, abortions, births, and increased mortality rates. Teachers play a very strategic role in enhancing students' literacy and numeracy skills. As motivators, teachers are expected to inspire and encourage students to be more active in the learning process, utilizing various creative and engaging approaches. Teachers must create an atmosphere that builds students' self-confidence, as well as design a learning environment that is not only enjoyable but also supports their emotional and intellectual development. Furthermore, teachers are expected to foster students' self-confidence by guiding them through learning challenges, so students feel capable and motivated to continue learning.

As facilitators, teachers should be more than just deliverers of content; they must be able to create an inclusive environment, provide appropriate learning resources, and design strategies that enhance students' understanding of the material (Edwards-fapohunda, 2024). Teachers are also required to actively support students, both individually and in groups, to help those who struggle with understanding literacy and numeracy concepts. In practice, this involves using innovative teaching tools, integrating technology into the learning process, and applying collaborative learning techniques that encourage students to think critically and solve problems effectively (Kamil et al., 2008; Suryono et al., 2023; Winiasri et al., 2023; Zulyusri et al., 2023).

Several relevant research findings support the discussion of literacy and numeracy. Arifin et al. (2025) highlighted the importance of literacy and numeracy as essential life skills in the digital age and Industry 4.0 revolution. These competencies must be developed integratively through families, schools, and communities. This research shows that literacy-numeracy learning can be conducted through structured curricular activities involving HOTS-based evaluations as well as extracurricular activities that support the development of these skills. The implementation of these activities online with teacher supervision and reflection has a significant impact on improving students' literacy and numeracy mastery.

Furthermore, D et al. (2021) emphasized the importance of strengthening literacy, numeracy, and technological adaptability to improve the quality of human resources in the digital age and disruption (Linder, 2011). This research suggests that the government and all relevant stakeholders, including educational institutions and parents, must collaborate to strengthen literacy and numeracy for both students and educators. One recommended approach is to integrate literacy, numeracy, and technology in the learning process, both in schools and at home, to create an educational ecosystem that supports holistic learning (Perera et al., 2015; Kobayashi et al., 1996).

Badri (2022) noted a cultural shift where society increasingly prioritizes verbal culture over reading culture. This research suggests that schools initiate literacy movements with a focus on numeracy literacy to address this trend and increase interest in reading,

especially in the context of numeracy literacy relevant to 21st-century development. Research by Vidiawati (2019) in MIN 4 Pondok Pinang, South Jakarta, found that implementing literacy programs such as a young journalists community, libraries, wall magazines, and student publishing can enhance student engagement in literacy. The success of this program was driven by student enthusiasm, a supportive school environment, and active help from parents and private sectors (Fisher & Frey, 2007; Whitaker & Valtierra, 2018).

Furthermore, research by Nur'aini (2021) emphasized the importance of policies that integrate literacy activities as daily routines for students, while enhancing teachers' capacity to create an atmosphere that encourages a love for reading. This could significantly contribute to improving students' literacy skills in Indonesia, as reflected in the 2018 PISA survey results. Additionally, the Directorate of Primary Schools (2021) developed a numeracy literacy module aimed at improving basic literacy competencies in elementary school students. This program includes various types of literacy, such as reading-writing literacy, financial literacy, numeracy, and digital literacy, with the primary goal of improving overall school competence. The program is designed to prepare students for future workforce challenges and social changes (Hawes et al., 2017; Higgins et al., 2005).

Overall, this research focuses on the implementation of numeracy literacy through everyday habits and its impact on improving students' literacy-numeracy competencies. However, significant challenges still hinder this effort. Many teachers face difficulties in designing relevant and interactive learning methods to increase student interest, especially in literacy and numeracy (Rofiah et al., 2024). Other challenges include the lack of professional training focused on strengthening these areas, as well as limited access to modern technology and pedagogical resources. Additionally, the variation in students' abilities within a single class requires more individualized learning designs to ensure that each student receives the attention they need, making the learning process more effective and equitable (Andriansyah et al., 2022; Linder, 2011).

Based on these dynamics, this research seeks to explore the role of teachers as motivators and facilitators in strengthening students' literacy and numeracy abilities. In addition to exploring the challenges faced by teachers, the research aims to identify effective strategies that have been implemented and their impact on student learning outcomes. It is hoped that this research will provide strategic recommendations to support the optimization of teachers' roles and contribute to realizing a higher-quality and more inclusive national education system, aligned with the demands of the 21st century.

Method

This research method employs a descriptive qualitative approach using library research techniques. The descriptive qualitative approach was chosen to provide an in-depth description of the phenomenon of implementing numeracy literacy in learning, which is directed through daily habits, as well as the challenges faced by teachers in efforts to enhance students' literacy and numeracy competencies. With this approach, the researcher aims to reveal and analyze how numeracy literacy is applied in the context of education in primary schools, and the factors influencing its success.

In this study, the primary data is obtained from literature or relevant written sources, such as scientific journals, books, research reports, academic articles, and policy documents discussing the topics of numeracy literacy, primary education, and the challenges faced by educators. The library research technique allows the researcher to collect and analyze information found in scientific publications and other related literature sources, providing a comprehensive understanding of the implementation of numeracy literacy in education.

The research process begins with the identification and collection of various relevant literature sources, followed by thematic analysis of the documents obtained. The collected data is then analyzed to identify themes, patterns, and information related to numeracy literacy practices, as well as the supporting or inhibiting factors for its implementation. The findings from this literature analysis will be presented in the form of descriptions that provide an in-depth understanding of the key issues related to strengthening numeracy literacy in primary schools. By utilizing this qualitative approach and library research method, this study is expected to make a significant contribution to the development of more effective numeracy literacy learning in Indonesia.

Result and Discussion

Results The implementation of a numeracy literacy habituation program in schools has significant potential to enhance students' competence in both of these areas (Rohmah et al., 2022; Singh et al., 2023). However, the successful execution of this program requires a comprehensive strategy and the active participation of various parties, such as teachers, students, and parents (Kim & & Corpus, 2023). This discussion will cover several key aspects related to the implementation of the numeracy literacy program, including habituation approaches, teacher training, and supporting factors that can strengthen the success of the program (Niemi et al., 2018).

To maximize the effectiveness of the program, it is essential for schools to foster an environment that promotes consistent engagement with both literacy and numeracy in daily activities (Al-Fraihat et al., 2024). Teachers, as the primary facilitators, play a central role in integrating these skills into various learning activities. Their continuous professional development is critical to ensuring they have the knowledge and tools to adapt to the diverse needs of students (Natalina & Hidayah, 2024; Utomo et al., 2023). Furthermore, collaboration with parents is necessary for reinforcing the program outside of school settings, particularly by encouraging activities that integrate reading, writing, and numeracy practices at home. When all stakeholders work together, the program has a much higher likelihood of achieving lasting impact and success in improving the students' foundational skills (Winarno et al., 2024). Therefore, a holistic approach that includes comprehensive training, resource provision, and active community involvement is indispensable in successfully implementing and sustaining a numeracy literacy program in schools.

Reading Habits and Educational Games

Reading habituation as a component of literacy has been proven to be effective in improving students' reading skills and comprehension. Schools offer opportunities for students to develop independent reading habits through facilities such as reading corners and diverse book collections. This activity, in addition to enriching their knowledge, also enhances understanding in the context of numeracy. Given that numeracy literacy involves the ability to read numbers and symbols, it is essential that the available reading materials address both elements concurrently. The use of educational games, such as the Linum game, which integrates elements of both literacy and numeracy, presents an innovative approach to learning.

This more enjoyable learning process aids students in grasping numeracy concepts in a hands-on and practical manner. By fostering an interactive environment, these games not only provide enjoyment but also present an alternative and engaging method to learn mathematical skills, which many students often find difficult (Windisch, 2015). As a result, numeracy learning becomes more effective, with students actively engaging in activities that offer a deeper and more applicable understanding of mathematical concepts. With the use of various fun and supportive facilities, as well as innovative methods like games that combine literacy and numeracy, mathematics education becomes more engaging and relevant. This approach aligns with research that suggests using activity-based learning methods can significantly improve student motivation and outcomes.

Provision of Learning Support Facilities

Support facilities such as reading corners and educational posters are instrumental in cultivating an environment conducive to the growth of numeracy literacy. Well-organized reading corners, stocked with a variety of books tailored to students' needs, enable easy access to foster reading habits. By thoughtfully designing reading spaces, schools can encourage students to spend more time reading, which deepens their understanding of a broad range of subjects, including numeracy (Delić et al., 2019). Research indicates that such environments not only promote engagement but also support the development of critical thinking and comprehension skills. In addition to reading corners, educational posters are highly effective tools in reinforcing numeracy literacy. Posters featuring vital information and activities that link literacy and numeracy can serve as constant visual reminders for students (Higgins et al., 2005).

When designed in an appealing and engaging manner, these posters act not only as informative visual aids but also enhance students' understanding of numeracy's relevance in daily life. By strategically placing posters in areas students frequently visit, such as classrooms or corridors, schools can offer contextual insights that promote awareness of the practical value of numeracy alongside literacy. Therefore, when combined, these resources play a crucial role in enhancing numeracy literacy beyond formal lessons, creating an ongoing, immersive learning experience (Lionakis et al., 2023). This integrated approach is supported by studies highlighting the benefits of environmental cues in reinforcing learning, suggesting that educational spaces can play a crucial role in making academic concepts more relatable and accessible.

Program Socialization Through In-House Training

In-House Training (IHT) is a vital component in the effective execution of numeracy literacy programs within schools, as it provides a structured framework for continuous teacher development. Through IHT, teachers gain exposure to a broad array of modern teaching methods, allowing them to integrate numeracy literacy seamlessly into their everyday instruction. This training gives teachers the confidence and tools to become key facilitators in promoting numeracy literacy among students (Fintz et al., 2022). Furthermore, the emphasis on student engagement in IHT helps teachers develop strategies to spark students' curiosity and active participation in lessons. Beyond traditional methods, IHT also guides educators in adopting innovative, technology-driven teaching approaches. In the digital age, the use of educational tools and resources such as interactive apps, online platforms, and digital games

plays an essential role in making learning more dynamic and engaging (Agrawal & Choudhary, 2019).

By incorporating technology, teachers can present numeracy literacy content in a way that resonates with digital-native students, offering a more flexible and engaging learning experience. Teachers also gain opportunities to refine their own digital literacy skills, ensuring that they remain equipped to manage the evolving demands of the modern classroom. Through this continuous professional development, IHT not only strengthens educators' pedagogical practices but also encourages them to experiment with creative and technology-enhanced methods that ultimately contribute to a more holistic and effective numeracy literacy program (Roche et al., 2023; Windisch, 2015). Thus, the success of numeracy literacy initiatives is largely dependent on ongoing investment in teachers' growth through IHT, helping them to remain adaptable and effective in their approach.

The Role of Supportive Factors in Program Success

Teachers are crucial to the success of the numeracy literacy program, as they are the driving force behind the learning process. To effectively implement this program, teachers must undergo continuous professional development to refine their teaching methods and keep pace with the latest educational strategies. This ongoing training equips educators with the necessary skills to adapt to the diverse needs of their students and implement innovative teaching techniques that engage every learner effectively. Teachers also need sufficient time and flexibility to experiment with different instructional strategies and refine their approaches to meet the varied learning preferences and abilities within the classroom (Hohman et al., 2019). Recognizing the individual differences in student learning styles and paces is essential for the personalized delivery of instruction. By focusing on these differences, teachers can design flexible lesson plans that cater to the unique needs of each student, fostering a learning environment where every child has the opportunity to succeed. This adaptability allows teachers to address both the strengths and areas for improvement in their students' learning processes.

Equally important to a child's numeracy literacy development is the involvement of parents and the broader community. Parental engagement provides a powerful reinforcement of the learning that occurs in the classroom, as parents can help solidify students' numeracy skills at home through regular activities like reading, counting, or problem-solving games. By fostering a numeracy-friendly environment at home, parents can extend the benefits of school-based learning and provide students with additional practice in a supportive setting. Beyond the walls of the classroom, the community also has a vital role to play (Eraslan et al., 2019; Shahinfar et al., 2020). Community members can contribute to creating an environment where literacy and numeracy are valued and where learning continues outside of school. From community events and after-school programs to local libraries or educational initiatives, the local environment should reflect and support the development of literacy numeracy skills in various aspects of daily life. When schools, parents, and the community collaborate, the effects of the numeracy literacy program are extended beyond the classroom and into the real world, making the skills more practical and relevant.

Strengthening Teacher Professionalism

The implementation of continuous training programs and professional development for teachers is crucial for the success of numeracy literacy initiatives. By engaging in regular training sessions and enhancing their professional skills, teachers can stay up to date with current educational trends and strategies. This continuous growth enables them to effectively manage increasingly diverse classrooms, addressing the varying learning styles and needs of each student. Moreover, professional development for teachers goes beyond acquiring technical knowledge; it encompasses reflective practices that encourage educators to examine their teaching methods critically. Teachers are given opportunities to reflect on what is working well, identify areas for improvement, and explore innovative teaching strategies that can boost engagement and comprehension.

As teachers' skills evolve through these programs, they become better equipped to present lessons in creative ways that cater to individual student needs. This personalized approach promotes a dynamic and interactive learning environment, where students are more actively involved and better able to develop their literacy and numeracy skills. Furthermore, the impact of teacher professional development extends beyond the classroom (Ahmed et al., 2010). When teachers continually refine their teaching approaches, the learning environment becomes more vibrant and motivating, which not only supports academic achievement but also enhances students' attitudes toward learning. By fostering a culture of continuous improvement, teachers can create a positive and lasting impact on students' academic journeys, contributing to the overall success of literacy and numeracy programs.

Overall, implementing the numeracy literacy habituation program in schools presents significant potential to enhance students' literacy and numeracy skills. To achieve optimal outcomes, the program must be applied using a holistic approach that involves not only the teachers but also the students, parents, and the

wider school community (Nurtamam et al., 2023; Rahman et al., 2023). The success of this initiative depends largely on the continuous professional development and support provided to teachers, enabling them to utilize innovative teaching strategies that engage students. Additionally, the availability of sufficient learning resources, such as reading corners, interactive posters, and diverse educational games, contributes to an effective learning environment (Kartini & Darmawan, 2025).

When students engage in regular reading habits and participate in educational games, they not only strengthen their reading comprehension abilities but also develop practical numeracy skills(Dewanto et al., 2023; Luciana et al., 2024; Santosa et al., 2020; Suryono et al., 2023). These resources, which combine elements of both literacy and numeracy, offer an engaging way for students to grasp complex concepts. The presence of supportive infrastructure, such as well-organized reading corners and visually stimulating educational tools like posters, fosters a deeper understanding of numeracy within the context of real-life situations (Roche et al., 2023). Moreover, educational games provide an interactive and enjoyable way to learn, turning difficult concepts into fun, hands-on activities. As students interact with these resources, they improve their mathematical understanding in a more applied manner, which enhances their problem-solving abilities and encourages active participation in learning. By integrating these different facets of learning, schools create an environment where literacy and numeracy development can thrive in an engaging and sustainable way.

The program's effectiveness hinges on the collaboration between all parties involved and the creation of a continuous, supportive learning ecosystem that extends beyond the classroom. Through this multi-dimensional approach, students can progressively build on their skills, leading to a solid foundation in both literacy and numeracy that will serve them in their academic journeys and everyday lives. Equally important is the dissemination of knowledge through the In-House Training program, which offers teachers continuous opportunities to refine their skills and enhance their abilities in managing the learning process. Through this program, educators gain access to updated and relevant content, enabling them to better integrate technology into their teaching (Rajput et al., 2023; Jordan & Mitchell, 2015). The inclusion of tech-driven teaching methods not only fosters engagement but also enhances interactivity and effectiveness, allowing teachers to adopt innovative strategies that keep students motivated and involved. Furthermore, other supporting factors, such as active parent involvement, extend the benefits of the numeracy literacy program beyond school grounds. Parents can help reinforce and nurture reading and numeracy habits at home, which helps solidify the skills students develop at school (Fintz et al., 2022; Vimala et al., 2023).

In addition, teacher professionalism is crucial to the success of this program. As teachers continue to grow through ongoing training and professional development, they gain more expertise in delivering effective lessons that are tailored to meet the diverse needs of their students. With increased competence in using various teaching techniques, flexibility, and adapting to individualized learning, teachers can ensure that each student is given the appropriate attention and support necessary for their learning journey. This approach not only enhances the quality of education but also makes the learning process more enjoyable and meaningful for students (Morgan & Jacobs, 2020; Agrawal & Choudhary, 2019). To ensure the continued success of the numeracy literacy habituation program, it is vital that its implementation is consistently reinforced through active support from various stakeholders. A collaborative approach involving teachers, parents, and the wider community creates a solid foundation that promotes effective learning and ensures that the program's objectives are achieved, leading to sustained improvement in students' literacy and numeracy skills. This holistic and supportive environment sets the stage for maximizing the impact and long-term success of the numeracy literacy program.

Conclusion

The conclusion of this study highlights the importance of implementing a numeracy literacy habituation program in schools to enhance students' competencies in both literacy and numeracy. The development of reading habits, facilitated through engaging reading corners, alongside the use of educational games that integrate literacy and numeracy elements, helps students develop the cognitive skills needed for everyday life. Strengthening teacher capacity through continuous training and In-House Training has proven crucial in fostering more creative and interactive teaching methods, ensuring the effective and comprehensive implementation of the numeracy literacy program in the classroom. Supporting facilities such as educational posters and well-organized reading spaces provide additional support for learning beyond school hours, encouraging students to apply their literacy and numeracy skills in broader contexts. However, the success of this program also heavily relies on collaboration among the school, parents, and the community. Parental involvement in supporting learning at home, such as fostering reading habits and

practicing numeracy, strengthens the positive impact of the program. With an integrated and participatory approach, the numeracy literacy program is expected to be optimally implemented, providing a sustainable impact on the improvement of education quality as well as students' literacy and numeracy skills, which are not only relevant within the school environment but also in their daily lives.

Acknowledgments
The author would like to thank those who contributed to this research.

Author Contributions
This study consists of four authors: A. and A.A.I. contributed to data collection. B.I. and S.R. contributed to the analysis and interpretation of research data.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Agrawal, A., & Choudhary, A. (2019). Deep Materials Informatics: Applications of Deep Learning in Materials Science. *MRS Communications*, *9*(3), 779–792. https://doi.org/10.1557/mrc.2019.73

Ahmed, N. K., Atiya, A. F., Gayar, N. E., & El-Shishiny, H. (2010). An Empirical Comparison of Machine Learning Models for Time Series Forecasting. *Econometric Reviews*, *29*(5), 594–621. https://doi.org/10.1080/07474938.2010.481556

Al-Fraihat, D., Sharrab, Y., Alzyoud, F., Qahmash, A., Tarawneh, M., & Maaita, A. (2024). Speech Recognition Utilizing Deep Learning: A Systematic Review of the Latest Developments. *Human-Centric Computing and Information Sciences*, *14*(March). https://doi.org/10.22967/HCIS.2024.14.015

Ali, M., Nurhayati, R., Wantu, H. M., Amri, M., & Santosa, T. A. (2024). The Effectiveness of Jigsaw Model Based on Flipped Classroom to Improve Students' Critical Thinking Ability in Islamic Religious Education Learning. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *8*(5), 1069–1078. https://doi.org/10.31004/obsesi.v8i5.6190

Andriansyah, E. H., Rafsanjani, M. A., & Priastuti, D. N. (2022). The Importance of Emotional, Spiritual Intelligence, and Self Efficacy on The Principal's Performance in Sekolah Penggerak Program Based on Merdeka Curriculum. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, *8*(4), 922. https://doi.org/10.33394/jk.v8i4.5910

Arifin, Z. B., Farkhan, M. N., Tasjuddin, M. R., Rahmadhani, S. A., & Salsabila, U. H. (2025). Digital Literacy as a Fundamental Competency in the 21st Century Education. *Linguanusa Social Humanities Education and Linguistic*, *2*(3), 18-32. https://doi.org/10.63605/ln.v2i3.68

Asnur, L., Jalinus, N., Faridah, A., Apra, T., Ambiyar, R. D., & Utami, F. (2024). Video-blogs (Vlogs)-Based Project: A Meta Analysis. *IJASEIT*, *14*(5), 1553–1557. https://doi.org/10.18517/ijaseit.14.5.16804

Badri, K. N. Z. (2022). Factors that Promote Reading Culture and Its Impact on Society. *JSSH (Jurnal Sains Sosial dan Humaniora)*, *6*(1), 35. https://doi.org/10.30595/jssh.v6i1.13301

D, D., Khasanah, M., & Putri, A. M. (2021). Penguatan Literasi, Numerasi, dan Adaptasi Teknologi pada Pembelajaran di Sekolah: (Sebuah Upaya Menghadapi Era Digital dan Disrupsi). *Eksponen*, *11*(2), 25–35. https://doi.org/10.47637/eksponen.v11i2.381

Delić, V., Perić, Z., Sečujski, M., Jakovljević, N., Nikolić, J., Mišković, D., Simić, N., Suzić, S., & Delić, T. (2019). Speech Technology Progress Based on New Machine Learning Paradigm. *Computational Intelligence and Neuroscience*. https://doi.org/10.1155/2019/4368036

Dewanto, D., Wantu, H. M., Dwihapsari, Y., Santosa, T. A., & Agustina, I. (2023). Effectiveness of The Internet of Things (IoT)-Based Jigsaw Learning Model on Students' Creative Thinking Skills: A-Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 912–920. https://doi.org/10.29303/jppipa.v9i10.4964

Edwards-Fapohunda, M. O. (2024). The Role of Adult Learning and Education in Community Development: A Case Study of New York. *Iconic Research and Engineering Journals*, *8*(1), 437–454. Retrieved from https://www.irejournals.com/paper-details/1706084

Elfira, I., & Santosa, T. A. (2023). Literature Study: Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555

Eraslan, G., Avsec, Ž., Gagneur, J., & Theis, F. J. (2019). Deep Learning: New Computational Modelling Techniques for Genomics. *Nature Reviews Genetics*, *20*(7), 389–403. https://doi.org/10.1038/s41576-019-0122-6

Fintz, M., Osadchy, M., & Hertz, U. (2022). Using Deep Learning to Predict Human Decisions and Using Cognitive Models to Explain Deep Learning Models. *Scientific Reports*, *12*(1), 1–12. https://doi.org/10.1038/s41598-022-08863-0

Fisher, D., & Frey, N. (2007). Implementing a Schoolwide Literacy Framework: Improving Achievement in an Urban Elementary School. *The Reading Teacher*, *61*(1), 32–43. https://doi.org/10.1598/rt.61.1.4

Hawes, Z., Moss, J., Caswell, B., Naqvi, S., & MacKinnon, S. (2017). Enhancing Children's Spatial and Numerical Skills Through a Dynamic Spatial Approach to Early Geometry Instruction: Effects of a 32-Week Intervention. *Cognition and Instruction*, *35*(3), 236–264. https://doi.org/10.1080/07370008.2017.1323902

Higgins, S., Falzon, C., Hall, I., Moseley, D., Smith, F., Smith, H., & Wall, K. (2005). Embedding ICT in the Literacy and Numeracy Strategies: Final Report. *Language Sciences*, *44*(March), 0–73. Retrieved from http://dro.dur.ac.uk/1899/

Hohman, F., Head, A., Caruana, R., DeLine, R., & Drucker, S. M. (2019). Gamut: A Design Probe to Understand How Data Scientists Understand Machine Learning Models. *Conference on Human Factors in Computing Systems - Proceedings*, 1–13. https://doi.org/10.1145/3290605.3300809

Jordan, M. I., & Mitchell, T. M. (2015). Machine Learning: Trends, Perspectives, and Prospects. *Science*, *349*(6245), 255–260. https://doi.org/10.1126/science.aaa8415

Kamil, M. L., Borman, G. D., Dole, J., Kral, C. C., Salinger, T., & ... (2008). Improving Adolescent Literacy: Effective Classroom and Intervention Practices. IES Practice Guide. NCEE 2008-4027. … *Center for Education …*. Retrieved from https://eric.ed.gov/?id=ED502398%0A

Kartini, E., & Darmawan, D. (2025). The Role of Policy in Improving Student Literacy and Numeracy in the Era of the Merdeka Curriculum. *Journal of Innovation and Research in Primary Education*, *4*(3), 476-484. https://doi.org/10.56916/jirpe.v4i3.1349

Kim, M., & Corpus, J. H. (2023). Self-Efficacy Buffers Against Belonging Loss for Hispanic Students During the First Semester of College. *European Journal of Psychology and Educational Research*, *6*(2), 69-76. https://doi.org/10.12973/ejper.6.2.69

Kobayashi, H., Kido, K., Koie, T., & Ohyanagi, H. (1996). Rabdomyosarcoma of the Bladder: A Case Report. *Japanese Journal of Cancer and Chemotherapy*, *23*(3), 365–368.

Linder, S. M. (2011). The Facilitator's Role in Elementary Mathematics Professional Development. *Mathematics Teacher Education and Development*, *13*(2), 44–66. Retrieved from https://mted.merga.net.au/index.php/mted/article/view/41

Lionakis, E., Karampidis, K., & Papadourakis, G. (2023). Current Trends, Challenges, and Future Research Directions of Hybrid and Deep Learning Techniques for Motor Imagery Brain–Computer Interface. *Multimodal Technologies and Interaction*, *7*(10). https://doi.org/10.3390/mti7100095

Luciana, O., Sjoraida, D. F., Santosa, T. A., Nugraha, A. R., & Zain, A. (2024). The Effect of Technology-Based Management Learning on Children's Organizational Skills Development: A Meta-Analysis Approach. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *8*(6), 1777–1786. https://doi.org/10.31004/obsesi.v8i6.6593

Morgan, D., & Jacobs, R. (2020). Opportunities and Challenges for Machine Learning in Materials Science. *Annual Review of Materials Research*, *50*, 71–103. https://doi.org/10.1146/annurev-matsci-070218-010015

Natalina, M., & Hidayah, H. (2024). Development of Video Tutorials as a Guide to Guided Inquiry-Based Practicum on Senior High School Biology Material. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6929–6940. https://doi.org/10.29303/jppipa.v10i9.5925

Negara, H. R. P., Santosa, F. H., & Siagian, M. D. (2024). Overview of Student's Mathematics Reasoning Ability Based on Social Cognitive Learning and Mathematical Self-efficacy. *Mathematics Teaching-Research Journal*, *16*(1), 121–142. Retrieved from http://files.eric.ed.gov/fulltext/EJ1427397.pdf

Niemi, H., Niu, S., Vivitsou, M., & Li, B. (2018). Digital Storytelling for Twenty-First-Century Competencies with Math Literacy and Student Engagement in China and Finland. *Contemporary Educational Technology*, *9*(4), 331–353. https://doi.org/10.30935/cet.470999

Noh, M. A. C., Tamuri, A. H., Razak, K. A., & Suhid, A. (2014). The Study of Quranic Teaching and Learning: United Kingdom Experience. *Mediterranean Journal of Social Sciences*, *5*(16), 313–317. https://doi.org/10.5901/mjss.2014.v5n16p313

Nur'aini, F. (2021). *Meningkatkan Kemampuan Literasi Dasar Siswa Indonesia Berdasarkan Analisis Data PISA 2018*. Pusat Penelitian Kebijakan.

Nurtamam, M. E., Santosa, T. A., Aprilisia, S., Rahman, A., & Suharyat, Y. (2023). Meta-Analysis: The Effectiveness of IoT-Based Flipped Learning to Improve Students' Problem Solving Abilities. *Jurnal Edumaspul*, *7*(1), 1491-1501. https://doi.org/10.33487/edumaspul.v7i1.6195

Perera, T., Frei, S., Frei, B., Wong, S. S., & Bobe, G. (2015). Improving Nutrition Education in U.S. Elementary Schools: Challenges and Opportunities. *Journal of Education and Practice*, *6*(30), 41–50. Retrieved from https://eric.ed.gov/?id=EJ1081364%0Awww.iiste.org

Putra, M., Rahman, A., Ilwandri, I., Suhayat, Y., Santosa, T. A., Putra, R., & Aprilisia, S. (2023). The Effect of

STEM-Based REACT Model on Students' Critical Thinking Skills: A Meta-Analysis Study. *LITERACY: International Scientific Journals of Social, Education, Humanities*, *2*(1), 207–217. https://doi.org/10.56910/literacy.v2i1.560

Rahman, A. A., Santosa, T. A., Nurtamam, M. E., Widoyo, H., & Rahman, A. (2023). Meta-Analysis: The Effect of Ethnoscience-Based Project Based Learning Model on Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 611–620. https://doi.org/10.29303/jppipa.v9i9.4871

Rajput, D., Wang, W. J., & Chen, C. C. (2023). Evaluation of a Decided Sample Size in Machine Learning Applications. *BMC Bioinformatics*, *24*(1), 1–17. https://doi.org/10.1186/s12859-023-05156-9

Roche, A., Gervasoni, A., & Kalogeropoulos, P. (2023). Factors That Promote Interest and Engagement in Learning Mathematics for Low-Achieving Primary Students Across Three Learning Settings. *Mathematics Education Research Journal*, *35*(3). https://doi.org/10.1007/s13394-021-00402-w

Rofiah, F., Sujadi, I., & Indriati, D. (2024). Implementing School Programs Supporting Numeracy: What We Can Learn from a Junior High School in Surakarta. *International Journal on Education Insight*, *5*(1), 19–26. https://doi.org/10.12928/ijei.v5i1.13677

Rohmah, A. N., Sutama, S., Hidayati, Y. M., Fauziati, E., & Rahmawati, L. E. (2022). Planning for Cultivation Numerical Literacy in Mathematics Learning for Minimum Competency Assessment (AKM) in Elementary Schools. *Mimbar Sekolah Dasar*, *9*(3), 503–516. https://doi.org/10.53400/mimbar-sd.v9i3.51774

Santosa, T. A., Agustina, N., & Yulianti, S. (2020). Jenis Tumbuhan Liar dalam Upacara Adat Kenduri Seko di Kerinci. *Pendekar: Jurnal Pendidikan Berkarakter*, *3*(1), 6–10. Retrieved from http://journal.ummat.ac.id/index.php/pendekar/article/view/2798

Shahinfar, S., Meek, P., & Falzon, G. (2020). How Many Images Do I Need? Understanding How Sample Size Per Class Affects Deep Learning Model Performance Metrics for Balanced Designs in Autonomous Wildlife Monitoring. *Ecological Informatics*, *57*. https://doi.org/10.1016/j.ecoinf.2020.101085

Singh, D., Chand, S. P., Kumar, K. K., & Ali, R. (2023). Effectiveness of Literacy and Numeracy in Commerce Subjects Among Secondary Schools in Fiji. *Journal of Education and Learning*, *17*(3), 447–454. https://doi.org/10.11591/edulearn.v17i3.20873

Solissa, E. M., Haetami, H., Yustita, V. V., Santosa, T. A., & Syafruddin, S. (2023). Effect Size Discovery Learning Model on Students Critical Thinking Skills. *Edumaspul: Jurnal Pendidikan*, *7*(2), 2083–2093. https://doi.org/10.33487/edumaspul.v7i2.6507

Suryono, W., Winiasri, L., Santosa, T. A., Sappaile, B. I., & Solehuddin, M. (2023). Effectiveness of the Inquiry Training Model to Improve Students' Critical Thinking Skills in Learning: Systematic Literature Reviews and Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 947–954. https://doi.org/10.29303/jppipa.v9i10.4804

Timperley, H., & Alton-Lee, A. (2008). Reframing Teacher Professional Learning: An Alternative Policy Approach to Strengthening Valued Outcomes for Diverse Learners. *Review of Research in Education*, *32*, 328–369. https://doi.org/10.3102/0091732X07308968

Utomo, W., Suryono, W., Santosa, T. A., & Agustina, I. (2023). The Effect of STEAM-Based Hybrid Based Learning Model on Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 742–750. https://doi.org/10.29303/jppipa.v9i9.5147

Vidiawati, V. (2019). *Implementasi Program Literasi dalam Meningkatkan Minat Baca Peserta Didik Madrasah Ibtidaiyah Negeri 4 Pondok Pinang Jakarta Selatan* (Thesis). Institut PTIQ Jakarta. Retrieved from https://repository.ptiq.ac.id/id/eprint/213/1/2019-VIVIN-VIDIAWATI-2017.pdf

Vimala, B. B., Srinivasan, S., Mathivanan, S. K., Mahalakshmi, M., Jayagopal, P., & Dalu, G. T. (2023). Detection and Classification of Brain Tumor Using Hybrid Deep Learning Models. *Scientific Reports*, *13*(1), 1–17. https://doi.org/10.1038/s41598-023-50505-6

Wantu, H. M., Muis, A., Zain, A., Hiola, S. F., Agustina, I., Santosa, T. A., Yastanti, U., & Nugraha, A. R. (2024). Effectiveness of Think-Pair-Share and STEM Models on Critical Thinking in Early Childhood Education. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *8*(5), 1320–1330. https://doi.org/10.31004/obsesi.v8i5.6202

Whitaker, M. C., & Valtierra, K. M. (2018). Enhancing Preservice Teachers' Motivation to Teach Diverse Learners. *Teaching and Teacher Education*, *73*, 171–182. https://doi.org/10.1016/j.tate.2018.04.004

Winarno, W., Muchtarom, M., & Fauziyah, H. (2024). Readiness and Efforts of Civics Teachers in Developing Literacy and Numeracy Skills. *Journal of Education and Learning*, *18*(4), 1209–1223. https://doi.org/10.11591/edulearn.v18i4.21425

Windisch, H. C. (2015). *Adults with Low Literacy and Numeracy Skills*. OECD Education Working Papers. Retrieved from https://www.oecd.org/en/publications/adults-with-low-literacy-and-numeracy-skills_5jrxnjdd3r5k-en.html

Winiasri, L., Santosa, T. A., Yohandri, Y., Razak, A., Festiyed, F., & Zulyusri, Z. (2023). Ethno-Biology

Learning Model Based on Design Thinking to Improve Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7767–7774. https://doi.org/10.29303/jppipa.v9i9.4213

Zulkifli, Z., Satria, E., Supriyadi, A., & Santosa, T. A. (2022). Meta-Analysis: The Effectiveness of the Integrated STEM Technology Pedagogical Content Knowledge Learning Model on the 21st Century Skills of High School Students in the Science Department. *Psychology, Evaluation, and Technology in Educational Research*, *5*(1), 32–42. https://doi.org/10.33292/petier.v5i1.144

Zulyusri, Z., Santosa, T. A., Festiyed, F., Yerimadesi, Y., Yohandri, Y., Razak, A., & Sofianora, A. (2023). Effectiveness of STEM Learning Based on Design Thinking in Improving Critical Thinking Skills in Science Learning: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 112–119. https://doi.org/10.29303/jppipa.v9i6.3709