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21st Century Learning: A Research Analysis of Numeracy Literacy Trends among Students

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ABSTRACT

Objective: This study analyzes recent trends in numeracy literacy among primary school students in Kediri District and identifies the challenges, opportunities, and steps to improve students' numeracy achievement in the 21st century. **Method:** A qualitative approach was used in this study, including interviews with teachers, classroom observations, and documentation of numeracy assessment results. The study involved 200 grade 4 and 5 students from 10 partner primary schools in the Campus on Duty (CoD) program. **Results:** The findings indicate that numeracy literacy trends are influenced by the integration of technology, including game-based learning applications and online platforms. Despite limited resources and insufficient teacher training, technology provides significant opportunities for enhancing numeracy learning. Project-based learning and collaboration with local technology communities were found to be effective in improving numeracy understanding by allowing students to apply concepts in real-world contexts. **Novelty:** This study emphasizes the unique role of project-based learning and collaboration with local technology communities as strategies for improving numeracy literacy. By integrating real-world contexts and technology, the findings offer new insights into bridging traditional teaching methods with innovative approaches, addressing the evolving demands of 21st-century education.

INTRODUCTION

In the 21st century, numeracy literacy has become an essential skill for students, reflecting the demands of a world increasingly driven by data and technological advancements. Despite this, numerous studies have pointed out considerable gaps in students' numeracy abilities, especially in developing countries like Indonesia. Integrating technology and innovative teaching methods has been suggested to bridge these gaps. However, challenges such as limited access to resources, inadequate teacher training, and varying levels of technological adoption continue to persist (Suryani & Nugroho, 2021; Ahmed & Khan, 2022; Beauchamp & Kennewell, 2013). Understanding the trends and factors influencing numeracy literacy is crucial for developing effective interventions. This study aims to explore these trends, focusing on integrating technology, project-based learning, and contextualized approaches in numeracy education, especially for primary school students in Kediri District. By examining these elements, the research addresses the urgent need for innovative and adaptable strategies to improve numeracy literacy in 21st-century learning environments.

Numeracy literacy is a crucial component of education in the 21st century (Fischer & Neumann, 2016; Moyo & Ndhlovu, 2021; Schleppegrell, 2018; Simons & de Vries, 2019). Amidst rapid technological advancements and socio-economic changes, numeracy literacy equips students with the necessary skills to tackle future challenges. It

encompasses the ability to understand and apply mathematics in everyday life, enabling individuals to make informed decisions and solve practical problems (Park & Kim, 2020); it is essential for tackling complex problems that arise in both social and professional life (Wesseling, 2021; Xiao, & Liu, 2020; Yılmaz & Demir, 2019; Cozma, 2020). In this context, numeracy extends beyond understanding numbers and basic operations. It also involves the ability to think critically and analytically and the capacity to use technology to solve problems effectively (Rashid & Maher, 2021; Thomas, 2000).

However, students' numeracy literacy faces significant challenges in many countries, including Indonesia. Various studies reveal that numeracy achievement among Indonesian students, particularly at the primary level, remains inadequate. According to the 2023 Minimum Competency Assessment (MCA) report, only a few students could solve intermediate numeracy problems, highlighting a gap between the curriculum and students' abilities. The current trend in numeracy literacy education is shifting towards technology and problem-based learning. However, many regions still struggle to implement these approaches effectively. This underscores the considerable gap in implementing technology-based numeracy literacy and the need to adapt to local contexts in Indonesia.

Numeracy literacy is a fundamental skill every individual needs to understand and apply numerical information daily. In a world increasingly shaped by technology and data, numeracy literacy goes beyond just the ability to count. It involves the capacity to interpret, analyze, and use numerical data effectively in various contexts, from personal decisions to professional and societal challenges (OECD, 2018; UNESCO, 2019; Smith & Brown, 2020; OECD, 2019). It encompasses thinking critically, solving problems, and interpreting data effectively. With technological advancements and the shift towards a knowledge-based economy, numeracy skills are becoming increasingly essential in addressing global challenges, such as climate change, the development of the digital economy, and the Fourth Industrial Revolution (Industry 4.0). These skills are vital for navigating the complexities of the modern world and finding solutions to pressing issues (UNESCO, 2020; Johnson & Clarke, 2017; Anderson & Smith, 2018; Perez & Gonzalez, 2019; Brown & Lee, 2020). Therefore, numeracy literacy is relevant within an educational context and is a crucial life skill necessary for active participation in an increasingly complex society. It empowers individuals to make informed decisions, engage in problem-solving, and navigate the challenges of modern life (OECD, 2020).

However, despite the crucial role of numeracy literacy in equipping students with the necessary skills to face the challenges of an increasingly complex world, the numeracy literacy achievements of students in Indonesia still show concerning figures. Based on the results of the Minimum Competency Assessment (MCA) conducted by the Indonesian Ministry of Education and Culture in 2023, only a tiny proportion of students could reach the expected level of numeracy skills. This outcome reflects a significant gap between the curriculum goals and the actual achievements of students in numeracy (OECD, 2019; Carter & Reynolds, 2022; Lin & Huang, 2018).

This gap is also reflected in various factors influencing numeracy literacy in Indonesia, including limited access to adequate educational resources, suboptimal teacher training, and varying levels of technological adoption across different regions. Although technology has been integrated into education in certain areas, many regions still face difficulties effectively utilizing technology to enhance students' numeracy literacy.

One key aspect that requires attention is integrating technology and innovative teaching methods to improve numeracy literacy. Although efforts have been made to adopt project-based learning and technology in numeracy education, significant challenges remain, particularly concerning resource gaps and teachers' readiness to implement these methods effectively. This highlights that while technology offers great potential to improve numeracy literacy, without proper support, its full potential has yet to be realized across Indonesia. In this context, there is a pressing need for more adaptive and innovative educational policies to bridge the gap between the curriculum taught and the student's abilities. Focused efforts are needed to improve teacher training, expand access to educational technology, and develop teaching methods relevant to the local context. These efforts would strengthen students' numeracy literacy achievements and better prepare them to face the challenges of a world increasingly reliant on numeracy and technology.

The factors contributing to low numeracy literacy among students in Indonesia are multifaceted. One significant cause is the limited innovation in teaching methods, with many schools still relying on traditional approaches that emphasize memorization and repetitive practice problems, rather than fostering a deeper understanding of mathematical concepts. Moreover, the underutilization of technology in numeracy education exacerbates the issue (Greenfield & Blackwell, 2020; Wong & Lim, 2021; Vasquez & Martinez, 2019). In the current digital age, technology-driven learning resources have the potential to enhance students' numeracy skills significantly. However, their use remains limited. Research by Hattie (2009) shows that effectively integrating technology into learning can substantially improve student outcomes. Therefore, it is crucial to identify the factors influencing numeracy literacy and develop suitable strategies to help students cultivate more substantial and relevant numeracy skills for the challenges of the 21st century.

To further enhance the novelty of this research, it is important to integrate the most recent studies, particularly those published in 2025, as they will provide fresh insights into advancements and trends in numeracy education. This inclusion will ensure the research stays relevant and up-to-date with the latest developments. In addition, the research questions should be outlined in great detail, offering a clear focus for the study and allowing for a more precise exploration of the topic. Moreover, ensuring alignment between the research questions, findings, and discussion is crucial to creating a logical and cohesive narrative throughout the study. This consistency will help to strengthen the overall analysis, providing a clear understanding of how the study's objectives, results, and implications are interconnected.

RESEARCH METHOD

This research utilized a qualitative approach with a literature review and case study design. The qualitative approach was selected to comprehensively understand numeracy literacy trends among primary school students in the Kediri district. A literature review was conducted to identify relevant theories and previous findings on numeracy literacy at both global and local levels, forming the basis for analysis within the Indonesian context. Case studies were then employed to examine the specific challenges and situations faced by students in the selected schools. This study's subjects consisted of 200 grade 4 and 5 students from 10 elementary schools in the Kediri district. The selection of these students was purposive, aiming to obtain a representative sample of those at the bare stage of numeracy literacy mastery. In addition to the

students, teachers who taught mathematics and numeracy literacy were also involved as informants to provide insights into numeracy learning in the classroom.

Several techniques were used to collect data. First, a literature review explored theories on numeracy literacy, 21st-century learning, and previous studies on trends and challenges in numeracy literacy. Second, in-depth interviews were conducted with teachers and students to understand better their perceptions of numeracy literacy, their learning experiences, and the factors influencing numeracy outcomes. The interviews with teachers focused on teaching strategies for numeracy, while student interviews aimed to gauge their understanding of numeracy literacy. Third, direct classroom observations were conducted to observe the interaction between teachers and students and the teaching methods used in numeracy literacy. Finally, documentation of student numeracy assessment results, learning progress reports, and other relevant documents provided additional data to offer a clearer picture of the numeracy literacy levels in the observed classrooms. The research instruments used for the data collection are presented as follows.

Table 1. Research instruments

No	Aspects	Instrument Research	Acquired Indicators/Aspects
1	Recent trends in numeracy literacy among students in Indonesia.	Literature study	Technological advancements in numeracy education: The application of context-based teaching methods, such as problem-based learning; the integration of numeracy literacy in mathematics education for the 21st century; and the utilization of digital tools and online resources to enhance numeracy instruction.
2	The challenges students and teachers face in numeracy literacy learning in the 21st century.	Teacher Interview	The challenges of integrating technology into numeracy learning stem from limited time and resources, which hinder the implementation of more context-specific and innovative learning approaches.
3	Opportunities that can be leveraged to improve primary school students' numeracy literacy outcomes in the face of social and technological changes.	Teacher Interview	The challenges of integrating technology into numeracy learning include the constraints of limited time and resources, which impede the adoption of more contextually relevant and innovative teaching methods.

RESULTS AND DISCUSSION

Result

This section presents the key findings derived from the study's analysis. The results offer valuable insights into the effectiveness of numeracy literacy interventions and the

role of different instructional strategies in enhancing student outcomes. Based on qualitative data, the study underscores the influence of technology integration, problem-based learning, and collaborative approaches in boosting numeracy skills in primary education. The following subsections will provide a detailed account of the findings, presenting a thorough overview of the observed trends, emerging patterns, and their implications for future educational practices.

Recent Trends in Numeracy Literacy Among Students, Especially in Indonesia

The trend of numeracy literacy among Indonesian students is increasing in tandem with the evolving learning methods that emphasize the use of technology. In recent years, the adoption of digital applications and interactive media in numeracy education has risen, with tools such as Khan Academy, Ruangguru, and Google Classroom pivotal in supporting mathematics and numeracy literacy. This technology-driven approach allows students to access more learning materials and promotes independent learning outside classroom hours. Moreover, technology aids in developing higher-order skills, such as problem-solving and critical thinking, which are integral to numeracy literacy in the 21st century (OECD, 2020).

Another emerging trend in Indonesia is the growing popularity of context-based learning (PBL). This approach, which emphasizes applying numeracy concepts to real-world situations, helps students recognize the relevance of numeracy learning beyond the classroom. Context-based learning offers students opportunities to engage with and solve mathematical problems more practically and meaningfully. In several experimental programs across Indonesian schools, efforts have been made to integrate numeracy lessons with real-world topics like economics, technology, and social issues (Suryani & Nugroho, 2021).

Despite these advancements, challenges persist in implementing numeracy literacy consistently across Indonesia. Limited access to technology and educational resources remains a significant barrier in many regions, especially those outside major cities. Teachers in these areas often face difficulties integrating technology into their teaching due to inadequate infrastructure and insufficient professional training. This disparity results in unequal numeracy literacy outcomes between urban and rural students. Therefore, while progress is being made, there is a need for more significant efforts to provide equal access and enhance teacher training throughout the country (BNSP, 2019).

Furthermore, learning approaches integrating numeracy literacy with 21st-century skills, such as collaboration, communication, and creativity, are gaining traction in Indonesia. These methods stress the importance of students mastering numeracy concepts and working collaboratively to solve complex problems. Many schools have started implementing team-based projects, where students research and develop solutions to real-life problems incorporating math and science. For example, math and science projects involving data analysis allow students to collect, analyze, and present data, thus improving their numeracy skills while preparing them for an increasingly collaborative and tech-oriented workforce (Rashid & Maher, 2021).

Additionally, there is a growing emphasis on inclusive numeracy literacy to cater to various learning styles. Some schools have started tailoring learning methods to meet students' individual needs and pace, utilizing visual, auditory, and interactive aids to support diverse learning needs. E-learning platforms and educational games have also gained popularity as an alternative method for introducing numeracy concepts

engagingly and enjoyably. These technologies increase student motivation and offer flexibility, allowing students to learn outside the classroom. However, to ensure the success of this approach, it is crucial to involve parents and the broader community in supporting more creative and effective numeracy learning (Kurniawan, 2020).

Challenges Faced by Students and Teachers in Learning Numeracy Literacy in the 21st century

The following table presents the results of the research on the challenges faced by teachers in learning numeracy literacy in the 21st century.

Table 2. The challenges faced by teachers in learning numeracy literacy in the 21st century

No	Aspects	Results of interviews with teachers and resource persons
1	Challenges in Integrating Technology in Numeracy Learning	One of the biggest challenges I face is the **lack of supporting facilities**. We have a few computers at school, but the internet connection is often intermittent, affecting the use of digitally-based numeracy applications or learning platforms. Also, although technology can be very helpful in enriching learning, many students are unfamiliar with digital platforms for numeracy material. For this reason, we as teachers have to give extra time to teach the numeracy material. them how to use the technology, which takes extra time." **(RN, 30 years old Teacher)** "I agree that technology is helpful, but in my class, the **use of technology is still limited** to learning media such as videos and PowerPoint. We do not have direct access to numeracy learning apps or more advanced digital devices. Some students also still find it difficult to use educational applications that require technical skills. In addition, not all students have personal devices, which reduces the effectiveness of using technology evenly in the classroom. the whole class." **(Ag, 30th Teacher)** "The integration of technology in numeracy learning is very beneficial, but on the ground, we face **difficulties in teacher training**. Many of us were not formally trained in integrating technology into numeracy teaching. Although we have tried using some educational apps, our mastery of the apps is limited, and I often feel rushed to customize the materials. with the available technology." **(Wl, 30 years old teacher)**
2	Time and Resource Limitations in Implementing	"The contextual learning approach is very effective in helping students understand numeracy concepts in everyday life. However, **time** constraints are a major obstacle. The busy curriculum makes it difficult for me

No	Aspects	Results of interviews with teachers and resource persons
	the Approach Learning that More Contextual and Innovative	to fit in enough time for problem-based projects or activities that involve the real world. Most of the time, I can only give the material conventionally without involving deeper contextualization." **(Bd 40 years old, Teacher)** "The contextual learning approach is very effective in helping students understand numeracy concepts in everyday life. However, **time** constraints are a major obstacle. The busy curriculum makes it difficult for me to fit in enough time for problem-based projects or activities that involve the real world. Most of the time, I can only give the material conventionally without involving deeper contextualization." **(Bd 40 years old, Teacher)** "Another challenge is **finding enough time to implement innovative approaches**. More contextualized numeracy learning often requires more time to plan, prepare materials, and engage students in discussions or projects. On the other hand, resources are limited, such as an **incomplete library** and **access to limited digital resources**, it also limits the implementation of problem-based or experimental learning approaches." **(Dk 43, Teacher)**

The interview data regarding the challenges in integrating technology into numeracy learning gathered from three teachers across different regions revealed that the primary challenge is the lack of facilities and limited training for teachers to use technology effectively. Inadequate infrastructure, such as poor internet connectivity and the absence of digital devices, hinders the optimal use of technology. The main obstacles to implementing contextual and innovative learning approaches are limited time and resources. Teachers expressed difficulty in incorporating methods that involve real-world applications, as these approaches require more tools, which are often not available.

Opportunities that can be utilized to improve students' numeracy literacy achievement in primary schools in the face of social and technological change.

Amidst rapid social and technological changes, there are numerous opportunities to enhance primary school students' numeracy literacy achievement. Incorporating digital tools and online platforms allows students to access various learning materials, offering a more personalized and flexible educational experience. Moreover, the increasing use of project-based learning (PBL) and the application of numeracy concepts to real-life situations enable students to recognize the practical value of their learning. Collaborations with local technology communities and the use of interactive media further enrich the learning environment, fostering creativity and critical thinking. These opportunities contribute to the development of numeracy skills and prepare students for the demands of the 21st-century workforce, where technological fluency and

problem-solving abilities are crucial. By taking full advantage of these opportunities, educators can create a more engaging, inclusive, and effective learning environment, ensuring students are well-prepared for future challenges.

Table 3. Challenges Faced by Teachers in 21st Century Numeracy Literacy Learning

School	Opportunities that found	Description	Potential
SDN Mlancu 2	App usage game-based numeracy learning	Schools have access to several game-based educational apps that can attract students' interest in learning numeracy.	Increase student motivation to learn and deepen the concept of numeracy.
SDN Karangtengah 3	Technology training for teachers and student	Technology training programs are available for teachers and students to improve their understanding of using technology—digital devices.	Increase students' and teachers' digital skills in numeracy learning.
SDN Besowo 4	Integration project-based learning	Enable students to solve numeracy problems through collaborative projects based on real-world data.	Improve ability to solve problems and apply numeracy in life.
SDN Manggis 2	Provision of visual aids and media for innovative learning	The school provides a variety of visual aids and media to make numeracy learning engaging and interactive.	It helps students understand abstract numeracy concepts to be more concrete.
SDN Satak 2	Cooperation with the community's local technology	Collaboration with the community's local technology to organize Learning workshops and seminars numeration.	Improve numeracy skills and student digital literacy Via contextualized learning

The documentation from 10 schools revealed several promising opportunities to enhance students' numeracy literacy achievements. Using game-based learning applications, online platforms, and collaboration with local technology communities can significantly boost student motivation and deepen their understanding of

numeracy. Additionally, project-based learning approaches and digital literacy programs for parents play an essential role in strengthening numeracy skills at school and home. Improving students' numeracy literacy in primary schools is greatly influenced by the ongoing development of technology and the social changes taking place in society. Based on observational data from various primary schools in the Kediri district, opportunities such as game-based learning apps, online platforms, collaborations with local tech communities, and project-based learning approaches were identified. These opportunities align with global research highlighting how technology and contextual learning methods can effectively enhance students' numeracy literacy outcomes.

a. **Use of Game-Based Learning Apps**
   Educational games are a highly effective strategy in numeracy learning. According to Gee (2003), educational games have been shown to enhance student engagement and develop problem-solving skills essential for numeracy. The integration of games in numeracy education boosts student interest and presents numeracy concepts in a more accessible and interactive format through simulations (Gee, 2003). This aligns with observations that game-based applications can significantly improve students' motivation and understanding of numeracy content.
b. **Online Learning Platform**
   In this digital era, online learning platforms present a valuable opportunity to enhance students' numeracy literacy. Chigona and Chigona (2013) highlight that online learning increases accessibility and flexibility, enabling students to access materials independently and at their own pace. These platforms also allow students to engage more deeply with the learning content through interactive modules and engaging videos. This technological approach is particularly relevant to numeracy learning in Indonesia, as evidenced by observational data documenting online learning platforms in various schools.
c. **Collaboration with the Local Tech Community**
   Collaboration with local technology communities also presents a significant opportunity to enhance students' numeracy literacy. Several studies, including those by Cozma (2020), demonstrate that partnerships between schools and technology communities can enrich learning experiences and provide essential resources for technology-driven education. This collaboration can supply digital learning tools and interactive platforms, crucial in improving students' numeracy skills.
d. **Project Based Learning**
   A project-based learning (PBL) approach is an effective alternative for enhancing numeracy literacy in primary schools. Thomas (2000) states that PBL helps students connect numeracy concepts with real-world applications. This method enables students to develop numeracy skills through activities like data collection, analysis, and applying mathematical concepts in practical situations, making it highly relevant to the challenges they face in everyday life.

Discussion

To enhance the depth and coherence of the research, the research questions, results, and discussion must be aligned and interconnected. This alignment ensures that the study's findings are effectively framed by the research questions, providing a clear and logical progression throughout the research process. The analysis becomes more cohesive and

comprehensive by linking the research questions to the results and discussion, leading to more actionable insights. In this context, the study reveals several trends, challenges, and opportunities related to numeracy literacy in primary schools, especially in Indonesia, amidst its rapidly changing social and technological landscape. The findings indicate a growing trend in the use of technology, such as digital applications and online platforms, to support numeracy literacy among students, reflecting the global shift towards technology integration in education, as noted by the OECD (2020). Applications like Khan Academy, Ruangguru, and Google Classroom are increasingly adopted, providing students access to diverse learning materials and enabling independent learning outside school hours. This trend aligns with the idea that technology can enhance critical thinking and problem-solving skills, which are essential for developing numeracy literacy in the 21st century.

However, the research also uncovers significant challenges students and teachers face. As reported by the interviewed teachers, integrating technology into numeracy learning remains challenging due to limited resources, poor internet connectivity, and inadequate teacher training. These limitations contribute to disparities in numeracy literacy between urban and rural areas and hinder the optimal use of digital learning platforms. Although technology is beneficial, the lack of infrastructure and the difficulty of mastering new digital tools complicate its effective implementation. These findings resonate with previous studies on challenges in integrating technology into education (BNSP, 2019).

Additionally, the study identifies that a contextual learning approach, such as project-based learning (PBL), can enhance students' understanding of numeracy by connecting it to real-life situations. However, teachers express difficulties in allocating sufficient time for this approach due to constraints within the national curriculum. This issue is consistent with previous educational research highlighting time limitations as a significant barrier to effectively delivering contextual learning methods (Thomas, 2000). Despite these challenges, the data suggests that PBL fosters collaboration and critical thinking, skills crucial for the 21st-century workforce (Rashid & Maher, 2021).

The study also highlights opportunities that could address these challenges, such as game-based learning applications, online learning platforms, and collaboration with local tech communities. Educational games have been shown to boost student engagement and motivation by presenting numeracy concepts in an interactive format (Gee, 2003). Online learning platforms offer flexibility and accessibility, allowing students to learn at their own pace, which is vital for catering to diverse learning needs (Chigona & Chigona, 2013). Collaboration with local tech communities also provides valuable support for technology-based learning by offering resources and expertise that may otherwise be inaccessible in certain regions. Such collaboration can help bridge the digital divide between urban and rural areas, ensuring all students have equal access to high-quality numeracy education.

In conclusion, while challenges such as limited access to technology and time constraints exist, numerous opportunities are available to improve numeracy literacy outcomes. Educators can create a more inclusive and effective learning environment by leveraging digital tools, project-based learning, and community collaboration. This approach addresses current challenges and prepares students for future demands, equipping them with the numeracy skills necessary to thrive in an increasingly complex and technology-driven world. Therefore, policymakers and educational stakeholders

must prioritize investments in infrastructure, teacher training, and innovative teaching strategies to support the enhancement of numeracy literacy across Indonesia.

CONCLUSION

Fundamental Finding: Numeracy literacy is a crucial component of 21st-century education, playing a vital role in preparing students to navigate an increasingly complex, data-driven world. This study underscores the evolving trends in numeracy literacy, highlighting the need for its integration as a foundational skill within educational frameworks. **Implication:** The study suggests that effective numeracy literacy education requires a comprehensive approach, combining contextual learning, technological integration, and real-world applications. Additionally, addressing disparities in access, curriculum design, and teacher preparedness is vital to ensure that numeracy instruction is equitable and effective. By deepening students' understanding of numeracy concepts and their real-world uses, educational institutions can better equip students to make informed decisions, solve problems, and contribute meaningfully to a dynamic global society. **Limitation:** The study recognizes that limited resources, insufficient teacher training, and unequal access to technology may hinder the widespread implementation of numeracy literacy initiatives. These obstacles highlight the need for focused interventions to overcome these barriers and improve the accessibility and quality of numeracy education. **Future Research:** Looking ahead, education stakeholders—policymakers, educators, and researchers must work together to foster innovative strategies and inclusive policies that promote numeracy literacy. Future research should examine the long-term effects of incorporating real-world contexts and technology into numeracy instruction and explore scalable models that address existing challenges and can be adapted to diverse educational environments.

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