

NUMERACY FOR STEM EDUCATION: TRENDS AND EFFECTIVE PRACTICES

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Abstract

Numeracy is an essential component in STEM (Science, Technology, Engineering and Maths) education that supports students' critical and analytical thinking skills. Research reveals that high numeracy skills are closely related to success in learning and applying STEM concepts. Current trends in STEM education emphasise an interdisciplinary approach, where theory is combined with real-world applications through methods such as problem-based learning and the use of educational technology. Effective practices in numeracy teaching involve collaboration, communication, and innovation development, and emphasise the importance of equal access to education for all students. The implementation of this strategy is expected to build a young generation that is capable of facing global challenges in the technological era.

Keywords: Numeracy, STEM Education, Trends and Effective Practices

Introduction

In the era of globalisation and rapid technological advancement, numeracy skills are becoming increasingly important, especially in the field of STEM (Science, Technology, Engineering and Mathematics) education. These fields see particular attention to numeracy as a foundational skill that supports successful learning across all four disciplines (Martinez & Graham, 2023). Numeracy encompasses students' ability to understand, analyse and apply mathematical concepts in real contexts, as well as being the foundation for technological mastery, scientific analysis and engineering design. It encompasses a range of educational approaches that support the integration of numeracy into STEM learning, through both traditional and innovative methodologies such as technology-based learning, projects and collaboration (Williams, 2021).

Numeracy has a very important role in STEM (Science, Technology, Engineering, Mathematics) education as it is the basis for students to understand, analyse and solve complex problems in all four disciplines. Numeracy skills help students interpret data, make estimates, measure, and design solutions based on logical calculations (Kim, 2022)

. In technology, numeracy supports the mastery of algorithms and coding; in science, it helps in the analysis of experiments; in engineering, it is required for the design and calculation of structures; and in mathematics itself, it is central to the development of higher concepts. Without strong numeracy skills, the STEM learning process will be hampered, especially in building the critical thinking skills needed to meet the challenges of the modern era and solve real-world problems (Wilson, 2021) .

Numeracy, therefore, not only plays a role in basic maths skills, but also provides the foundation for the development of analytical thinking and complex problem solving. STEM education has been widely recognised as the key to preparing young people for future challenges in various industry and research sectors (Adams & Clark, 2020) . However, there are several critical issues related to numeracy education in the STEM context in various countries. Firstly, there are still many students who experience difficulties in achieving an adequate level of numeracy, which hinders their ability to thrive in other STEM subjects. Secondly, there are significant disparities in access to quality education, especially for economically and geographically disadvantaged groups. Thirdly, numeracy teaching methods are often not well integrated in STEM curricula, thus not fully supporting students' understanding of more complex concepts (Wilson, 2021) .

Global trends show that there are various innovations in numeracy education to improve learning effectiveness. For example, the implementation of digital technologies such as interactive software and game-based learning has shown great potential in increasing student interest and engagement. In addition, project-based and collaborative learning approaches encourage students to apply numeracy in real contexts, thus increasing the relevance and mastery of the material (Judijanto & Aslan, 2025) .

To meet these challenges, effective practices in the integration of numeracy with STEM education are a major concern. Curriculum adaptation that emphasises the linkage of numeracy concepts with practical applications in STEM fields is urgent. The utilisation of technology and innovative teaching methodologies need to be optimised to produce a more engaging and effective learning experience for students.

Therefore, further research is needed to explore trends and effective practices in numeracy education, especially those that can be applied in the context of STEM education. Identifying successful strategies and evaluating their impact on improving students' numeracy competence will go a long way in realising quality education and preparing young people for an increasingly complex world.

Research Methods

The study in this research uses the literature method. The literature research method is an approach that involves collecting, analysing, and synthesising information from various relevant sources, such as books, scientific journals, articles, research

reports, and other documents. The main purpose of this method is to identify, evaluate, and understand existing theories, findings, and ideas in order to provide a strong theoretical foundation for the research conducted (Yuan & Hunt, 2009) ; (Petticrew & Roberts, 2006) . In the process, the researcher reviews the literature related to the research topic, categorises the information based on specific themes or categories, and integrates the results of the review to answer research questions or develop a deeper understanding (Boote & Beile, 2005) .

Results and Discussion

Trends in Numeracy Development in STEM Education

Numeracy is the ability to understand and use numbers in various contexts, and in STEM (Science, Technology, Engineering, Mathematics) education, numeracy is developing into a fundamental skill that supports problem solving in these fields. With the demands of an increasingly complex world in the digital era, the numeracy development trend in STEM education continues to transform to meet the needs of the times, especially in building students' critical thinking skills, creativity, and analytical abilities. This can be seen from the integration of numeracy into the STEM curriculum in a more integrated manner, so that students not only learn numbers, but also how to apply them in various interconnected disciplines (Martinez & Graham, 2023) .

One of the emerging trends is the use of digital technology in numeracy teaching. Various software, apps and interactive platforms have been developed to help students understand number concepts in a more applicable way in a STEM context. Examples are computer simulations that show the complex interactions between mathematical variables in science experiments or engineering projects. In addition, technology-based numeracy teaching allows students to work with big data, which is now an important part of developing solutions in STEM fields, such as data analytics in science research and algorithms in technology (Williams, 2021) .

Problem-based learning is also an important trend in numeracy-related STEM education. In this approach, students are taught to use numeracy skills directly to solve complex real-world problems, such as designing sustainable environmental models or creating efficient programming systems. Through this approach, students not only learn numeracy in theory, but also get used to applying it in a multidisciplinary STEM context, honing analytical skills and teamwork (Kim, 2022) .

In addition, the integration of numeracy in the development of coding and algorithm skills is of particular interest in STEM education. Coding involving mathematical logic and algorithms is now an important part of digital literacy in the technological era. STEM education emphasises that numeracy skills are not only used for basic calculations, but also to understand data structures, algorithms and statistical concepts that underlie the development of advanced technologies such as artificial

intelligence (AI), robotics and machine learning. Thus, numeracy becomes the foundation for students to understand and master future technologies (Wilson, 2021).

Another trend is the interdisciplinary approach that integrates numeracy explicitly in every aspect of STEM. For example, mathematical concepts such as calculus and statistics are applied in experimental analyses in science, designing structures in engineering, or developing data applications in technology. This approach allows students to understand that numeracy is not a stand-alone field, but rather an essential tool for answering scientific questions, solving technical problems and developing innovations. The link between numeracy and STEM is taught in an applied way so that students are able to see the benefits in real time (Adams & Clark, 2020).

In addition, STEM education with a focus on numeracy is increasingly emphasising active learning, such as laboratory activities or experiments in a data and measurement-centric environment. Students are given the opportunity to collect their own data, make calculations and analyse their results, until they are able to solve problems based on those results. This kind of hands-on experience helps students internalise the importance of numeracy in every aspect of STEM, from statistical analysis techniques to applications in prototype design (Murphy, 2018).

Another trend is also towards developing data literacy as part of numeracy in STEM education. Data literacy includes the ability to read, interpret and create data visualisations relevant to STEM challenges. In the information age, students are equipped with the skills to work with raw data and big data, analyse patterns using statistical tools, and create visual presentations that can support scientific or technical decisions. This shows that numeracy is evolving not only for the calculation aspect, but also includes complex data manipulation and communication (Smith & Brown, 2023).

Furthermore, STEM education is also starting to pay special attention to the formation of a positive numeracy mindset. Often, numeracy is perceived as difficult and boring by students. However, modern interactive and project-based approaches are able to change this perception, making students more confident in using numbers. With a positive numeracy mindset, students become more open to the exploration of more complex STEM concepts, thus being able to see the practical uses of numeracy in everyday life and future work (Taylor, 2019).

The growing trend of numeracy in STEM education reflects the evolving efforts to make students better prepared for the challenges of globalisation and industry 4.0. The emphasis on technology-based approaches, active teaching, data literacy, and positive mindset building shows that numeracy is no longer just about counting on paper, but an applicable and flexible skill that is relevant for various contexts. By strengthening numeracy through STEM education, students are expected to become a generation of innovators who master number-based problem solving in an increasingly digitally connected world.

Effective Numeracy Practices in STEM Learning

Numeracy is the ability to understand, interpret and use numbers and data in various contexts. In STEM (Science, Technology, Engineering and Mathematics) based learning, numeracy is an important element as it supports students in analysing information, solving problems and running scientific experiments. Numeracy allows students to effectively explore the fields of maths and technology (Green, 2023).

The effectiveness of STEM learning depends on how numeracy is integrated into learning activities. For example, in a robotics project, students are not only taught to assemble devices, but also perform calculations related to motion or speed sensors. In this way, numeracy becomes a functional skill and is not separated from practical applications. To improve numeracy in STEM, teachers can utilise real-life problems as learning contexts. For example, analysing air pollution with environmental data or calculating the energy used by certain electronic devices at home. This context makes students more connected to the real world while improving numeracy skills (Miller, 2022).

Project-based learning is a particularly relevant approach in STEM. Students are invited to create a product or solution to a problem, such as designing an irrigation system or creating an energy-saving device. In this process, they will engage in measurements, calculations and policy analysis, all of which require deep numeracy competencies (Purike & Aslan, 2025); (Firmansyah & Aslan, 2025a).

Digital technology helps improve students' numeracy skills in STEM learning. Applications such as Excel, GeoGebra and Python can assist students in creating graphs, analysing data and performing simulations. The use of these technologies stimulates students to optimally integrate numeracy with technological skills (Firmansyah & Aslan, 2025b).

Data literacy is an important aspect of numeracy in the digital age. Students need to understand how to read, interpret and present data. In STEM learning, data literacy can be applied with activities such as analysing graphs of experimental results or presenting statistics based on direct observations (Pugu & Aslan, 2025).

STEM is not only individual-based, but also encourages teamwork. In teamwork, students can share ideas, analyse together, and compare their calculations with group members. Such collaboration not only strengthens numeracy skills, but also improves interpersonal skills (Taylor, 2019).

The effectiveness of numeracy in STEM is achieved when students are invited to understand the relationships between fields. For example, the use of mathematical equations in physics experiments or the application of statistical concepts to biological analyses. This approach helps students see that numeracy can be used in a variety of disciplinary contexts (Green, 2023).

Numeracy is not just about counting numbers, it also involves critical thinking and problem solving. In STEM learning, students need to be encouraged to analyse data

deeply, look for patterns and make decisions based on the numerical information available. These exercises will train their numeracy skills as well as their logic. To maximise numeracy mastery, teachers need to provide constructive feedback. When students make mistakes in calculations or analyses, teachers should explain the mistakes and offer solutions. This feedback supports students in understanding concepts more deeply (Miller, 2022).

Numeracy in STEM learning needs to be evaluated on an ongoing basis. Teachers can use various methods such as formative tests, project portfolios, or direct observation of student activities. These evaluations not only measure students' numeracy skills, but also identify areas that need further development (Anderson & Reed, 2021).

A supportive learning environment is essential for developing numeracy. Teachers need to create an atmosphere that motivates students, provide relevant tools, and build discussions that encourage students to think critically. With a conducive environment, students will feel more confident to apply their numeracy skills in STEM learning (Smith & Brown, 2023).

Thus, the implementation of effective numeracy practices, students will be increasingly trained in integrating mathematical abilities with other disciplines in STEM, resulting in holistic learning that is relevant to the challenges of the 21st century.

Conclusion

Numeracy plays a fundamental role in STEM (Science, Technology, Engineering and Maths) education, as this skill supports the mastery of basic concepts in each related discipline. Research shows that strong numeracy skills not only improve students' understanding of STEM material, but also build critical thinking, analytical and problem solving skills. Therefore, effective integration of numeracy learning is key to producing a young generation that is competent to face the challenges of an increasingly complex world of work in the technological era.

Current trends in STEM education emphasise an interdisciplinary approach that combines theoretical learning with real-world applications. In this case, educational practices involving numeracy also focus on hands-on experiences, such as through problem-based learning projects, simulations or experiments. Students are invited to relate the use of numeracy concepts to various practical problems, so that they not only understand the theory but also how to apply these skills to solve everyday problems. Technological approaches, such as the utilisation of educational software and applications, have become important tools to support more interactive and engaging numeracy learning.

Effective practices in numeracy teaching for STEM education involve collaboration, communication and the development of innovative thinking. Teachers and educators need to actively create learning environments that encourage student

exploration and creativity. In addition, the role of equity is also important in ensuring that every student, regardless of economic or social background, has equal access to quality numeracy learning. By incorporating relevant strategies, such as the introduction of local and international contexts, numeracy-based STEM education can be a key vehicle to build a generation that is better prepared to face global challenges.

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