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Research Article

Implementation of STEAM-based digital learning for students' numeracy literacy in elementary schools

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Abstract: The lack of optimal empowerment of effective numeracy literacy at the elementary school level can result in less-than-optimal mathematics learning outcomes for students. This research aims to see the effect of implementing digital learning integrated with the STEAM approach on the numeracy literacy of fifth grade elementary school students. This research combines experimental and quantitative methods with Nonequivalent Control Group Design. The sample was 40 students from classes VA and VB at SDN 200304 Padangsidimpuan City who were selected using purposive sampling. The research results show an increase in students' numeracy literacy skills after using STEAM-based learning media. In conclusion, the application of digital learning with the STEAM approach has a positive impact on increasing the numeracy literacy of elementary school students.

Keywords: digital learning; numeration literacy; STEAM approach

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1. Introduction

Digital learning is a form of learning that refers to the use of digital technology to support learning (Basak et al., 2018). Digital learning can improve students' abilities in line with the demands of the current modern era and encourage various 21st Century skills (Abdullateef, 2021; Hover & Wise, 2022; Phoon et al., 2021). This learning promotes inquiry activities and facilitates knowledge construction by facilitating long-distance communication and the use of various other modern technologies in the field (Hofhues, 2019; Mason & Pillay, 2015). Digital tools such as Google and YouTube can be used as a source of knowledge that stimulates the learning environment with contextualized audio, video and visual materials (Barry et al., 2016; Orús et al., 2016). Digital learning, together with e-learning, can increase learning motivation (Ciampa, 2014; Lin et al., 2017) and enable self-directed learning (Morris & Rohs, 2023; Sumuer, 2018), thereby providing various important benefits for the student learning process.

When applied properly, digital learning can improve student engagement with teachers and other students as well as the quality of educational institutions and graduates (Hutain & Michinov, 2022; Wiseman et al., 2016). It can also foster the development of good learning communities and increase students' interaction with one another and with teachers. engage, give, and receive from one another without being confined to one place. Online media include self-contained educational materials that may be accessed and distributed through many online platforms such as podcasts, web pages, downloaded documents, forums, Twitter, blogs, and others (Gutmann et al., 2015; Rodriguez-Triana et al., 2014; Wong et al., 2020). So that the goals and benefits of digital learning can be realized well, there needs to be help from a good learning approach.

The Science, Technology, Engineering, Art, and Mathematics (STEAM) approach is one educational strategy that encourages the use of digital learning. With the use of activities based on five integrated scientific disciplines, STEAM is a teaching strategy that enables students to generate concepts based on science and technology (Boice et al., 2021). In the face of technological advances, the use of STEAM in learning is a process of using ideas, notions and concepts included in meta-disciplines in a learning environment which has potency to increase learning achievement (Chen & Huang, 2023) and competencies (Wannapiroon & Pimdee, 2022).

The STEAM approach is teaching that allows students to create concepts based on science and technology through inquiry and problem-solving exercises based on five interrelated scientific disciplines (Ozkan & Topsakal, 2021). By applying the STEAM approach as a learning approach, students can explore and develop ideas through problem solving activities based on five interconnected scientific disciplines (Erol et al., 2023; Quigley et al., 2017). The goal of implementing the STEAM approach is to teach students how to solve problems creatively, confidently, and logically. When a problem is solved using principles from several scientific disciplines, very precise answers are produced, making the problem-solving process very interesting, rewarding, and effective. The STEAM learning approach also encourages students' curiosity, openness, experience and questions so that students can learn more about the world by observing, observing, discovering and researching the problems they face (Suryaningsih & Nisa, 2021).

On the other hand, observations carried out in fifth grade at the research location in this paper revealed significant problems related to numeracy literacy among students. This problem is caused by inadequate implementation of the comprehensive literacy movement in the school curriculum. Numeracy literacy involves the ability to understand, interpret, and use numbers and mathematical symbols to solve real-world problems and analyze data presented in a variety of formats such as graphs and tables. Preliminary analysis shows that 63 fifth grade students have low numeracy literacy, with an average error rate of 71.56% on the literacy test. Contributing factors include a lack of numeracy activities in schools, students' misunderstanding of mathematical concepts, and a general reluctance towards mathematics due to lack of literacy, low knowledge and lack of interest. Interviews with teachers highlighted the need for better guidance and support to improve students' understanding and engagement in mathematics.

The STEAM approach combined with digital learning has great potential to improve students' numeracy literacy. Digital learning provides interactive tools and resources that can integrate various disciplines on one platform. By using digital technology, students can explore mathematical concepts through simulations, visualizations and practical applications that are more interesting and contextual. The STEAM approach allows for more integrated and relevant learning, where students can see the connections between mathematics and other disciplines, thereby increasing their understanding and interest. Additionally, dynamic and interactive digital learning environments can increase student motivation and engagement, as well as provide opportunities for independent and collaborative learning.

The novelty of this research is that it uses digital learning in the form of digital books designed by the researcher himself by applying the STEAM approach. Digital books combined with the STEAM approach are something new in mathematics learning in elementary schools. Previous studies carried out simple digital learning without combining it with digital books or interesting learning approaches. Approach STEAM in this research will be integrated with digital learning using e-books prepared through the online book creator application. The STEAM learning approach is a combination of science, technology, engineering, art and mathematics into a learning model that improves student performance, activity, communication skills and critical thinking. From observation data, it is known that students' skills in mathematical concepts are still lacking and assessment results are still low. Therefore, the aim of this research is to see the influence that the application of digital learning integrated with the STEAM approach has on the numerical literacy of fifth grade elementary school students.

2. Materials and Methods

This study combines experimental and quantitative research techniques. Examining the correlations between variables is one way that quantitative research tests certain theories. This research uses a Nonequivalent Control Group Design and the research aims to obtain information from experiments based on the treatment of an experimental unit within the design limits set in the experimental class so that data is obtained that describes what is expected.

This research was conducted at SDN 200304 Padangsidimpuan City with a total of 40 students in classes VA and VB. The sampling technique was carried out with the consideration that one school that has parallel classes has the same ability to understand numeracy literacy and learning outcomes. Research sampling is purposive sampling. The class chosen to be used as an experimental group provides digital learning integrated with the STEAM approach to see students' numeracy literacy abilities. The instruments used to test the research were numeracy literacy questions in the form of 10 multiple choice items and cognitive questions in the form of 5 fill-in-the-blanks. The data analysis technique in this research is the independent sample t test. Before the data is analyzed, it is necessary to test the prerequisites for data analysis, namely normality and homogeneity tests. The scheme of this research is presented in Figure 1.

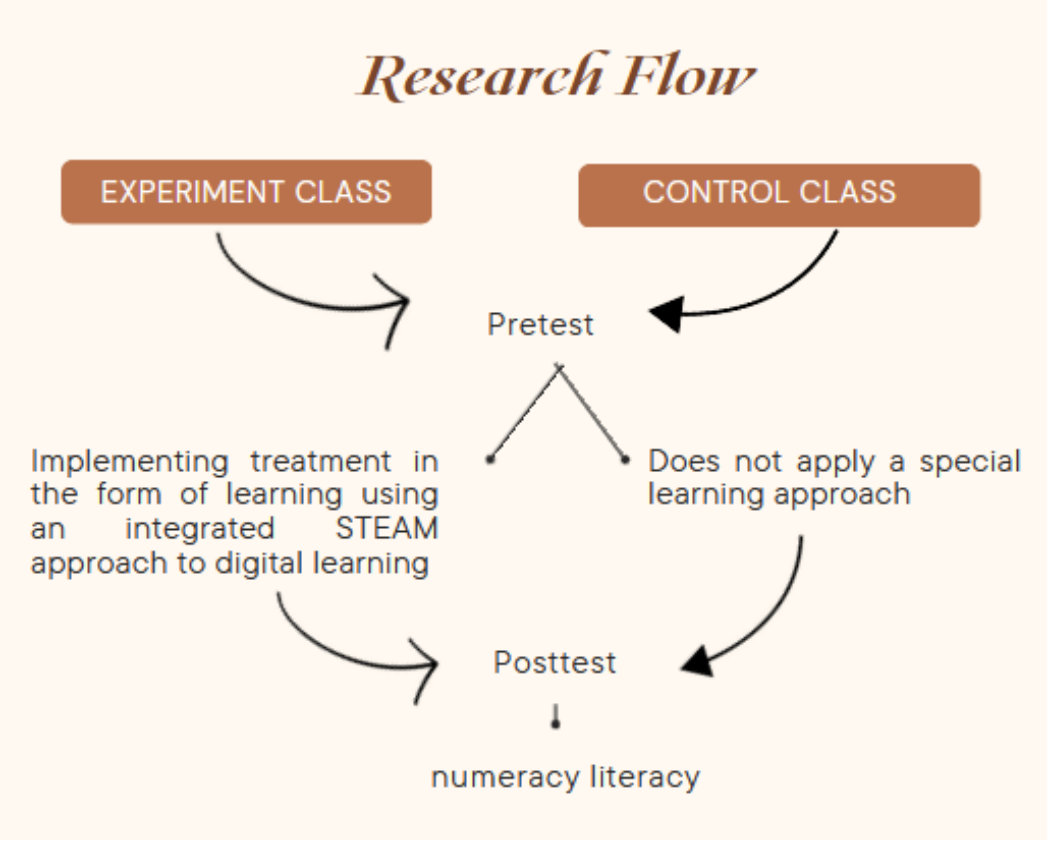

Figure 1. Research flows

3. Results

The application of digital learning combined with the STEAM method is summed up in the study's findings. In the experimental class, 90% of digital learning is implemented through a combination of STEAM phases. This demonstrates that practically every stage of the learning activities has been executed flawlessly, yet there are a few roadblocks at the engineering level when students get lost trying to figure out how to solve their learning difficulties. The control class has a 100% implementation rate of learning, indicating that the activities there have been successful and that special methods or treatments are not used in the control class. The calculation results are presented in the Table 1.

The analysis test results in the Table 1 illustrate the implementation of integrated digital learning with a STEAM approach to numeracy literacy showing a coefficient of determination of 74.1%. The significant level is 0.000 < 0.05, which means that there is an influence of integrated digital learning with the STEAM approach on the numeracy literacy of fifth grade elementary school students. Then the average value of students' numeracy literacy was calculated. The increase in the average score from the application of integrated digital learning with the STEAM approach to students' numeracy literacy can be seen from the pretest and posttest scores in the experimental group which have quite higher scores than the control group. The calculation results are presented in the Table 2.

Table 1. Results of learning implementation consistency test

Influence	R Square	Sig.	F	B
Integrated Digital Learning STEAM Approach to Numeracy Literacy – Experimental Class	0.741	0.000	58.541	0.614
Ordinary Learning for Numeracy Literacy – Control Class	0.603	0.004	56.003	0.770

Table 2. Results of the average value of students' numeracy literacy

Class	Strategy	Pretest	Posttest	Enhancemen (%)
Experiment	integrated digital learning with a STEAM approach	60.51	83.33	22.82
Control	Conventional	52.08	66.14	14.06

In the experimental class, there was an increase in the average value of numeracy literacy of 22.82%, whereas in the control class, it was 14.06%. This indicates that the use of integrated digital learning in conjunction with a STEAM approach helps to improve primary school kids' numeracy literacy in the fifth grade. The necessary tests the homogeneity and normality tests are next administered following the determination of the average student score.

Use the SPSS 24 tool to verify the requirements for the homogeneity and normality assumption. The significance level value indicates if the data is considered to be regularly distributed, and these are the requirements for viewing the normality test. In the meanwhile, if the data is not normally distributed. The Table 3 displays the results of the tests for homogeneity and normality. Based on Table 3, all data is normally distributed. Furthermore, the result of homogeneity test is presented in Table 4. Based on Table 4, the homogeneity assumption is also met.

Table 3. Normality of numeracy literacy test data

Class	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	Df	Sig.
Pretest Experiment	0.138	20	0.166	0.939	20	0.150
Control Pretest	0.142	20	0.143	0.914	20	0.063
Experiment Posttest	0.110	20	0.191	0.921	20	0.072
Control Posttest	0.149	20	0.163	0.961	20	0.148

Table 4. Homogeneity of numeracy literacy test data

Levene Statistics	df1	df2	Sig.
0.256	3	40	0.148

Furthermore, because all research data met the assumptions of normality and homogeneity, the data continued to be analyzed using the independent sample t-test. The results of the t test are presented in Table 5. Based on Table 5, the average numeracy literacy score of students in the experimental class is significantly different from the control class. This result indicates that the use of integrated digital learning in conjunction with a STEAM approach has an impact on students' numeracy literacy in fifth grade elementary school mathematics instruction. The influence provided is in the form of increasing students' numeracy literacy which is calculated and obtained from the results of students' work on numeracy literacy practice questions. Students really like the application of digital learning and they are enthusiastic about learning new things through digital media and technology. Moreover, in this learning, students apply the STEAM approach which requires students to be creative and create a project that can solve their learning problems.

Table 5. Independent sample t test result

Class	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		Q	df	Sig. (2-tailed)
				Lower	Upper			
Experiment - Control	21.000	10.802	2.351	14.891	26.571	8.114	18	0.001

4. Discussion

The results from this study reveals that the influence of digital learning in the form of use e-book prepared through the online book creator application and combined with the STEAM approach could to improve numeracy literacy for fifth grade elementary school students. This digital learning was created as a numeracy literacy material and a solution to develop students' learning creativity in the increasingly rapid digital era (Sousa et al., 2022). Increasing students' numeracy literacy can minimize students' learning difficulties because numeracy iterations can improve students' skills in recognizing symbols and numbers in mathematics, analyzing information displayed in various forms (graphs, tables, charts, diagrams, etc.), and solving problems (Rohim, 2021). Numeracy literacy also plays an important role in various aspects of life. In the field of education, numeracy literacy plays a significant role in students' learning outcomes and problem-solving skills, especially those related to mathematics. Furthermore, empowering numeracy literacy is also linked as a factor that can influence social and professional harmony in accordance with the Sustainable Development Goals (SDGs) and financial literacy objectives (Bellini et al., 2019).

In line with the findings of this research, digital learning was also reported to have a positive impact on numeracy literacy in several previous studies. Integrating digital technology in mathematics education shows an increase in students' skills, their mathematical knowledge, and their critical thinking skills (Geiger et al., 2015). The use of digital technology in mathematics learning is also in line with the current generation of elementary school students who are surrounded by online resources and tools so that they can improve their learning experiences and outcomes (Dorris et al., 2021). Other research also reports that computer-assisted instruction can improve preschoolers' literacy and numeracy skills thereby showing a positive effect of technology use on students at an early age (Rogowsky et al., 2018). Furthermore, research indicates that higher levels of math-related literacies are associated with increased internet use and travel distance (Hong et al., 2020).

In line with all this, the use of digital storytelling in learning is also able to encourage the development of knowledge, collaboration, and engagement in mathematics learning, thus emphasizing the role of technology in improving 21st Century skills and students' mathematical literacy (Niemi et al., 2018).

The STEAM approach provides students with the opportunity to develop positive attitudes towards various fields of knowledge, including science and mathematics. This can be a strong foundation for students to build an attitude of liking mathematics and science, so that they can easily face academic tasks at school age (Quigley et al., 2020). The application of STEAM in several previous studies was also reported to have a positive impact on students' numeracy literacy. One study revealed that using STEMA can improve linguistic and mathematical competencies, especially in several aspects such as calculations and problem-solving (Duo-Terron et al., 2022). Additionally, integrating STEAM in learning has a positive correlation with problem-solving skills and reading comprehension (Pahmi et al., 2022). Apart from problem solving skills, creative abilities can also be empowered through STEAM-based learning methods, thus showing how useful the use of STEAM is in improving students' 21st Century skills (Wahba et al., 2022).

5. Conclusions

This research reports that the application of digital learning integrated with STEAM plays a significant role in increasing the numeracy literacy of elementary school students. Students like the application of digital learning and they are enthusiastic about learning new things through digital media and technology. Moreover, in this learning, students apply the STEAM approach which requires students to be creative and create a project that can solve their learning problems. In line with the rapid development of education from time to time, it is recommended that teachers continue to learn to apply diverse learning, to develop learning innovations, one of which is by digital learning.

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