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Evaluation and effects of STEAM-PBL on mathematics interest and numeracy skills on elementary school

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ABSTRACT

The integration of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach with a project-based learning model is increasingly recognized as a potent strategy for fostering the development of 21st-century skills. This study explores the application of this strategy in the context of elementary school mathematics education and investigates its impact on students' interest in learning mathematics and their numeracy skills. The research employs a mixed-methods approach, utilizing a combination of questionnaires, tests, observations, and interviews for data collection. The primary aim is to evaluate the effectiveness of the project-based STEAM approach in enhancing students' interest and numeracy literacy skills in mathematics.Statistical analysis of the collected data reveals a significance value of 0.00<0.05. This finding suggests that the implementation of a project-based STEAM approach has a positive and significant effect on students' interest in learning mathematics and their numeracy skills.Observations and interviews further corroborate the effectiveness of this approach in improving students' abilities. However, the study also identifies certain shortcomings in its application, underscoring the need for careful preparation to ensure optimal outcomes.In conclusion, this study provides valuable insights into the potential of the STEAM approach, combined with project-based learning, to enhance elementary school students' engagement and performance in mathematics. It also highlights the importance of continuous evaluation and refinement of teaching strategies to meet the evolving needs of 21st-century learners.

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INTRODUCTION

Mathematics, as a subject, plays a pivotal role in fostering intellectual growth and honing critical thinking skills among students (Larbi & Okyere, 2016). Its importance is underscored from the elementary school level, where it serves not just as a conduit for learning concepts and procedures, but also as a catalyst for creativity, critical thinking, problem-solving, and communication skills. Law Number 20 of 2003, which governs the National Education System, in Article 37, designates mathematics as one of the compulsory subjects at the Elementary and Secondary Education levels (Undang-Undang Republik Indonesia Nomor 20 Tahun 2003 Tentang Sistem Pendidikan Nasional, 2003).

The objective of mathematics education extends beyond mere comprehension of the subject matter; it plays a crucial role in character development, enhancing rational, critical, and logical thinking, stimulating creativity, and strengthening problem-solving skills (Irfan, 2018). Despite its significant role and substantial allocation in the curriculum, mathematics education continues to face challenges in terms

of teaching methodologies and learning outcomes (Rosyada & Retnawati, 2021). The results of learning mathematics in schools are often unsatisfactory and tend to regress in many schools, and this is a challenge and problem that needs to be overcome (Prabowo et al., 2018). Mathematics education is often perceived as daunting by students (Amir, 2013; Efendi et al., 2021). This negative perception of students towards mathematics is one of the problems faced in the process of learning mathematics. Negative perceptions of mathematics can arise from several factors, such as previous difficult experiences, pressure from others, or lack of confidence in mathematical abilities (Kandari et al., 2023). These negative perceptions certainly affect students' interest in learning so that, learning mathematics needs to be designed and planned as well as possible in order to stimulate students' interest in learning mathematics.

Developing an interest in learning is a critical component of any educational process, including in the context of mathematics education (Adnyana & Yudaparmita, 2023). This interest plays a vital role in motivating students to be more enthusiastic and focused on assimilating mathematical knowledge and skills. When nurtured and reinforced, this interest can lead to increased engagement in the learning process and motivate students to delve deeper into mathematical concepts (Herpratiwi & Tohir, 2022). Thus, it can be said that having an interest can significantly aid individuals in the mathematics learning process. Interest in learning mathematics refers to a strong inclination, eagerness, or high desire towards mathematics learning. It encompasses a genuine liking and attachment to mathematical learning activities without any external pressure (Bicer & Lee, 2019; Irfan et al., 2020). Interest in learning mathematics is not an innate trait but can be developed and influenced by prior learning experiences (Amalia & Khoiruddin, 2023). This indicates that interest in learning can be enhanced through various efforts and relevant experiences in the learning process.

In reality, most students' interest in learning mathematics is still relatively low. According to Firdaus (2019) 58.47% of the 90 elementary school students surveyed demonstrated a low level of interest in mathematics. This data shows that most of the students who were respondents were not interested in learning math. In line with this, Putri & Safrizal (2023) revealed that from interviews it was found that some elementary school students lacked confidence and were passive (reluctant to ask questions) during mathematics learning. Therefore, efforts are needed to increase students' interest in learning mathematics. A positive interest in learning drives learning motivation (Nawahdani et al., 2022). In the context of mathematics, the presence of an interest in learning mathematics can drive the motivation to delve into mathematics in everyday life. An individual with a high interest in mathematics tends to seek opportunities to hone their numeracy skills. Mastery of mathematics helps an individual have a strong foundation of knowledge in calculations and problem-solving. Numeracy skills also help individuals apply mathematical knowledge in various real-life contexts.

Numeracy skills are important abilities to be developed in shaping skilled learners in a world increasingly dominated by numbers and data. Numeracy skills are the ability to understand numbers and symbols related to basic mathematical concepts to solve practical problems in various daily life situations (Kementerian Pendidikan dan kebudayaan Republik Indonesia, 2019). This includes an individual's ability to recognize, understand, and utilize numbers and mathematical concepts in real contexts, enabling students to make smart decisions, plan budgets, and solve problems that arise in various aspects of life, such as shopping, managing finances, or even in everyday situations like cooking, measuring, and planning travel routes.

However, the reality is that students' numeracy skills in Indonesia are relatively low, as indicated by the results of the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). In 2015, Indonesia ranked 44th out of 49 participating countries, with an average mathematics ability score of 397 (Harususilo, 2019). The TIMSS survey, which involved fourth-grade elementary school students, revealed that Indonesia's mathematics score was below the TIMSS Scale Center average. In 2018, the PISA-based mathematics ability assessment yielded a score of 379, below the ASEAN average (431) and the global PISA participant average (490). Even in regions known for their strong education systems, such as DKI and DIY, mathematics ability scores still lagged behind at 416 and 422 respectively (Wuryanto & Abduh, 2022).

Enhancing interest in learning mathematics and numeracy skills is essential in the context of contemporary education. As a key element in the formation of intellectual skills and critical thinking, a deep understanding of mathematics and numeracy has a significant impact on students' cognitive development. Therefore, there needs to be a commitment and appropriate strategy to address this. By

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using innovative and supportive learning models and methods, such as project-based or information technology approaches, schools can create a learning environment that stimulates students' interest in mathematics. Thus, enhancing interest in learning mathematics and numeracy skills will provide a strong foundation for academic advancement and students' adaptability in this era of globalization.

One of the 21st-century learning strategies related to the development of mathematical abilities is the use of the STEAM approach. The STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach is an innovative way of learning (Mu'minah & Suryaningsih, 2020). STEAM integrates various disciplines, including mathematics, with arts, science, technology, and engineering, to create a more comprehensive and engaging learning experience for students. By combining mathematics subjects with creative elements such as arts and technology, students can see the connection between mathematics and the real world in a more tangible and relevant way (Bertrand & Namukasa, 2023).

The STEAM approach can be integrated with a project-based learning method. When integrating the STEAM approach with project-based mathematics learning, a strong blend of mathematical concepts and practical applications in daily life can occur (Zubaidah, 2019). In project-based mathematics learning, students not only understand mathematical concepts but also apply them in real-world situations, including in the context of science, technology, engineering, arts, and mathematics (Wicaksana & Ridlo, 2017). his approach allows students to see the relevance of mathematics in various contexts and develop a deeper understanding and strong problem-solving skills. So, the STEAM approach opens the door to deeper and more meaningful mathematics learning through challenging and inspiring projects. This research will analyze the influence of the project-based STEAM approach on the interest in learning mathematics and the numeracy skills of elementary school students and how its implementation in mathematics learning.

METHOD

This research was designed using a mixed methods approach that combines two primary methodologies: quantitative and qualitative. The quantitative approach involves the collection and analysis of numerical or statistical data to investigate patterns in students' numeracy skills and their interest in learning mathematics at the elementary school level. Additionally, it aims to examine the influence of project-based STEAM (Science, Technology, Engineering, Arts, and Mathematics) approaches. And the qualitative approach focuses more on gaining in-depth understanding of the context, meaning, and interpretation of subjects in the research. By employing a mixed methods design, this study aims to provide a more comprehensive advantage, offering a profound understanding of the topic under investigation.

The subjects of the study are upper-grade students from 3 Elementary Schools in Bone-Bone Subdistrict, North Luwu Regency, South Sulawesi Province. The three schools are UPT SD Negeri 211 Bone-Bone, UPT SD Negeri 215 Banyuurip, and UPT SD Negeri 219 Sukaraya. The total number of respondents is 229 students. For the fourth grade, there are 70 students, the fifth grade has 79 students, and the sixth grade has 80 students.

Data collection was conducted through various methods, including questionnaires, tests, observations, and interviews. The questionnaire was used to collect data on students' interest in learning mathematics. The questionnaire consisted of 20 Likert-scale questions based on indicators reflecting active engagement, interest in mathematics learning, enjoyment, attention, and positive responses to mathematical challenges during learning. The questionnaire had been previously validated by experts, with an average expert rating of 3.92, categorized as appropriate and usable. Additionally, construct validity was tested using the product-moment correlation, with 21 out of 25 questionnaire items deemed valid. The questionnaire's reliability was assessed using Cronbach's alpha, yielding a reliability score of 0.876, categorized as reliable.

For the test instrument measuring students' numeracy skills in Grades IV, V, and VI, it was adapted from modules developed by (Pusmenjar, 2020a, 2020c, 2020b). Furthermore, the observation instrument is used to help researchers or observers observe, record, and evaluate how mathematics learning with a project-based STEAM approach and the application of mathematical concepts. This observation instrument has been validated by experts in material and media aspects and is said to be valid. In addition, at the end of each session, an evaluation is also carried out together by the class teacher

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and the researcher through semi-structured interviews. Semi-structured interviews in research on mathematics learning with a project-based STEAM approach involve a number of relevant indicators to collect comprehensive and in-depth data. The interview indicators explore the teacher's experience from the implementation of the learning, the challenges faced, the benefits and impacts, changes in student learning. This research will analyze the influence of the project-based STEAM approach on the interest in learning mathematics and the numeracy skills of elementary school students and how its implementation in mathematics learning.

Data analysis for students' interest in learning mathematics and numeracy skills involved descriptive statistical analysis and inferential statistics. Descriptive statistical analysis included presenting various information such as frequency and percentage data categorized into very low (20-35), low (36-50), moderate (51-65), high (66-80), very high (81-100) (Widoyoko, 2015). Similarly, the interest in learning mathematics and numeracy skills data are analyzed using both descriptive and inferential statistical approaches. Descriptive statistics for numeracy skills are categorized into Proficient, Competent, Basic, and Low (Direktorat Pendidikan Dasar, 2021). Inferential statistics are employed to identify the influence of the STEAM approach with project-based learning models on students' interest in learning mathematics and numeracy skills. This inferential statistical analysis involves the use of paired sample t-tests to assess the differences between pretest and posttest data. Additionally, the normalized gain test is employed to examine the improvement from pretest to posttest data. Qualitative descriptive analysis was used for observational data to provide detailed findings on significant events or occurrences reflecting the quality of mathematics learning with project-based STEAM approaches. Interview data were analyzed thematically by identifying thematic patterns or topics that emerged repeatedly in the interviews with each respondent.

RESULT AND DISCUSSION

Elementary school mathematics learning using project-based STEAM approach

The implementation of project-based STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in elementary school mathematics education involves a series of systematic steps:

1) The initial step involves identifying the mathematical concepts that will be imparted to the students. The choice of mathematical concepts, topics, and themes for the project-based STEAM approach is customized according to the learning objectives and the students' grade level.
2) Following the mathematical concepts are identified, relevant projects are selected. In this research, the projects selected are simple and closely related to the concepts being taught.
3) The planning phase of the project is conducted in collaboration with the students. The teacher guides the students in the planning process, which includes determining the tools and materials required for project completion, outlining the steps to be followed, and identifying the necessary resources.
4) After the project is completed, the students present their findings, which can take the form of reports, presentations, or project exhibitions. Students are required to explain the mathematical concepts they have learned and how these concepts were applied in the project they worked on.
5) The final step involves evaluating the project or assessing the quality of the students' work. This step is crucial in assessing the students' understanding and application of the mathematical concepts in a real-world context.

The implementation of mathematics learning with a STEAM-based project approach at the Elementary School is organized into small groups, with a maximum of five students per group. Each student assumes distinct roles within the group based on their individual skills and interests, fostering an environment conducive to active participation in the learning process.

In the 4th-grade at the Elementary School, the focal point of instruction revolves around the concept of angles. The assigned project tasks students with creating a floor plan of a house and identifying objects within the home that exhibit angular characteristics. The Science component of this project entails students engaging in observation and comprehension of the concept of angles as an integral facet of mathematics, incorporating scientific elements. Students are guided through the utilization of straightforward scientific methodologies to identify and measure angles within their

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immediate surroundings. The Technological dimension of the project encompasses the procedural aspects of documentation, design, printing, and presentation. Students are afforded the autonomy to leverage cameras or smartphones for capturing images of discerned angles, as well as digital devices for designing, printing, and presenting the outcomes of their projects.

The Engineering facet of the project introduces rudimentary engineering concepts concerning the selection of tools, methods of measurement, and data recording. Furthermore, students are granted the flexibility to employ tools or objects in the formulation of their floor plans. The Arts element is manifested during the culmination of this mathematical project through the creation of aesthetically pleasing and captivating products and presentations, incorporating drawings and illustrations of identified angles. The Mathematics component concentrates on the fundamental concept elucidated in this project, namely the comprehension and classification of angles in mathematics. Students undertake the identification and categorization of various angles, encompassing obtuse, acute, and right angles, along with the measurement of these angular entities. This integrated pedagogical approach ensures that students not only assimilate mathematical concepts but also cultivate skills in observation, scientific inquiry, technology utilization, engineering principles, and artistic expression.

In the 5th grade of Elementary School, the focal point of instruction is the concept of fractions. The assigned project entails guiding students to identify and elucidate how fractions are utilized in daily life. While the Science aspect in this project is not as dominant, students can acquire foundational concepts such as division, parts of a whole, and comparisons, which constitute the fundamental mathematical basis of fractions. The Technology aspect during the project allows students to utilize technology in various ways, such as capturing images of objects involving fractions, creating digital presentations, or using calculators to aid in measurements or calculations related to fractions.

The Engineering aspect of the project involves students completing tasks and applying simple design thinking, either manually through paper-based designs or using technology. This includes the selection of tools or methods for students to measure or record data related to fractions. The Arts aspect is integrated by prompting students to create engaging and informative presentations. Students can incorporate visual design elements, images, and illustrations to convey information about the application of fractions. Subsequently, the Mathematics aspect focuses on the key concept taught in this project, namely the concept of fractions in mathematics. Students identify, explain, and illustrate everyday situations where fractions are employed. Additionally, students learn how to calculate and comprehend fraction comparisons. This integrated approach ensures that students not only grasp the mathematical intricacies of fractions but also gain practical insights into their application in real-life scenarios. The incorporation of various aspects, including Science, Technology, Engineering, Arts, and Mathematics, provi

In the 6th grade, students are instructed to comprehend the concept of circles through a project-based approach. In this project, the Science aspect involves students learning through discovery, observation, investigation, and identification of circular objects in their surroundings. Students measure the diameter, radius, circumference, and area of these circular entities. The Technology aspect integrates various technological applications, such as capturing photos of circular objects in daily situations, creating digital presentations, or utilizing graphic software to generate circle illustrations.

The Engineering element is not as prominent in this project, but students can employ various techniques to design and conceptualize products, images, or tools. For instance, they may use smartphone software or engage in the process through sketches and drawing papers. The Arts element is integrated as students create engaging and informative presentations, utilizing creative visual design elements and illustrations, as well as when producing drawings or artworks. The Mathematics aspect taught in this project centers on the mathematical concept of circles. Students identify, explain, and measure circles, applying mathematical concepts such as diameter, radius, and circumference within the context of everyday situations they encounter.

The implementation of the STEAM approach, coupled with project-based learning in Elementary School, is evident in the emphasis on the Science aspect, which aligns with scientific attitudes or practices. Students, when completing the project, apply scientific steps, including observation, formulating questions, data collection, reasoning or classification, communication, and creation (Hosnan, 2014; Musfiqon & Nurdyansyah, 2016; Novili et al., 2017; Sani, 2015).

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The Technology aspect in elementary school mathematics projects is primarily focused on the utilization of information technology, such as the internet, smartphones, or computers. Information technology is employed to seek information sources supporting the ongoing project. Presently, the use of information technology in elementary school learning is widespread, particularly in online learning. Additionally, information technology supports distance or online learning, especially in situations where in-person schooling is not feasible, such as during the COVID-19 pandemic. Information technology enables teachers to conduct lessons online, interact with students, and electronically deliver assignments.

The Engineering aspect in project-based mathematics learning at the elementary school level emphasizes the execution of projects that do not necessarily adhere to a singular methodology but can be accomplished using various techniques with an outcome-oriented focus. Students are provided with opportunities to explore and experiment with diverse mathematical techniques to achieve the desired results.

When the Arts aspect is integrated with project-based mathematics learning in elementary school, it refers to the aesthetic aspects of project outcomes and the visualization of compelling data during the presentation phase of the generated products. Learning that incorporates the artistic element involves an understanding of how aesthetic values communicate messages to an audience. In this context, students learn how to select and utilize various artistic elements, such as color, form, and visual techniques, to convey messages or ideas to others. Meanwhile, the mathematical aspect in the project-based STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach to elementary school mathematics refers to the use of numerical data and mathematical concepts that are pertinent and relevant to everyday life.

The impact of the STEAM approach with project-based learning model on students' interest in learning mathematics

The statistical analysis results to examine the impact of the STEAM approach with project-based learning model on students' interest in learning mathematics involve comparing the pretest and posttest scores of students' interest. Table 1 below represents the results of this analysis.

Table 1. The results of the analysis of students' interest in learning mathematics

Test	Mean	StD	n-gain	Sig.	t-test
Pretest	49.36	10.91	20,29%	0,00	28.586
Posttest	59.64	12.07			

Based on Table 1, it is evident that the average mathematics learning interest of students has increased from an initial value of 49.36 to 59.64, falling into the moderate category. Furthermore, the normalized gain (n-gain) value is 20.29%, indicating that after receiving instruction, students' interest in learning mathematics has increased by 20.29% from pretest to the posttest. Several studies have demonstrated that an enhancement in mathematics learning interest has a positive impact on students' understanding and performance in the learning process (Andira et al., 2022; Dang et al., 2023; Fadilah & Alwi, 2020; Sauer, 2012).

The standard deviation of the data has also increased from the pretest (10.91) to the posttest (12.07), indicating that the data has become more heterogeneous, or has a greater variation. The t-test score for both sets of data is 28.586 with a significance value of 0.00, indicating that the STEAM approach with project-based learning significantly influences the students' interest in learning mathematics at the Elementary School (SD) level. This suggests that this teaching strategy can stimulate students' interest in mathematics.

After the mathematics learning intervention, students' interest was identified through the analysis of indicators present in the structured questionnaire. Subsequently, data regarding mathematics learning interest were grouped based on the percentage of students categorized as positive (moderate, high, and very high). Information regarding the distribution of students in each category can be found in Table 2.

Table 2. Percentage of Students with Positive Learning Interest

Indicators of learning interest	Persentase
Learning activity	86%

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Interest in learning mathematics	76%
Enjoyment of mathematics learning	80%
Focus during mathematics learning	76%
Positive response to mathematical challenges	74%

After the learning process, t was observed that 86% of students actively participated in the learning activities. Active involvement in learning, which includes asking questions, participating in discussions, and contributing to the learning class, is indicative of students' interest in the ongoing learning process. Active involvement in learning is a crucial aspect of understanding and mastering the learning material (Kiryakova, 2022; Sulistyoningsih, 2020). When questioned about their interest in learning mathematics, 76% of students responded positively. This suggests that the majority of students have a positive inclination towards mathematics, indicating that most students are interested or enjoy the subject of mathematics and have an interest in learning mathematics.

The indicator related to the enjoyment of learning mathematics shows that 80% of students derive pleasure from studying mathematics using a project-based STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach. This approach encourages collaborative group work, fostering enjoyable learning experiences (Kemendikbudristek, 2022). In terms of student focus during mathematics instruction, a positive response was obtained from 76% of the students. This indicates that when this method of instruction is applied, students become more focused on their learning.Moreover, when asked whether students are willing to take on mathematical challenges, 74% of the students feel prepared and courageous in facing mathematical challenges. This demonstrates that students have confidence in their ability to learn mathematics and are interested in the learning process.

The impact of the STEAM approach with project-based learning model on students' numerasi skill

Students' numeracy skills were measured using a test instrument. Subsequently, the data were grouped based on the categories outlined by the Directorate of Direktorat Pendidikan Dasar (2021) and the respective grade levels. Table 3 below provides a description of students' numeracy skills.

Table 3. Frequency of numeracy skill

Interval	Pretest			Posttest			Category
	IV	V	VI	IV	V	VI	
90-100	0	0	3	1	4	7	Advanced
75-89.99	1	1	6	19	29	31	Competen
60-74.99	23	37	35	45	42	35	Basic
<60	46	41	36	5	4	7	Low
Total	70	79	80	70	79	80	229

Based on Table 3, the pretest results reveal that there were 123 students sampled from all classes. This indicates that 53.71% of students, before undergoing the learning process, scored below 60 in numeracy skills, falling into the "low" category or needing special guidance. In the "basic" category, there were 95 students, accounting for 41.48% of the total respondents. Meanwhile, in the "proficient" and "advanced" categories, only 3.49% and 1.31% of students were found, respectively. These data show that the majority of students faced challenges in understanding mathematical problems and interpreting information related to numbers, statistical data, and mathematical concepts. This aligns with the findings of previous research (Iswara et al., 2022; Lopez-Pedersen et al., 2023; Nisa' et al., 2023)

After receiving mathematics education using a project-based STEAM approach, some students moved into the "basic" category, accounting for a significant percentage of 53.28%. Additionally, 34.50% of students achieved the "proficient" category, while 5.24% reached the "advanced" category. However, 6.99% of respondents still remained in the "low" category, requiring special guidance. Numeracy skills can change over time, as indicated by Rohmah, Sutama, Hidayati, Fauziati, & Rahmawati (2022) research, which showed variations in the development of individual numeracy skills, with some individuals improving while others might experience a decline.

Analyzing the posttest data, it's evident that in the "proficient" and "advanced" stages, the highest percentage was achieved by sixth-grade students with a score of 47.5%, followed by fifth-grade students at 41% and fourth-grade students at 28%. This indicates that the grade level influences students' literacy

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abilities. Factors such as age, educational level, and changes in population composition, as highlighted by Lechner, Gauly, Miyamoto, & Wicht (2021) can affect changes in numeracy skills over time.

The impact of mathematics education through the project-based STEAM approach can be observed in Table 4.

Table 4. The results of the analysis of numeracy skills data.

Test	Mean	StD	n-gain	Sig.	t-test
Pretest	58.45	9.87	33,64%	0,00	45.24
Posttest	72.43	9.69			

Table 4 indicates that prior to the implementation of instruction, the mean student proficiency was 58.45 with a standard deviation of 9.87. This mean falls into the low category as it is below the threshold of 60. Subsequently, following the application of the project-based STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach, the average score increased to 72.43 with a standard deviation of 9.69. Both pretest and posttest averages exhibited improvement in numeracy skills. The paired-sample t-test yielded a t-value of 45.24 with a significance level of 0.00<0.05. These results suggest a positive and significant influence of implementing the project-based STEAM approach on students' numeracy skills.

The STEAM project-based approach engages students actively in problem-solving, experiments, and collaborative projects. This involvement stimulates critical thinking, solution design, and participation in activities that enhance mathematical understanding (Burrows et al., 2021; Gillies, 2020; Kazemi et al., 2022; Kyllonen & Christal, 1990; Pratt, 1928). This theory supports the findings indicating an increase in the average proficiency of students following the application of the STEAM approach with a mathematical project-based learning model.

The n-gain scores for pretest and posttest data were 33.64%. This n-gain score signifies progress in students' numeracy skills through the STEAM approach with a project-based learning model. The improvement falls into the moderate category. The increase in the average proficiency suggests that students have entered the Zone of Proximal Development (ZPD) in numeracy skills, where learning occurs with appropriate assistance, guidance, or instruction (Margolis, 2020; Sage, 2022). With the project-based STEAM approach, students receive guidance tailored to their skill levels, thereby facilitating their entry into this zone.

Numeracy skills are a subset of cognitive abilities, particularly related to the comprehension and utilization of numerical information (Knops, 2018; Safitri & Khotimah, 2023; Sayekti et al., 2021). Cognitive abilities are fundamentally influenced by internal and external factors (Slameto, 2017), with one external factor being the instructional strategy employed by teachers. In this context, the STEAM approach with a project-based learning model proves to be a strategy that effectively influences numeracy skills.

Result of teacher interviews

The teachers interviewed all implement mathematics education using the STEAM-based project approach. There were a total of 9 teachers from 3 different schools in the sample. All the teachers provided positive comments about this approach, although there were some adjustments needed to align with the class's context and culture. One 4th-grade teacher stated,

> *"When I apply this teaching method, I see that students tend to be more active, and many of them have a better understanding compared to the previous year when they learned the same concept."*

According to the opinions expressed, teachers believe that the instructional approach has enhanced students' understanding of the taught material concepts.

When asked about what sets this teaching approach apart from other mathematics teaching strategies, several teachers mentioned that it is more relevant to the real world and fosters greater collaboration among students. A 5th-grade teacher explained,

> *"This method is excellent because students directly encounter objects related to the mathematical concepts they are learning. For example, in my class, students can immediately find objects related to fractions, such as portions of food or object pieces."*

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The teachers' opinions suggest that this instruction is indicative of relevance to the real world or the environment close to the students. Learning that is relevant to the real-world context and collaborative can construct students' knowledge by connecting the knowledge they possess with its application in their daily lives (Budiman et al., 2020; Muharam et al., 2023).

When asked what impressed them the most about implementing this teaching method, several teachers had similar views. Some noticed that students who were previously somewhat passive in their learning became more active when using this approach. A 6th-grade teacher commented,

> *"I was somewhat surprised because some students who were initially quiet and not very active, especially those with artistic inclinations, could express themselves when designing or sketching circles or circular objects."*

Regarding the difficulties faced when implementing project-based STEAM education, the respondent teachers expressed several challenges, including: Planning that is time-consuming and requires extensive thought; The need for additional resources, including equipment, materials, and technology, considering the rural school setting; Requiring more time than traditional teaching; Difficulty in grading students due to the focus on both the process and the final project outcome; Requiring more guidance; Demanding active collaboration among teachers, students, and families; Managing a complex and challenging classroom; Demanding strong teaching skills.

When asked about what should be revised and improved in the teaching approach, some teachers recommended the following: To address the complex planning, open information sources should be provided through modules and video resources on how to effectively implement this teaching method. Active collaboration should be established between teachers, students, and families during the learning process. Schools should create collaborative programs between the school and families to ensure support from all parties and enhance the effectiveness of learning.Regular practice should be introduced to make it easier to implement the teaching approach, allowing students to become more skilled in project execution.

CONCLUSION

The statistical analysis of mathematics learning interest data yielded a significance value of 0.00<0.05, indicating a positive and significant impact of the project-based STEAM approach on elementary school students' mathematics learning interest, with an n-gain value of 20.29%. Similarly, the analysis of numeracy skills data revealed a significance value of 0.00<0.05, signifying a substantial influence of the project-based STEAM approach on the numeracy skills of elementary school students, with an n-gain value of 33.64%. Observations and interviews underscore the effectiveness of implementing mathematics instruction through the project-based STEAM approach in enhancing student abilities. However, acknowledging its inherent limitations, careful preparation and optimization are essential for its successful application.

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