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Students views on STEAM-based mathematics learning

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Abstract

The 21st century demands educational approaches that align with technological advancements and societal needs. STEAM (Science, Technology, Engineering, Arts, and Mathematics) integrates multiple disciplines to foster critical thinking, creativity, communication, and collaboration in solving real-world problems. This study aims to explore ninth-grade students' perceptions of STEAM-based mathematics learning at SMP Negeri 13 Palembang. A mixed-method approach was employed, involving 94 students aged 13–15 years through questionnaires and unstructured interviews. Quantitative data were analyzed using Likert scale scoring, while qualitative data were assessed descriptively. Results indicate that students generally understand the concept of STEAM but lack clarity regarding its learning models, benefits, and assessment techniques. Most students (70.68%) perceived STEAM-based mathematics learning positively, finding it engaging, beneficial for understanding and retaining concepts, and motivating for further learning. Additionally, integrating technology and arts in mathematics increased student interest and participation. The study concludes that STEAM-based learning can enhance the effectiveness of mathematics education by creating a more interactive and meaningful experience for students. This approach equips students with essential 21st-century skills, making it a relevant strategy for future educational practices. Further studies are recommended to assess its long-term impact on student achievement and engagement.

Keywords: mathematics; STEAM; students' perception

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I. Introduction

In the 21st century, it is crucial to direct student education in alignment with the times. This aligns with the educational goals proposed by Ki Hajar Dewantara, who stated that education should guide the nature of the world and the times so that humans can achieve complete safety and happiness, both as individuals and as social beings living in society (Januar, 2023).

Entering the era of the Industrial Revolution 4.0 in the 21st century, all human activities are dominated by high-tech products, making it seem that people cannot live without technology. This demonstrates the rapid development of science and technology, whose impacts cannot be avoided but must be faced and mastered (Fitriyah & Ramadani, 2021). Mastery of science and technology has now become a necessity, requiring the development of

technological capabilities by various parties. Teaching students how to use technology effectively is a legal requirement in education. This has been attempted in every educational plan update completed by public authorities to prepare the nation for a strong and ready future in facing globalization (Audiana & Rusnilawati, 2024).

The things that teachers must master are the curriculum, learning process, and assessment system (Nuraeni, 2019). The curriculum and learning process must also be adapted to current trends and the skills needed. Learning integrates knowledge, attitudes, skills, and mastery of technology in the 21st century (Sari & Sutihat, 2022). 21st-century learning is technology-based and is rapidly evolving. Education today faces extraordinary challenges in developing students to have skills and understanding relevant to the real world (Sartika et al., 2023). Many research findings indicate that 21st-century learning has its characteristics and uniqueness, where education in educational institutions must focus on 21st-century skills (Jannah & Atmojo, 2022; Rosnaeni, 2021), in line with the core competencies and skills of the 21st century to meet future challenges, summarized in the 4Cs (Creativity, Communication, Critical Thinking, and Collaboration) that emerged in the 2030 Agenda: Creativity, Communication, Critical Thinking, and Collaboration (Perales & Aróstegui, 2024).

In education, the selection of media and learning resources has changed significantly; the learning process, which was once teacher-centered, is now more student-centered. The development of modern learning approaches must include 21st-century skills as students' provisions and attract and encourage their enthusiasm for learning (Ratnasari et al., 2023). One such approach is the implementation of STEAM-based learning (Napisah, 2023), which supports 21st-century learning (Qonita, 2023).

STEAM is an approach used in education that integrates concepts from various disciplines to develop skills relevant to current times (Budiyono et al., 2023). Before STEAM was introduced, the National Science Foundation first recognized the term STEM in the late 1990s in the United States (Johnson et al., 2022). The STEAM approach is a multidisciplinary approach that evolved from the STEM approach by adding the element of art to its learning process (Mu'minah & Suryaningsih, 2020). The STEAM approach (Science, Technology, Engineering, Arts, and Mathematics), which has recently emerged, represents ongoing efforts by researchers, practitioners, and education policymakers (Mejias et al., 2021).

STEAM can make learning more engaging, increase motivation, and encourage creative and critical thinking about real-world issues (Conradty & Bogner, 2020). STEAM combines the ideas of transdisciplinary learning, where students learn through a fusion of actual disciplines and solve problems within real-world contexts (Rohman et al., 2021). Integrating mathematics with science, technology, engineering, art, and mathematics can help students see mathematical concepts' relevance and practical applications (Kartikasari et al., 2022; La'ia & Harefa, 2021). Learning through the STEAM approach actively involves students, includes practical activities, and is directed toward real-world situations (Nurwulan, 2020), making the learning experience with STEAM meaningful for students (Estriyanto, 2020).

Previous research explored the perceptions of elementary school teachers toward implementing learning using the STEAM model. The results of data analysis in this study showed that the teachers' perceptions at SDN Banjarwaru 01 regarding STEAM learning received positive responses. The teachers at SDN Banjarwaru 01 were very interested in STEAM learning because it made learning more innovative and creative. However, its application might be more suitable for higher-grade classes, such as grades 5 and 6 (Napisah, 2023).

Furthermore, other research investigated the perceptions of prospective mathematics teacher students' perceptions towards

implementing STEAM learning in schools. The results of this study indicated that STEAM learning could increase student engagement in the classroom learning process. The term "engagement" here refers to students' active participation in the learning process, including the courage to ask questions, express opinions, answer questions, collaborate with other students, and complete assigned tasks (Naufal & Asdar, 2022).

However, there has been no research on secondary school students' perceptions regarding mathematics learning with STEAM. Without good student perceptions, the results will be meaningless (Pitriani & Afriansyah, 2017). Therefore, this study aims to describe students' responses to mathematics learning with STEAM. Thorough preparation is needed to facilitate students' learning with STEAM. In the future, STEAM can be used as a learning approach. Certainly, a learning environment that combines five disciplines—science, technology, engineering, art, and mathematics—to address real-life problems will benefit both students and teachers.

II. Research Method

To achieve the research objectives, a survey was conducted involving 94 ninth-grade students at SMP Negeri 13 Palembang as participants. There were 47 female, and 47 male students aged 13 to 15 years. They were selected using a voluntary and random sampling technique.

Quantitative and qualitative data in this study were collected using a questionnaire regarding students' perceptions of mathematics learning with STEAM. The questionnaire consisted of closed-ended statements for the first part and open-ended statements for the second part. The statements in the first part included a 5-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) and (always, often, sometimes, rarely, and never). In contrast, the second part included questions about the students' preferred method of mathematics learning, their reasons, and their expectations for mathematics learning. The questionnaire used is outlined in Table 1 below.

Closed-Ended Statements

Table 1. Research questionnaire

No.	Statement	Never	Rarely	Sometimes	Often	Always
1.	I like learning math material that is connected with other subjects such as science.					
2.	Mathematics learning is more interesting when using technology and art.					
3.	STEAM makes it easier for me to understand the material in mathematics learning					
4.	Learning with STEAM motivates me to work harder in mathematics learning					
5.	STEAM helps me retain my knowledge of math material					

In addition to using the student response questionnaire, we also collected data from interviews. Unstructured interviews were conducted with the participating students' original school mathematics teachers. The interview data were used to confirm the questionnaire's results. The data obtained from the questionnaire were processed using Microsoft Excel and SPSS. Then, the data were further analyzed qualitatively using the descriptive method.

III. Results and Discussion

The scores obtained from each answer choice can be seen here. Students' views on STEAM-based mathematics learning in class IX SMP Negeri 13 Palembang can be seen here.

Table 2. Total score opinion

No.	Never	Rarely	Sometimes	Often	Always
1.	6	31	21	29	7
2.	3	20	12	41	18
3.	2	7	28	40	17
4.	0	5	32	45	12
5.	0	3	32	42	17
Total	11	66	125	197	71

Sugiyono (2018) states that the Likert scale measures a person's or group of people's opinions, attitudes, and perceptions about social phenomena.

The answer options derived from qualitative data were previously converted into quantitative data to simplify the calculation.

Positive questions were scored in the following way: always 5, often 4, sometimes 3, rarely 2, never 1.

Ideal score (criterion) = highest score x statement items x number of respondents
= 5 x 5 x 94
= 2.350

Table 3. Percentage calculation of quantitative data

Sum of answer	Total			
Always	71	5	355	15,10%
Often	197	4	788	33.53 %
Sometimes	125	3	375	15,96 %
Rarely	66	2	132	5,62 %
Never	11	1	11	0,47 %
Total			1661	70,68 %

Total ideal score (criterion) for all items = 5 x 5 x 94 = 2350 (if all answered always). The total score obtained from research = 1661. So, based on the data above, the students' views on STEAM-based mathematics learning = (1661: 2350) x 100% = 70.68% (included in the good category).

From a brief interview with several students, they already knew what STEAM is—a learning approach that integrates science, technology, engineering, arts, and mathematics concepts. However, they were not yet sure about the learning model, its benefits, and its assessment techniques.

When asked whether they liked learning mathematics integrated with other subjects like science, 31 students (33%) disagreed, 29 students (31%) agreed, 21 students (22%) answered “not sure,” while 7 students (7%) strongly agreed, and 6 students (6%) strongly disagreed.

However, when asked whether mathematics learning would be more interesting if technology and arts were incorporated, 3 students (3%) strongly disagreed, 20 students (21%) disagreed, 12 students (13%) were unsure, 42 students (44%) agreed, and 18 students (19%) strongly agreed.

For the statement "STEAM can make it easier for students to understand mathematics material," 2 students (2%) strongly disagreed, 7 students (7%) disagreed, 28 students (30%) were unsure, 40 students (43%) agreed, and 17 students (18%) strongly agreed.

When asked whether STEAM motivates students to work harder in learning mathematics, 5 students (5%) disagreed, 32 students (34%) were unsure, 45 students (48%) agreed, and 12 students (13%) strongly agreed.

For the statement "STEAM can help students retain knowledge in mathematics," 3 students (3%) disagreed, 32 students (34%) were unsure, 42 students (45%) agreed, and 17 students (18%) strongly agreed. So, students’ perceptions of mathematics learning using STEAM showed that the majority of them agreed with the approach on each indicator.

IV. Conclusion

Based on the research results, students' perceptions of learning mathematics with STEAM can be divided into two large groups: positive and negative. Students generally understood the concept of STEAM but lacked clarity on its learning models, benefits, and assessment techniques. Most students expressed a preference for mathematics learning that integrates technology and the arts, showing increased interest and engagement.

STEAM-based learning was perceived as beneficial for improving understanding of mathematical concepts, retaining knowledge, and motivating students to study harder. Quantitatively, students' views on STEAM-based mathematics learning were categorized as "good," with a 70.68% score based on the Likert. Further research is needed to see how STEAM can influence students' cognitive and affective processes. All of these responses can be used as references in designing mathematics learning using STEAM in future research.

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