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Literature Review: The Effect of STEAM-Based Learning on Students' Mathematical Learning Outcomes

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Abstrak

Indeed, various disciplines in education are related to each other. Combining several related disciplines can improve students' insights and skills. STEAM-based learning *(Science Technology Engineering Art Mathematics)* is an approach that integrates several disciplines in one curriculum. The purpose of this literature review is to investigate the implementation of STEAM-based learning on students' mathematical learning outcomes. This literature review includes an analysis of several literature sources, such as scientific journals, books, and research reports related to the implementation of STEAM-*based learning*. This study will analyze student learning outcomes from several existing studies. The results of the study provide information that the STEAM approach has a positive influence on improving students' mathematical learning outcomes. So that with STEAM nuanced learning can be used as an option by educators to create better learning.

Kata kunci:

. Learning Outcomes; STEAM-based learning

1. Introduction

Education continues to develop from time to time. Along with the times, students are required to be able to master various disciplines and skills so as not to be left behind. One of the breakthroughs in education so that students can develop their knowledge is the STEAM approach. STEAM is a learning approach that combines several disciplines namely science, technology, engineering, art, and mathematics to solve problems. "STEAM is a meta-discipline that integrates science, technology, engineering, art and math into an integrated approach that can be implemented in school learning."(Nurhikmayati, 2019).

There are basic abilities that students need to have in learning. These mathematical abilities are classified into five standard abilities, namely: (1) mathematical understanding; (2) mathematical communication; (3) mathematical reasoning; (4) mathematical connection; (5) mathematical problem solving. These abilities need to be possessed by students so that they can use them in solving problems in learning. Until now, students' mathematical abilities in Indonesia are still relatively low when compared to other countries. The results of the 2018 *Program for International Students Assessment (PISA)* survey show that Indonesia's math, science, and reading skills are ranked low. If this is not addressed immediately, it is feared that the problem will affect the level of achievement and student learning outcomes.

One of the most important things about the learning process is learning outcomes. Learning outcomes can be said to be changes that occur in students after the learning process takes place. In learning, learning outcomes are not only in the form of grades but can be in the form of changes, reasoning, discipline, skills and so on that lead to positive changes. So that learning outcomes can be used as a benchmark to determine whether students have understood the material that has been delivered or not. If student learning outcomes are in accordance with the learning objectives, it can be said that the learning process is successful. Lestari (2017) says that there are several factors that influence student success in learning, including internal factors

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which include intelligence level, learning motivation, learning habits, and so on. There are also external factors including the family environment, school environment, community environment, and so on. In the learning process, methods, media to learning approaches can also affect student success in achieving learning outcomes.

This literature review focuses on reviewing various sources related to the implementation of STEAM in mathematics learning to improve student learning outcomes. So based on the background description above, this article is written with the aim of knowing how the implementation of STEAM in mathematics learning in students.

2. Discussion

This literature study uses several related articles that are thoroughly reviewed. The aspects reviewed are the results of the research and discussion which will then be summarized and analyzed. The category of articles analyzed is the implementation of STEAM in mathematics learning to improve student learning outcomes. Student learning outcomes are seen from the improvement in student abilities as a result of the implementation of STEAM in mathematics learning. Based on the previous category, 7 studies have been determined to be analyzed. The seven research articles have been presented in the table below:

Table 1. STEAM-based learning articles

Tittle	Author
Implementasi Pembelajaran Matematika Realistik Berbasis Steam Di Sekolah Dasar	Ninit Permata Sari
Efektifitas Pembelajaran Berbasis STEAM (Science, Technology, Engineering, Art, and Mathematics) terhadap Hasil Belajar pada Materi Dimensi Tiga SMK	Suriyana dan Metia Novianti
Efektivitas Pendekatan Pembelajaran Science Technology Engineering Art Mathematic (Steam) Terhadap Kemampuan Komunikasi Matematis	Muhammad Syahril Harahap, Febriani Hastini Nasution, dan Nurhidaya Fithriyah Nasution
Meningkatkan Hasil Belajar Matematika Dengan Pendekatan Steam Di Sekolah Dasar	Kartikasari, Herlina Usman, Resi Ratna Suminar, dan Nuryani
Analisis Mengukur Kemampuan Berpikir Kritis Melalui Pembelajaran Menggunakan Metode STEAM-PjBL	Deni Nasir Ahmad, Maya Masitha Astriani, dan Mul Alfahnum
Implementasi Pendekatan STEAM dalam Pembelajaran Matematika untuk Menyongsong Era Society 5.0	Yogi Ferdianto, Nike Handayati, Nevita Falasyifa, dan Ahmad Faridh Ricky Fahmy
Pengaruh Model Pembelajaran STEAM terhadap Kemampuan Sains dan Numerasi Siswa Madrasah Ibtidaiyah	Aan Budiyono, Amir Luthfi, dan Ramdhan Witarsa

2.1. STEAM in Mathematics Learning

STEAM is a learning method that involves students as responsible where students learn the arts of mathematics and science and introduce them more closely to nature (Wahyuningsing et al, 2020). Basically, STEAM comes from the development of STEM-based learning (Science, Technology, Engineering, Mathematics) which adds elements of art to STEM to create more interesting and art-based learning which will certainly have a positive influence on students (Katz-Buonincontro, 2018). With the element of art in STEAM nuanced learning, students will be given the opportunity to be creative and innovate in the art of mathematics so that it can improve student learning outcomes.

According to Hairul (2019) learning with STEAM nuances has several advantages, including: (1) Improve understanding of the relationship between concepts, principles and domain skills in a particular discipline; (2) improve students' critical thinking, creative thinking, and stimulate students' imagination; (3) help students in understanding the process of scientific inquiry; (4) encourage students' ability to solve problems; (5) expand students' knowledge; (6) build understanding and active memory through independent learning; (7) strengthen the relationship between thinking, action, and learning; (8) increase students' interest, participation, and activeness; (9) foster students' skills in applying their knowledge.

Learning with STEAM nuances involves students actively, so learning with STEAM nuances will be more fun and interesting. Currently, STEAM nuanced learning has been widely implemented in learning in various subjects. Mathematics is one of the lessons that can implement STEAM nuances into the learning process. Which is in the STEAM element itself math has become an integrated discipline so it is very effective to use this nuance. That is by applying the ideas of other disciplines, science, engineering, technology, and art in learning mathematics.

2.2. Student Mathematical Learning Outcomes

According to Utami et al (2018) learning outcomes are the result of the learning experience that students have received which results in the ability that students have both regarding cognitive, affective, and psychomotor aspects. Student learning outcomes can be obtained using an assessment tool, namely an evaluation test that produces a form of values, attitudes, and skills. The cognitive domain is a learning outcome in the form of knowledge, intellectual abilities and skills (Kartikasari et al., 2022).

Bloom's taxonomy states that the cognitive domain includes the categories of knowledge, comprehension, application, analysis, evaluation, and create. The affective domain relates to students' feelings, attitudes, and interest in STEAM nuanced learning. The categories that are the focus in the affective development of learners include acceptance, response, appreciation, regulation, and the formation of life patterns based on the complexity of values. Meanwhile, the psychomotor domain is related to aspects of physical abilities, such as motor skills, object manipulation, and neural coordination. The components of the psychomotor domain include perceptual preparation, guided response, mechanism, complex response, adaptation, and creative creation.

Learning outcomes in mathematics learning are defined as an achievement obtained by students through a series of learning processes that include the realm of attitudes, knowledge, and skills in mathematics (Setyowati & Mawardi, 2018). Mathematical learning outcomes are the results of student learning of mathematics learning in the form of increasing students' mathematical abilities. Students' mathematical thinking ability consists of 5 components, namely: (1) mathematical understanding; (2) mathematical problem solving; (3) mathematical reasoning; (4) mathematical connections; (5) mathematical communication. To create maximum student mathematical learning outcomes, an interesting and enjoyable mathematics learning is needed.

2.3. The Effect of STEAM Nuanced Learning on Student Learning Outcomes

Based on the articles that have been reviewed and analyzed, it is found that there is an increase in students' abilities after using STEAM nuanced learning. The results and conclusions are as follows:

1. Implementation of STEAM-based Realistic Mathematics Learning in Elementary Schools (Sari. N. P, 2020). The results of this study are the implementation of STEAM-based realistic mathematics learning can develop students' abilities in cognitive aspects and can also develop abilities that are useful for students to be ready to face the challenges of the era of technology and globalization in the future.
2. Effectiveness of STEAM-Based Learning (Science, Technology, Engineering, Art, and Mathematics) on Learning Outcomes in Three-Dimensional Materials of Vocational Schools (Suriyana et al, 2018). The results of this study are STEAM-based learning (Science, Technology, Engineering, Art, and Mathematics) effectively applied to XII grade students of SMK Muhammadiyah Rasau Jaya. Learning outcomes in students after STEAM-based learning takes place get an average score of 77.14% with 90.47% completeness. This is also in line with the positive response of students to STEAM-based learning of 95.85% of the total number of students.
3. The effectiveness of the Science Technology Engineering Art Mathematic (STEAM) Learning Approach on Mathematical Communication Skills (Harahap et al, 2021). The results of this study are that learning with the STEAM approach carried out can have an effect on students' mathematical communication skills in class VII SMP Negeri 9. This is in line with the increase in students' mathematical communication skills from an average of 62.73 to 85.05. So it can be concluded that the STEAM approach is effective in improving students' communication skills.

4. Improving Mathematics Learning Outcomes with the STEAM Approach in Elementary Schools (Kartikasari et al, 2022). The results of this study are that learning with the STEAM approach can increase the level of student completeness for the better with the acquisition of student learning activity data reaching 35.71% good and 64.28% very good.
5. Analysis of Measuring Critical Thinking Skills Through Learning Using the STEAM-PjBL Method (Ahmad et al, 2020). The result of this study is that the STEAM-PjBL method has a direct impact on student learning outcomes on the experience in learning as evidenced by the difference in student learning outcomes before and after STEAM-PjBL-based learning.
6. Implementation of STEAM Approach in Mathematics Learning to Welcome the Era of Society 5.0 (Ferdianto et al, 2022). The result of this research is that the STEAM approach in learning is needed to train students' abilities and talents to welcome the era of society 5.0. STEAM-based learning is expected to produce output as a result made by students.
7. The Effect of STEAM Learning Model on Science and Numeracy Skills of Madrasah Ibtidaiyah Students (Budiyono et al, 2023). The result of this study is that STEAM learning is proven to significantly affect students' science and numeracy skills.

From the literature study on several articles regarding the implementation of STEAM to improve student learning outcomes, it was found that STEAM nuanced learning is very effective in improving student learning outcomes. Improvement in student learning outcomes occurs in three aspects or domains according to Bloom's taxonomy, namely the cognitive domain, affective domain, and psychomotor domain.

1. Cognitive domain
   The collaboration of several disciplines in STEAM will increase students' knowledge in other sciences, not only mathematics. So that STEAM nuanced mathematics learning can improve students' mathematical abilities, including problem solving skills, critical thinking skills, creative thinking skills, literacy skills, and communication skills. In learning mathematics with STEM nuances, students are able to answer questions correctly and completely so that there is an increase in students' cognitive abilities.

2. Affective domain

Tabel 1
Aktivitas siswa Pembelajaran STEAM (*Science, Technology, Engineering, Art, and Mathematic)*

No	Kegiatan Siswa yang di amati	Persentasi (%)		
		Sebelum (*treatment*)	Sesudah (*treatment*)	Peningkatan
	Aktivitas siswa terlibat dalam pembelajaran berbasis STEAM (*Science, Technology, Engineering, Art, and Mathematic)*	67%	86%	19%

Picture 1.

Learning with STEAM nuances requires students to be active in learning. The picture above is a table of research results (Suriyana & Novianti, 2021) regarding student activity in STEAM nuanced learning on three-dimensional material in vocational schools. Which resulted in an increase in student activity by 19%. So that with STEAM nuanced learning can increase student activity.

3. Psychomotor domain
   In STEAM nuanced learning, students not only develop abilities in knowledge but also in skills. STEAM can be implemented with projects which with this implementation can improve students' physical abilities.

3. Conclusion

Based on the review and analysis of literature sources in the results and discussion, it can be concluded that the implementation of STEAM-based learning (Science, Technology, Engineering, Art, and Mathematic) on students can improve student learning outcomes. STEAM-based learning can also improve students' mathematical abilities, including problem solving skills, critical thinking skills, creative thinking skills, literacy skills, and communication skills. The implementation of STEAM-based learning can be said to be

very useful to help prepare students to master various disciplines and have the ability that they can use to solve problems in everyday life in accordance with the times.

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