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Literature Review: STEAM Approach to Improve High School Students' Problem-Solving Ability in Physics Learning

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ABSTRACT

Objective: *This study aims to collect information on the STEAM approach to enhance high school students' problem-solving skills in physics learning.* ***Method:*** *The method employed is a systematic literature review (SLR) using the PRISMA method. Article Collections or journals were searched using tools, namely Watase Uake, to assist in the search.* ***Results:*** *From as many as (245) relevant articles, researchers identify and filter so that researchers get the results of as many as (20) articles to be reviewed. Based on the literature review conducted, researchers found that learning using the STEAM learning approach can improve problem-solving skills.* ***Novelty:*** *The STEAM approach offers advantages over traditional methods, including an enhanced ability to identify problems, think critically, develop creative solutions, understand concepts, analyze information, increase motivation and interest, and improve student learning outcomes. These problem-solving skills are needed to be equipped to face various challenges in the coming era. A literature review indicates that learning with the STEAM approach can enhance problem-solving skills and hold promising potential, particularly in physics subjects at the high school grade XI level. The STEAM approach offers advantages over traditional methods, including an improved ability to identify problems, think critically, develop creative solutions, understand concepts, analyze information, increase motivation and interest, and enhance student learning outcomes.*

INTRODUCTION

Technology plays a crucial role in modern human life. The development of science, which occurs within the educational world, is essentially a result of technological advancements. Therefore, it is also appropriate for education to utilize technology to facilitate learning (Lestari, 2018). In this digital era, technological developments bring significant changes in various fields, including education, where education is a process of communication and information from educators to students containing educational information, which has elements of educators as sources of information, media as a means of presenting ideas, ideas and educational materials and students themselves (Nurfadilah & Siswanto, 2020). The increasing use of technology in the modern era of globalization can be applied to the world of education as a sophisticated tool to facilitate the learning process. This is the opinion of Tondeur et al. (Selwyn, 2011), which states that educational institutions have begun to use digital technology to support learning, both as an information tool and as a learning tool. With the help of technology, students can become more innovative and creative and learn more effectively and efficiently.

In this era of rapid technological advancement, education must prepare students to keep pace with the world's progress. One of the most important is the ability to solve problems (Putri et al., 2019). Problem-solving is the strategic competence demonstrated by students in understanding, choosing approaches and strategies to solve problems, and solving models to solve problems (Ubaidah et al., 2020). These problem-solving skills are needed to be equipped to face various challenges in the coming era. Science education in Indonesia, particularly in the field of physics, is expected to produce students with high problem-solving abilities. Therefore, students are not only educated to understand concepts but also directly involved in the process of knowledge discovery. In the learning process, teachers not only convey information but also help students develop the skills necessary to face the challenges of the globalization era, including problem-solving abilities (Dewi, 2018). The ability to solve problems enables students to understand scientific concepts in physics, recognize situations, and apply them to various problems.

In Indonesia, learning focuses more on helping students master concepts. Students are less directed towards developing science literacy in problem-solving. This means that students cannot solve problems, especially those in physics. Based on this, it can be seen that physics learning is still a transfer of knowledge; therefore, students' ability to solve problems remains very low. One effort to improve students' ability to solve problems is to give meaning to the concepts they learn, so one way to enhance classroom learning is to connect students' initial knowledge and daily experiences with the material they are learning. Therefore, proper learning is needed to improve students' ability to solve physics problems.

One approach that can be applied is to integrate Science, Technology, Engineering, Art, and Mathematics (STEAM) in physics learning. Learning with the STEAM approach is contextual learning. The STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach to physics learning is a method that integrates these five disciplines to enhance critical thinking, problem-solving, and creativity. This STEAM approach refers to the four components of science, namely knowledge, technology, engineering, and mathematics (Septiani & Love, 2021). In line with this, according to Permanasari (2016), the STEAM model can help develop knowledge, answer questions based on investigation, and enable students to create new knowledge. The STEAM method encourages students to explore their abilities in different ways. This learning links science (science), technology, engineering, art, and mathematics so that students are equipped with a comprehensive understanding of the relationship between fields of science and knowledge through 21st-century skills and learning experiences.

STEAM, or Science, Technology, Engineering, Art, and Mathematics, is an integrated learning that can be said to foster problem-solving skills in students (Yuliari & Hanim, W. 2020). STEAM learning can help students develop a mindset that enables them to find solutions to every problem using the scientific process. Students are allowed to engage in the learning process directly and produce products that demonstrate creativity and problem-solving abilities (Nurhikmayati, 2019). STEAM learning also

aims to increase learners' confidence in developing an interest in science and mathematics as well as in solving real-life problems (Ferdianto et al., 2022). 1 The application of the STEAM approach can be used in physics learning to enable students to reflect on learning in schools that initially focused on educational theory and transition it into practice, supported by aspects of STEAM. The STEAM approach has an additional aspect: art. The function of art is to train the creativity of students. It is through this creativity that students can solve problems and understand physics concepts (Fitria et al., 2023).

This study aims to systematically examine previous studies on applying the STEAM approach to enhance the problem-solving abilities of high school students in physics learning. This research has provided information on commonly used elements in the STEAM approach to physics learning in Indonesia. This article emphasizes the importance of integrating self-directed learning, physics innovation, and the STEAM approach to enhance problem-solving abilities in physics education. Through this approach, students can gain a deeper understanding of how to solve problems using creative solutions. This article provides insight to students on how integrating some of these elements can improve problem-solving skills in physics learning.

RESEARCH METHOD

The research examines the STEAM Approach that can help high school students improve their problem-solving skills in physics learning. This research is a type of qualitative study with a primary focus on gaining an in-depth understanding of the phenomenon or topic under investigation. The goal is to provide further insight into what is already known about the topic. The data sources in this study include various journals, articles, and other references that align with the research topic's criteria.

The research employs a single type of literature research method, namely systematic literature review (SLR), utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. There are several stages involved in conducting a literature review, including defining eligibility criteria, identifying information sources, selecting relevant literature, collecting data, and selecting data items. This search process is divided into several steps, namely identification, screening, eligibility, and inclusion. This method enables researchers to access a range of sources to support the understanding and analysis of research topics.

Article or journal collections are searched using a tool, namely Watase Uake, to assist with the search. Watase.web.id was created to facilitate collaborative research among researchers. By using Watase, researchers aim to share information with their peers. Features developed by Watase include a systematic literature search with PRISMA, simple meta-analysis, article classification, and data visualization. In searches using the keywords "steam learning," "Physics problem solving' and "steam education UAKE Watase application and Scopus search engine API key are used to search literature. The purpose of choosing this search engine is to access scientific literature that is well-

indexed in Scopus Q1, Q2, Q3, and Q4. Additionally, there are articles from other sources that meet the criteria and were published between 2018 and 2023.

RESULTS AND DISCUSSION

The data collection process uses a web watch with the keywords "STEAM," "STEAM learning," "Physics problem solving," and "STEAM education researchers get as many as (245) relevant articles. However, some articles do not align with the study's provisions. There are (6) duplicate articles, so they are deleted before filtering. Then the article was deleted because it did not enter Level [Q1, Q2, Q3, Q4] as many (19) articles. There are (3) articles without abstracts so that researchers issue them. After identification, the Next stage is screening. At this stage, the article remains (217). After that, researchers excluded (182) articles for several reasons that did not meet the screening criteria—leaving (35) articles to retrieve. The selection of articles is filtered and adjusted according to keywords related to STEAM, limited topics in educational implementation and physics. Researchers get rid of as many articles as (15) to be discarded because they do not fit the topic discussed. As a result, researchers assessed 20 articles for feasibility and deemed them suitable for inclusion.

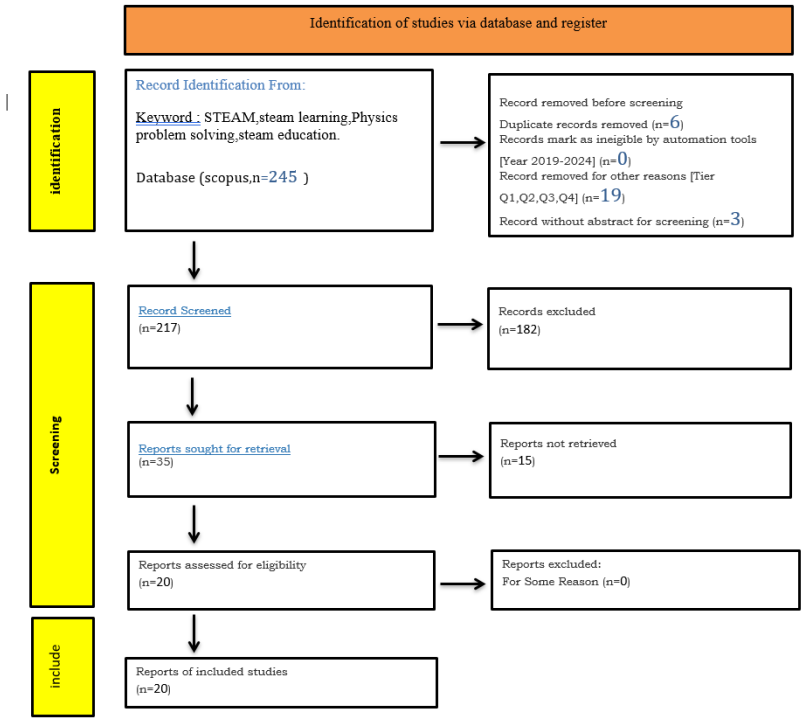

Figure 1. SLR with prism method.
Source: www.watase.web.id

Based on the research conducted, researchers found several findings from various articles that describe how the STEM approach is implemented in the learning process for students. The STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach offers an innovative and exciting way to improve students' problem-solving skills in physics. The STEAM approach, which integrates five disciplines, helps students improve their problem-solving skills in physics. This approach helps students acquire a range of essential skills and prepares them for future problems. The following is a summary table of selected articles with a focus on the STEAM approach and problem-solving in Physics:

Analysis of understanding the concept of physics education students through solving unit review questions on free fall motion material has the highest percentage. In the problem-solving indicators of the Physics Approach, Specific Application of Physics, and Logical Progression, students' abilities are in the low category.

Table 1. Top 10 cited articles focusing on the STEAM approach to improve high school students' problem solving ability in physics learning

No	Title (Researcher, Year published)	Result
1.	Agnesi Sekarsari Putri, Zuhdan Kun Prasetyo , Lusila Andriani Purwastuti , Anti Kolonial Prodjosantoso , Himawan Putranta (2023)	Indonesia has low critical thinking skills compared to other countries. The journal has tujuan meningkatkan kemampuan berpikir critical and creative students through the utilization of science, technology, engineering, art, mathematics (STEAM) blended learning. Research in this journal shows steam-based blended learning can improve critical and creative thinking skills. STEAM-based blended learning can be an alternative for teachers to overcome the problem of low critical and creative thinking skills. Critical thinking skills can help students to think rationally.
2.	Miriam, Timiraos; Francisco, Zayas-Gato; Álvaro, Michelena; Elena, Arce, (2024)	From the results of the laboratory journal the virtual for distance learning with STEAM mentioned that students have the opportunity to improve their adaptability to responsibilities, hone their decision-making acumen, foster teamwork, cultivate an entrepreneurial mindset, and develop proficient problem-solving skills. They have acquired the ability to assimilate innovative technologies in pursuit of development sustainable and have seen an increase in their entrepreneurial potential.
3.	P. Hariati Winingsiha,d, , H. Kuswantob , H. Saputroc , J. Purwantoa , S. Yunior Erlanggad , A. Yoga Purnamad,e, R. Sebastiand,f , and S. Silviad (2023)	Analysis of understanding the concept of physics education students through solving unit review questions on free fall motion material has the highest percentage. In the problem solving indicators of Physics Approach, Specific Application of Physics, and Logical Progression, students' abilities are in the low category
4.	Nam Nguyen, Hai; Huy Thanh, Le; Hai Nguyen, Thanh; Van Giao, Le, (2023)	This study aims to explore the learning approach and preferences of high school when studying physics. Most students focus only on the steps involved in solving physics problems. Study The study also found that students preferred physics exercises with facts and questions are clear, while a quarter of students prefer practice with Specific facts and clear questions.
5	Maria Teresa, Caccamo; Annarosa, Serpe, (2023)	Physicists and mathematicians are trained differently – and that's normal – because they have different ways of doing things, and different ways of saying or writing things.

		Troubleshooting strategies are presented here for provide a methodological The approach that aims to help students improve their mathematical reasoning skills, which is essential for strengthening students' knowledge of physics concepts. Applying educational situations based on problem solving allows to reduce the distance between Mathematics and Physics and, therefore, facilitates the transfer of concepts from one scientific discipline to another. The purpose of the author is to give teachers a way to highlighting the role of knowledge in problem solving while maintaining the implementation of methodological approaches that are flexible and adaptable to different curriculum needs.
6	Binar Kurnia, Prahani; Khoirun, Nisa; Maharani Ayu, Nurdiana; Erina, Krisnaningsih; Mohd Zaidi Bin, Amiruddin; Imam, Sya'roni, (2023)	Further research into STEAM education trends can be done by focusing on one area or on a more specific issue. This information can be used as a guide for institutions to support training initiatives that improve teaching and learning berbagai disiplin ilmu. In addition, this information can support Educational strategies that Provide learners learners to synthesize information from several fields of study.
7	Ibrahim, Arpaci; Muhammed Said, Dogru; Hassan, Kanj; Nawaf, Ali; Mahadi, Bahari, (2023)	STEAM-based space-themed learning modules showed significant improvement as a result of participation in the module. The test scores of female students participating in the module improved the most. Non-formal and non-school learning has been shown to reduce gender differences with cognitive and motivational learning and encourage careers with the help of extracurricular activities and teacher encouragement. New research suggests that modeling classical structural equations with artificial intelligence-based algorithms can achieve better results by considering linear and non-linear relationships. These results have an effect on education policy makers, curriculum developers, and syllabus designers. Each student who follows the learning STEAM module-based gets better grades, but suggested modules will be more beneficial for students who achieve better academic results.

8.	Natalia, Spyropoulou; Achilles, Kameas, (2024)	STEAMComp has shown success in the professionaldevelopment of educators by emphasizing the value of frameworks in developing self-assessment tools and designing STEAM educator job profiles. These profiles are aligned with ESCO (European Skills, Competencies, Qualifications and Occupations) standards, thereby contributing to a more structured and widely recognized approach in the field of STEAM education.
9.	Fitria, T., Kuswanto, H., Dwandaru, W. S. B., Jumadi, J., Putri, D. P. E., & Juneid, A. Z. (2023)	In the journal, it was explained that learning media integrated with the PjBL-STEAM model, provides an increase in students' creative thinking skills and understanding of concepts. By integrating more sophisticated technology will make it easier for teachers to teach and will be effective for students in understanding material that is still abstract
10.	Sakdiah, H., Ginting, F. W., Rejeki, N. S., & Miranda, A. (2022).	It is proven that students' science process skills can be improved by applying the STEAM learning approach and the PjBL learning model. For STEAM learning to be successful, students must have a scientific attitude. Students with a strong scientific attitude have better SPS scores, as shown by the difference between students with high and low scientific attitudes.

Discussion

Various studies in the document demonstrate that the STEAM approach can enhance students' critical and creative thinking skills, as well as their understanding of physics concepts. For example, research shows that STEAM-blended learning is efficacious in improving students' critical and creative thinking skills in Indonesia, which have been considered low (Putri et al., 2023). In addition, STEAM-based space-themed learning modules have been shown to provide significant improvements in learning outcomes, particularly for female students, and can bridge the motivational and cognitive gaps through non-formal activities. Another study by An & Yang (2020) also emphasized that the application of the 6E-based learning process in the context of STEAM in junior high schools can significantly improve students' understanding of concepts, emotions, and thinking skills.

However, several challenges were also revealed in implementing STEAM. Students continue to demonstrate low abilities in physics problem-solving indicators (Winingsih et al., 2023). This suggests that STEAM integration has not been entirely successful unless it is accompanied by a mature learning design strategy that is tailored to the context of the material. In addition, most students tend only to follow the steps to solve problems without exploring the creative and reflective thinking aspects that are the primary targets of STEAM. In other words, although the STEAM approach has great potential, its implementation needs to be tailored to the characteristics of students and the existing learning context, especially in subjects such as physics, which require the simultaneous development of conceptual and procedural skills.

Based on these results, the STEAM approach is highly relevant for improving high school students' problem-solving abilities in physics learning. Physics, as a complex subject, requires integration between theoretical concepts and practical skills, which STEAM-based activities can facilitate. The integration of technology and engineering elements helps students see real applications of physics concepts, while art and mathematics can strengthen understanding through visualization and logical reasoning. For this reason, teachers need to design project-based learning or challenges with a STEAM approach that is adjusted to the level of student readiness. This approach not only improves problem-solving skills but also makes learning more contextual, engaging, and meaningful.

CONCLUSION

Fundamental Finding: The STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach to physics learning is a method that integrates these five disciplines to enhance critical thinking, problem-solving, and creativity. Problem-solving is the strategic competence demonstrated by students in understanding, choosing, and applying approaches and strategies to solve problems. **Implication:** These problem-solving skills are needed to be equipped to face various challenges in the coming era. A literature review indicates that learning with the STEAM approach can enhance problem-solving skills and hold promising potential, particularly in physics subjects at the high school grade XI level. The STEAM approach offers advantages over traditional methods, including an improved ability to identify problems, think critically, develop creative solutions, understand concepts, analyze information, increase motivation and interest, and enhance student learning outcomes. **Limitation:** Most of the findings supporting the effectiveness of STEAM come from literature studies or overseas contexts, while direct empirical evidence of STEAM implementation in high school physics classes in Indonesia is still limited. **Future Research:** Quantitative-experimental research is recommended to evaluate the impact of STEAM on specific aspects of problem-solving (understanding problems, designing strategies, implementing solutions, and evaluating results).

AUTHOR CONTRIBUTIONS

Vivian Oktab Fransiska: Conceptualization, Methodology, and Validation; **Binar Kurnia Prahani**: Methodology and Writing - Original Draft; **Dwikoranto**: Formal Analysis, Resources, Data Curation, Project Administration, and Writing - Original Draft. All authors have read and approved the final version of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that generative artificial intelligence (Gen AI) and other AI-assisted tools were used judiciously, not excessively, during the research and preparation of this manuscript. Specifically, ChatGPT was used for brainstorming; Grammarly for grammar and style correction. All AI-generated materials have been reviewed to strengthen data accuracy, completeness, and compliance with ethical and scientific standards. The authors are fully responsible for the final content of the manuscript.

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