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Analysis the Implementation of STEAM Approach on Creative Thinking Ability in Science Learning

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Abstract: This study aims to analyze the impact of applying the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach in science education on students' creative thinking skills. The STEAM approach offers an integration of various disciplines, creating a holistic and interactive learning environment that has proven effective in enhancing creative thinking skills. The method used is content analysis with a qualitative descriptive approach, through a literature review of national and international journals. The results from 11 journals show that the application of STEAM in science education has a significant effect on improving students' creative thinking skills. STEAM-based learning encourages students to be more active in exploring ideas, designing innovative solutions, and connecting scientific concepts to real life. The discussion reveals that traditional teaching methods, which tend to be passive, contribute to the low level of students' creative thinking skills, while STEAM offers a more contextual approach involving hands-on experiences. In conclusion, the STEAM approach has been proven effective in improving the quality of science education and developing students' creative thinking skills, thus preparing them to face the challenges of the 21st century.

Keywords: Creative thinking ability; Science learning; STEAM approach

Introduction

21st-century skills are essential for adapting to and contributing to a knowledge and information-based society (Stehle & Peters-Burton, 2019). Seven core skills need mastery: technical, information management, communication, collaboration, creativity, critical thinking, and problem-solving (van Laar et al., 2017). As the foundation for learning, 21st-century skills underscore the need for a comprehensive approach to student education (Muhali, 2019). These skills can be enhanced through science learning.

Science is a discipline comprising concepts, principles, laws, and theories formed through a systematic and creative process, alongside continuous empirical observation (Chiappetta & Koballa, 2006). Utilized as both a skill and strategy, science is employed to process data, and its validity can be tested (Mariana & Praginda, 2009). The study of science involves examining events and phenomena occurring in nature with a keen focus on the processes involved (Sulistiani, 2020).

Science learning is intricately connected to everyday life. Educational materials are crafted to cultivate students' knowledge and understanding of the natural environment and its surroundings (Sukmana & Suartama, 2023). Science learning fosters students' comprehension and problem-solving abilities related to the universe, grounded in facts, concepts, principles, procedures, and theories that can be applied in daily life, driven by their inherent curiosity (Jamaluddin et al., 2019; Putri et al., 2021). Science learning places a premium on direct experiences that students must actively undertake, engaging their ability to explore and understand a phenomenon scientifically (Efendi & Muliadi, 2023; Trisnayanti et al., 2020).

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Creative thinking is an essential skill that students must cultivate in the process of learning science (Zubaidah et al., 2017). Creative thinking unfolds through two distinct modes: divergent thinking, serving as a process to generate ideas, and convergent thinking, an evaluative action applied to the generated ideas (Guilford, 1956). The essence of creative thinking lies in the capacity to conceive original ideas, requiring a method to transform these ideas into tangible realities (Marsono et al., 2019). Framed as a problem-solving approach, creative thinking involves the integration of solutions into the identified problem, subsequently subject to evaluation (Willemsen et al., 2023).

Empirical evidence from the field indicates a prevalent deficiency in students' creative thinking abilities (Jumadi et al., 2021). The inadequate level of creative thinking among students in science learning emanates from the prevalent use of lecture-based teaching methods, rendering student's passive in the learning process (Cintia et al., 2018; Suryana et al., 2021). The paucity of opportunities for students to generate creative outputs also contributes to the diminished creative thinking levels (Conradty et al., 2020). The challenges in cultivating creative thinking are further exacerbated by the utilization of ineffective teaching methods and a dearth of activities fostering student motivation to learn (Sandika & Fitrihidajati, 2018). The resultant low creative thinking abilities pose significant hurdles for students when confronted with problem-solving tasks (Madyani et al., 2020).

Teachers are mandated to enhance students' creative thinking abilities, given the crucial role of these skills in science learning (Trisnayanti et al., 2020). Creative students exhibit an active exploration of various perspectives and demonstrate the capability to perceive problems from diverse angles (Türkmen & Sertkahya, 2015; Yamin et al., 2020). Creative thinking serves as a facilitator for students to adapt to the rapidly changing world (OECD, 2019). Moreover, it enables students to express their ideas fluently and encourages them to acquire new knowledge by engaging their imagination (Ersoy & Başer, 2014). Therefore, an approach that stimulates students' creative thinking is imperative.

The STEAM (Science, Technology, Engineering, Arts, Mathematics) approach emerges as a viable strategy for integrating creative thinking skills (Conradty et al., 2020; Suganda et al., 2021). STEAM represents a fusion of diverse scientific disciplines by amalgamating varied knowledge sources (Li et al., 2018). Originating from STEM and incorporating art, the STEAM concept concentrates on amplifying students' creativity through the incorporation of technology as an innovative element (Kim et al., 2023; Wannapiroon & Pimdee, 2022). The incorporation of STEAM into learning has been shown to heighten students' activity levels and skill sets (Mejias et al., 2021). The application of the STEAM approach as a contextual method in science learning proves highly effective as it invites students to comprehend phenomena occurring in daily life through direct learning and experience (Dewi et al., 2023). The integration of art and technology into science learning establishes an environment conducive to supporting creative thinking, enhancing the learning journey, and affording students opportunities to develop multidisciplinary skills.

Several studies have demonstrated that the implementation of the STEAM approach in science learning can enhance students' creative thinking abilities. These investigations encompass an analysis of the impact of STEAM on students' creative thinking, evaluating their capacity to present ideas for problem-solving, create innovative solutions for complex issues, and assess the outcomes of problem-solving (de Vries, 2021; F. Rahmawati & Retnawati, 2019; Suganda et al., 2021; Zhan et al., 2023). The STEAM approach aids students in refining their skills and fosters higher-level thinking through STEAM-based problem-solving (Maghfiroh et al., 2023).

Despite the increasing adoption of the STEAM approach, there remains a gap in the understanding of its specific impact on creative thinking in the context of science learning. Most studies focus on general cognitive improvements without isolating creative thinking as a distinct outcome. This study introduces a fresh perspective by systematically reviewing findings from 2018 to 2023 to provide a comprehensive analysis of how the STEAM approach specifically enhances creative thinking in science education. The novelty of this research lies in examining the intersection of STEAM's multidisciplinary framework with the development of creativity, a critical skill for students facing the complex challenges of the 21st century.

This research is important because it addresses the urgent need to develop pedagogical strategies that can enhance students' creative thinking skills, which are crucial for innovation and problem-solving in the modern world. Since traditional science teaching methods often fail to engage students in creative processes, the integration of the STEAM approach offers a promising solution. By synthesizing recent research, this study aims to guide educators in optimizing the STEAM framework to foster creativity, preparing students not only for academic success but also for real-world applications in an increasingly complex world.

Method

This research employs a content analysis approach with a qualitative descriptive method. Content analysis is a technique utilized to systematically organize a large amount of text, facilitating the streamlined extraction of data on the research focus, and it incorporates complementary quantitative and qualitative approaches (Macnamara, 2018; Stemler, 2009; Stemler, 2015). The research stages encompass literature analysis or literature review (Elo et al., 2014; Khirfan et al., 2020; Wong et al., 2013), as illustrated in Figure 1. The data sources utilized in the research consist of journal articles published in national and international journals, along with seminar proceedings published from 2018 to 2023. Article searches were conducted through platforms such as Scopus, Google Scholar, and Sinta Kemendikbud, using keywords like 'STEAM Approach to Creative Thinking Ability in Science Learning' and 'STEAM-based Science Learning' to retrieve pertinent articles.

The research flow begins with a Preliminary Study, where an initial review is conducted to understand the context and formulate research questions. The criteria for selecting data sources involve articles discussing the influence of the STEAM approach on creative thinking skills in science learning, specifically focusing on the application of STEAM as an innovation and learning approach. Next, in the Designing Reviews stage, the methodology and criteria for the upcoming study are designed. The Data Collection phase involves gathering relevant data through various methods. A comprehensive search and filtering process from various sources yielded 11 scientific articles addressing the influence of the STEAM approach on creative thinking skills in science learning. After the data is collected, a Reference Analysis is conducted to evaluate the quality and relevance of the information sources used. Then, in the Data Selection stage, the most significant data is chosen for analysis. In the Data Identification phase, the researcher organizes and identifies patterns or trends within the data. Finally, in the Writing up Literature Review stage, the main findings are summarized, and information from relevant literature is synthesized to support the understanding and contribution of the research.

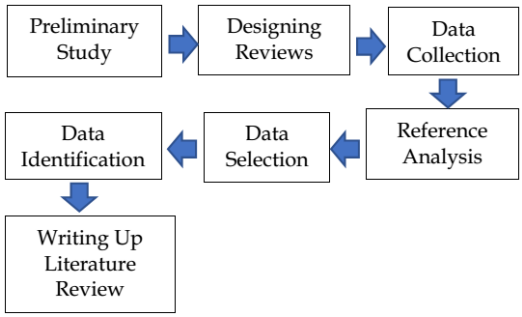

Figure 1. Research flow

Result and Discussion

Result

Based on the results of preliminary studies and data filtering, a total of 11 journals were identified regarding the impact of the STEAM approach on creative thinking abilities in science learning. The findings of the analysis of these 11 journals are presented in Table 1. Scientific journal searches were conducted through sinta.ac.id, Google Scholar pages, and scopus.com using the keywords 'STEAM approach to creative thinking skills in science learning,' resulting in a total of 11 journals. Upon reviewing several journals related to the application of the STEAM approach in science learning, it was evident that this approach proves to be relevant in science education. The analysis presented in table 1 indicates a significant influence of the STEAM approach on students' creative thinking abilities in science learning.

Table 1. Analysis of 15 Scientific Journals on the Influence of the STEAM Approach on Creative Thinking Abilities in Science Learning

Researcher and Year	Research Methodology	Findings
(Rahmawati et al., 2019)	Qualitative research	The skills of critical and creative thinking can be cultivated in students through STEAM-based learning.
(Suganda et al., 2021)	Quantitative-descriptive method	STEAM learning is well-suited for enhancing students' creative thinking abilities.
(Dermawan & Andartiani, 2022)	Research and Development	The STEAM-based E-LKPD developed demonstrates high validity, effectiveness, and practicality in enhancing students' creative thinking abilities.
(Almuharomah et al., 2023)	Research and Development	The STEAM-based creative thinking skills test instrument, integrated with Local Wisdom, has been proven to enhance students' creative thinking skills.
(Arpaci et al., 2023)	Study's experimental	STEAM-based learning modules can offer benefits to students in terms of cognitive, creative, and collaborative skills.
(Putri et al., 2023)	Quasi-experimental research	STEAM-based learning can enhance students' critical and creative thinking skills across all indicators, ranging from medium to high

Researcher and Year	Research Methodology	Findings
		categories. It serves as an alternative for teachers to address the challenge of low critical and creative thinking skills.
(E. P. Mariana & Kristanto, 2023)	Descriptive qualitative method	During the integrated STEAM-CT learning process, students exhibit critical thinking and creative thinking skills, particularly in planning problem-solving, demonstrating flexibility in offering solutions, and incorporating aesthetics in designing products.
(Habibi, 2023)	Quasi-experimental research	The STEAM approach to learning can enhance creative thinking skills across each specific indicator.
(Maghfiroh & Wilujeng, 2023)	Qualitative descriptive	STEAM learning can effectively cultivate creative thinking skills in students.
(Sakdiah et al., 2023)	Quantitative research method Pre-Experimental Design	There is a significant impact of STEAM learning and scientific attitudes on students' creative thinking skills.
(Tasya et al., 2023)	Research and Development	The developed e-Worksheet can serve as a learning alternative to enhance students' creative thinking abilities.

Discussion

Education and learning evolve in tandem with the progress of time. Researchers in the field of science persistently explore innovative learning methods to ensure students can optimize their potential. One noteworthy innovation is the application of the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach in science learning (Li et al., 2018).

The STEAM approach involves the integration of various disciplines, including science, technology, engineering, arts, and mathematics (Conradty et al., 2020). What sets this approach apart is its holistic nature, providing a more comprehensive and immersive learning experience. In the context of science learning, the application of the STEAM approach has garnered attention due to its perceived effectiveness in enhancing students' creative thinking abilities. An analysis of the implementation of the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach on creative thinking abilities in science learning offers valuable insights into its effectiveness and impact on students. Several studies consistently demonstrate that applying the STEAM approach in science learning has a positive and significant influence on students' creative thinking abilities (de Vries, 2021; Rahmawati & Retnawati, 2019; Suganda et al., 2021; Zhan et al., 2023). The integration of diverse disciplines, such as science, arts, and technology, creates a holistic learning environment that fosters creativity.

The effectiveness of the STEAM approach in enhancing problem-solving skills and fostering innovative thinking among students has been substantiated (Maghfiroh et al., 2023). Involving students in real-world problem-solving situations that demand the application of multiple disciplines, STEAM-based learning cultivates a mindset that appreciates creative solutions to intricate challenges. The integration of diverse disciplines within the STEAM framework plays a pivotal role in nurturing learners' multidisciplinary skills.

The STEAM approach enables learners to connect various fields of knowledge, fostering a comprehensive understanding of scientific concepts and their practical applications. For instance, the creation of STEAM-based learning modules has been shown to enhance student engagement and participation (Arpaci et al., 2023). The interactive and hands-on nature of STEAM activities motivates students to actively engage in the learning process, thereby deepening their comprehension of scientific concepts.

The analysis underscores the potential of the STEAM approach in addressing challenges related to low creative thinking abilities in science learning. Traditional lecture methods were identified as a contributing factor to the reduced passivity and creativity in students. STEAM provides a more engaging alternative methodology. Teachers play a crucial role in facilitating creative thinking among students within the STEAM framework (Trisnayanti et al., 2020). Their ability to design and implement STEAM-based activities, encourage exploration, and provide guidance significantly influences the development of students' creative thinking skills. The application of the STEAM approach as a contextual and effective learning strategy is emphasized in the literature (Dewi et al., 2023). The contextualization of scientific concepts in everyday life through direct experiences enhances the effectiveness of the learning process.

Relevant research indicates that the implementation of the STEAM approach in science learning yields a significantly positive impact. Students not only grasp scientific concepts theoretically, but they are also provided with opportunities to relate this knowledge to real-world situations. This fosters a more profound learning experience, refines creative thinking skills, and sparks students' imaginations.

Crucial findings from this research affirm that the STEAM approach is not merely a passing trend but an effective solution to enhance the quality of science learning. By integrating elements of art, technology, and

various other disciplines, students can cultivate creative thinking skills essential for confronting the complex challenges of the future. This innovative approach represents a significant stride in addressing the dynamics of modern education and preparing the younger generation for success in the 21st century.

Conclusion

Based on the results of this study, the STEAM approach has proven effective in enhancing students' creative thinking skills in science learning. STEAM creates a holistic and interactive learning environment, allowing students to be more active in exploring ideas, designing innovative solutions, and connecting scientific concepts to real-life situations. The findings from the analyzed journals indicate that the STEAM approach significantly influences the improvement of students' creative thinking skills. The implementation of STEAM also addresses the weaknesses of traditional teaching methods, which tend to be passive and contribute to the low levels of students' creative thinking skills. Therefore, STEAM is a relevant solution for improving the quality of science education and preparing students to face the challenges of the 21st century.

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The authors declare no conflict of interest in this research.

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