



## STEAM Approach in Science Education: A Literature-Based Conceptual Analysis

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**ABSTRACT.** Science education in the 21st century is required to present a learning model that emphasizes not only cognitive aspects, but also creativity, collaboration, and critical thinking skills. One approach deemed relevant to these demands is the integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics), which is able to combine the dimensions of science with artistic creativity to produce more meaningful learning. The purpose of this study is to analyze the concept, advantages, and challenges of implementing STEAM in science learning through a literature review. This study uses a literature study method by reviewing various scientific articles, books, and relevant research reports from the last five years, then analyzing them descriptively and qualitatively to identify key patterns and findings. The results of the study indicate that the STEAM approach contributes significantly to improving scientific literacy, problem-solving, and student innovation, although it still faces obstacles in teacher readiness, curriculum, and supporting facilities. The conclusion of this study confirms that STEAM has great potential to become a new paradigm in science learning, while contributing to the development of 21st-century competencies and supporting the achievement of national education goals.

**Keywords:** *Internet-Based Learning Media, Student Learning Motivation*



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## INTRODUCTION

Science education in the 21st century faces major challenges in preparing students to adapt to technological developments, global competency demands, and the complexity of modern life. The phenomena of globalization and the industrial revolution 4.0 demand curriculum transformation and learning strategies that not only focus on cognitive aspects but also emphasize creativity, collaboration, digital literacy, and problem-solving skills (hidayat & yuliani, 2021). These changes highlight the urgency of developing innovative learning models that are relevant to contemporary needs.

One approach that has gained significant attention in science education is the integration of steam (science, technology, engineering, arts, and mathematics), which is considered capable of providing meaningful and contextual learning experiences. The integration of art into science education is viewed as a breakthrough that balances logical and creative aspects, producing graduates who excel not only in knowledge but also in imagination and innovation (rahayu, 2020).

The urgency of this research becomes increasingly evident when connected to the need for developing highly competitive human resources in indonesia.

The research problem focuses on how the concept, advantages, and challenges of implementing the steam approach can be described through a literature review in science education. The study aims to answer fundamental questions about the role of steam in improving the quality of science learning in schools and its contribution to developing 21st-century competencies. The objective of this research is to critically analyze relevant literature related to steam integration while emphasizing the potential innovations it offers for educational practice in indonesia (putri & anwar, 2022).

A review of previous studies shows that numerous researchers have discussed the importance of inquiry-based, problem-based, and project-based learning in improving science literacy (lestari, 2021). However, studies that specifically address the integration of art into science, technology, and mathematics remain relatively limited in the indonesian educational context (fadilah & nurjanah, 2022). The novelty of this research lies in providing a conceptual analysis of steam integration based on recent literature, thereby enriching academic discourse while offering practical guidance for science teachers.

The research gap identified is that most science education literature in indonesia still focuses on the stem aspect without sufficient attention to the artistic dimension (nugroho, 2019). Yet, art holds great potential in developing divergent and imaginative thinking skills, which are crucial for navigating the complexity of the 21st century. Thus, this study aims to fill that gap by offering a conceptual analysis that emphasizes the importance of the artistic dimension in science learning (aulia & sari, 2020).

Furthermore, steam integration aligns with national education policies, particularly within the framework of the *kurikulum merdeka*, which emphasizes project-based learning, learner autonomy, and character building. This curriculum requires teachers to be more flexible, creative, and adaptive in designing their lessons (kemendikbudristek, 2021). Through the review of recent literature, this study contributes not only to the theoretical domain but also provides practical insights for developing classroom learning strategies.

The scientific contribution of this research lies in its effort to present a critical synthesis of the role of steam in science education while reinforcing the urgency of pedagogical transformation in the digital era. This article is expected to enrich academic discourse on learning innovation and serve as a foundation for future empirical studies (pratiwi & hasanah, 2023). Ultimately, this research asserts that steam integration is not merely a global trend but a genuine necessity to prepare young indonesians to become scientifically literate, creative, and globally competitive (suryana, 2019).

## METHOD

This research employed a qualitative design using a literature study approach. The literature study approach was chosen because the focus of this research is to critically analyze the concepts and practical implementation of the STEAM approach in science education based on previous studies. A literature study is considered relevant when the research objective is to explore, synthesize, and critique various published works, including journal articles, academic books, and conference proceedings (Zed, 2019). Therefore, this study did not involve direct field data collection but was instead based on an in-depth review of existing scientific documents.

The data sources in this study were drawn from scientific literature relevant to the topic of STEAM integration in science education. The reviewed literature was limited to publications from the past five years to ensure the recency of findings, although some classical references were also used as theoretical foundations. Accredited national journals (SINTA) and reputable international

journals served as primary references, along with academic books discussing science education and the STEAM approach (Sukardi, 2020). The selection of data sources was carried out systematically by considering content relevance, publication quality, and significance in addressing the research focus.

The data collection technique involved searching scientific databases such as Google Scholar, DOAJ, and Garuda. Selected articles were filtered using relevant keywords such as *STEAM education*, *science learning*, *21st-century skills*, and *curriculum innovation*. The selection process followed inclusion and exclusion principles for example, only including articles that explicitly discuss STEAM integration within the context of formal education (Sugiyono, 2019). This procedure ensured that the data obtained were representative and supportive of in-depth analysis.

Data analysis was conducted using the content analysis technique. This method was selected because it aligns with the research objective of identifying patterns, categories, and key themes across the reviewed literature. The analysis process consisted of several stages: data reduction, data presentation, and conclusion drawing (Miles, Huberman, & Saldaña, 2018). In the data reduction stage, the researcher filtered essential information from relevant sources. During the data presentation stage, the reduced information was organized into main themes such as the advantages of STEAM, challenges in implementation, and its relevance to 21st-century competencies. The final stage involved drawing conclusions based on the synthesis of all analyzed literature.

The validity of the data in this literature study was ensured through source triangulation. Triangulation was conducted by comparing and verifying information obtained from various types of literature national journals, international journals, and academic books (Moleong, 2021). Additionally, data credibility was reinforced by selecting literature published in indexed and peer-reviewed journals. This strategy minimized potential bias and strengthened the validity of the research findings.

All stages of this research method were designed to be replicable by other researchers working on similar topics. Through detailed explanations of the research type, data sources, data collection techniques, analysis procedures, and validation strategies, this study emphasizes academic credibility while providing a clear methodological framework. Thus, this methodological section serves as an essential foundation for the entire literature-based research process (Arikunto, 2021).

## RESULT AND DISCUSSION

### Result

Based on a literature analysis of more than 30 scientific articles, books, and research reports published within the last five years, three main themes were identified regarding the implementation of STEAM in science education: (1) the contribution of STEAM to the development of 21st-century skills, (2) the challenges of implementing STEAM in Indonesian schools, and (3) the relevance of STEAM to the *Kurikulum Merdeka* policy.

**Table 1** Summary of Key Research Findings on STEAM

No.	Fokus Kajian	Temuan Utama	Sumber
1	21st century skills	STEAM enhances students' creativity, problem solving, and collaboration.	(Syamsuddin & Rahmi, 2021)

2	Implementation challenges	Teachers experience constraints on pedagogical readiness and limited facilities	(Nisa & Ridwan, 2020)
3	Independent Curriculum	STEAM aligns with project-based learning and character	(Hidayati & Anam, 2022)

The literature review confirms that the STEAM approach has been shown to positively impact students' cognitive, affective, and psychomotor development. However, the literature also highlights implementation barriers, particularly teacher limitations in designing integrative learning.

## Discussion

### STEAM and 21st Century Competencies

The main findings indicate that STEAM is effective in enhancing 21st-century competencies, particularly creativity, collaboration, communication, and critical thinking. For example, studies show that the integration of art in science projects allows students to freely express creative ideas and develop innovative solutions to real-world problems (Syamsuddin & Rahmi, 2021). This aligns with constructivist theory, which emphasizes active experience as the foundation of knowledge construction (Rahman, 2019).

Compared to the STEM approach, STEAM is superior because it provides space for students' imagination, which serves as a driving force for innovation. These findings support international research showing that students with STEAM learning experiences are more adaptive to global changes (Anderson & Pitts, 2020). Therefore, STEAM implementation not only enriches science literacy but also develops the soft skills essential for the 21st-century workforce. Tantangan Penerapan STEAM di Sekolah

### Challenges in Implementing STEAM in Schools

Despite its great potential, the implementation of STEAM in Indonesia faces significant challenges. The main obstacle lies in teachers' limited competence in designing integrative lessons that combine all five dimensions of STEAM simultaneously (Nisa & Ridwan, 2020). Many teachers are still accustomed to conventional approaches that emphasize rote memorization of concepts, making it difficult to adapt to project-based models. In addition, limited school facilities also pose barriers, especially in areas with poor access to technology. This finding aligns with studies showing that disparities in educational infrastructure widen the quality gap between urban and rural schools (Kurniasih & Pratama, 2021). Therefore, strengthening teacher capacity through training and providing adequate learning resources are key factors in the successful implementation of

### STEAM and the Merdeka Curriculum

Other findings reveal that the STEAM approach is highly relevant to the *Kurikulum Merdeka* policy, which emphasizes project-based learning, differentiation, and character development (Hidayati & Anam, 2022). Through STEAM, students can engage in real-world projects such as designing simple eco-friendly tools or creating science-based art, aligning with the principles of student-centered learning. This supports the idea that 21st-century education should be life-oriented rather than merely focused on knowledge transfer (Wibowo, 2021). Thus, STEAM can serve as a strategic instrument for realizing the vision of the *Kurikulum Merdeka*, namely fostering Pancasila Student Profiles who are faithful, creative, and independent.

### Position and Scientific Contribution of the Study

Based on the synthesis of the literature, the scientific contribution of this study lies in emphasizing that the integration of art into science education is not merely an addition but an essential element in shaping creative and innovative generations. Unlike previous studies that primarily focused on STEM, this study positions art as a catalyst that enriches the learning process. This novelty extends the academic discourse and provides a conceptual foundation for future empirical research on the effectiveness of STEAM in Indonesian schools.

## CONCLUSION

This study affirms that the integration of the STEAM approach in science education has a significant contribution to improving the quality of 21st-century learning. The findings of the literature review show that STEAM effectively develops critical thinking, creativity, collaboration, and communication skills—competencies that are highly relevant to global demands. The inclusion of the arts within STEAM has proven to be an essential element that enriches the cognitive dimension with imagination and innovation, thereby ensuring that science learning is not only oriented toward factual knowledge but also toward strengthening practical and affective skills.

Nevertheless, the implementation of STEAM in Indonesian schools still faces several challenges, including limited teacher competence, inadequate supporting facilities, and a persistent tendency toward traditional teaching practices. These challenges highlight the need for targeted strategies to enhance teacher capacity and develop a more flexible curriculum. The integration of STEAM also aligns with the direction of the *Kurikulum Merdeka* policy, which emphasizes project-based learning, making it highly relevant within the context of national education.

Thus, this research provides a scientific contribution through a critical synthesis of the potential and challenges of implementing STEAM in science education. In practical terms, the findings of this study can serve as a reference for educators, curriculum developers, and policymakers to optimize STEAM integration in order to foster a scientifically literate, creative, and competitive generation in the digital era.

## BIBLIOGRAPHY

- Amalia, R., & Handayani, E. (2021). Pendekatan STEAM dalam Pembelajaran Abad 21. *Jurnal Inovasi Pendidikan IPA*, 7(2), 115–124.
- Anderson, M., & Pitts, C. (2020). Creativity and Innovation in STEAM Education. *Journal of Science Education Research*, 15(2), 87–98.
- Arifin, M., & Lestari, D. (2020). Kreativitas Guru dalam Implementasi STEAM pada Pembelajaran IPA. *Jurnal Pendidikan Sains*, 6(1), 45–54.
- Arikunto, S. (2021). *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.
- Aulia, F., & Sari, M. (2020). Seni dalam Pendidikan Sains: Sebuah Kajian Konseptual. *Jurnal Ilmu Pendidikan*, 12(4), 331–340.
- Fadilah, M., & Nurjanah, S. (2022). Analisis Perbandingan STEM dan STEAM dalam Pembelajaran IPA. *Jurnal Pendidikan Sains*, 8(2), 77–89.
- Halimah, N., & Yusuf, R. (2022). Kerangka Konseptual Integrasi STEAM dalam Pendidikan Sains. *Jurnal Ilmu Pendidikan Indonesia*, 11(2), 201–213.
- Hidayat, R., & Yuliani, N. (2021). Transformasi Pendidikan Abad 21: Literasi Digital dan Tantangan Global. *Jurnal Pendidikan Indonesia*, 10(2), 145–156.
- Hidayati, R., & Anam, S. (2022). STEAM dalam Konteks Kurikulum Merdeka: Analisis Konseptual. *Jurnal Pendidikan Nasional*, 14(3), 211–223.
- Kemendikbudristek. (2021). *Panduan Implementasi Kurikulum Merdeka*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

- Kurniasih, T., & Pratama, A. (2021). Kesenjangan Fasilitas Pendidikan dalam Implementasi STEAM. *Jurnal Inovasi Pendidikan Sains*, 9(2), 133–144.
- Kurniawan, D., & Wibowo, A. (2019). *Konsep Dasar STEAM dalam Pendidikan*. Yogyakarta: Deepublish.
- Lestari, R. (2021). Problem Based Learning untuk Literasi Sains. *Jurnal Ilmiah Pendidikan IPA*, 11(3), 201–210.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2018). *Qualitative Data Analysis: A Methods Sourcebook*. Thousand Oaks, CA: Sage Publications.
- Moleong, L. J. (2021). *Metodologi Penelitian Kualitatif*. Bandung: Remaja Rosdakarya.
- Nisa, H., & Ridwan, F. (2020). Tantangan Guru dalam Implementasi STEAM di Sekolah Menengah. *Jurnal Ilmu Pendidikan Indonesia*, 8(1), 45–56.
- Nugroho, Y. (2019). *Pengembangan Kurikulum STEM di Indonesia*. Yogyakarta: Deepublish.
- Pranata, H., & Gunawan, A. (2021). Literasi Digital dalam Pendidikan Abad 21. *Jurnal Teknologi Pendidikan*, 9(1), 33–44.
- Pratiwi, R., & Hasanah, U. (2023). STEAM Education: Kontribusi terhadap Kompetensi Abad 21. *Jurnal Pendidikan dan Teknologi*, 14(2), 99–110.
- Putri, D. K., & Anwar, H. (2022). Integrasi Pendekatan STEAM dalam Kurikulum Merdeka. *Jurnal Inovasi Pendidikan*, 7(1), 55–67.
- Rahayu, S. (2020). *Inovasi Pembelajaran Sains Berbasis STEAM*. Bandung: Remaja Rosdakarya.
- Rahman, A. (2019). *Teori Belajar Konstruktivisme dan Implementasinya*. Bandung: Alfabeta.
- Rahmasari, E. (2021). Implementasi STEAM dalam Proyek IPA SMP. *Jurnal Pendidikan IPA Indonesia*, 10(3), 276–285.
- Rosita, A., & Mahendra, P. (2021). Integrasi Seni dalam Pembelajaran Sains. *Jurnal Pendidikan Humaniora*, 9(2), 144–153.
- Sari, I., & Susanto, B. (2020). Literasi Sains dalam Konteks Kurikulum Abad 21. *Jurnal Pendidikan Nasional*, 12(1), 99–109.
- Sugiyono. (2019). *Metode Penelitian Kualitatif, Kuantitatif, dan R&D*. Bandung: Alfabeta.
- Sukardi. (2020). *Metodologi Penelitian Pendidikan*. Jakarta: Bumi Aksara.
- Suryana, D. (2019). *Pendidikan Anak Usia Dini dalam Era Digital*. Jakarta: Kencana.
- Syamsuddin, A., & Rahmi, D. (2021). Penerapan STEAM untuk Meningkatkan Kreativitas Siswa. *Jurnal Pendidikan IPA Indonesia*, 10(2), 155–166.
- Utami, P., & Dewi, L. (2020). Pengaruh Pembelajaran Berbasis STEAM terhadap Kreativitas Siswa. *Jurnal Inovasi Pendidikan Sains*, 8(2), 177–188.
- Wibowo, A. (2021). Pendidikan Abad 21: Dari STEM ke STEAM. *Jurnal Teknologi Pendidikan*, 13(1), 45–58.
- Wulandari, T. (2022). Peran Seni dalam Pendidikan Interdisipliner. *Jurnal Seni dan Pendidikan*, 14(1), 55–66.
- Zed, M. (2019). *Metode Penelitian Kepustakaan*. Jakarta: Yayasan Obor Indonesia.