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The Impact of The STEAM Approach on The Level of Students Creativity and Critical Thinking Levels: A Systematic Literature Review

Aprilia Enggaring Tyas[1]
[1]Universitas Bengkulu, Bengkulu, Indonesia,

Corresponding author e-mail: liaapril52@gmail.com

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Abstract: This systematic literature review investigates the impact of the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach on students' creativity and critical thinking across various educational levels. Drawing on a comprehensive selection of national and international studies, the review reveals consistent evidence that STEAM-based learning implemented through project-based, problem-based, and integrative instructional models significantly enhances students' creative abilities, critical thinking skills, learning outcomes, engagement, and scientific disposition. The integration of art within STEM is shown to play a crucial role in fostering imagination, expression, and holistic problem-solving. Findings indicate that STEAM benefits not only early childhood learners by strengthening curiosity and confidence but also elementary and secondary students through improved higher-order thinking and collaboration skills. Moreover, STEAM contributes to broader educational, social, and economic outcomes by promoting transferable 21st-century competencies such as communication, adaptability, and perseverance. Despite its effectiveness, successful implementation requires adequate teacher readiness, structured learning design, and supportive educational policies. Overall, this review affirms STEAM as a relevant and impactful pedagogical innovation that supports meaningful, humanistic, and future-oriented learning.

Keywords: Critical and Creative Thinking, High Order Thinking Skills, STEAM Approach

A. Introduction

In the 21st century, students need critical thinking skills to solve problems. Not only critical thinking, but also creativity is essential. Various learning approaches have been developed and are starting to be implemented in schools, the STEAM approach being one of them. The STEAM approach is an interdisciplinary learning method that is currently trending. The STEAM approach attempts to combine the fields of Science, Technology, Engineering, Art, and Mathematics to solve problems creatively. The goal of this approach is to develop students' critical and creative thinking skills in problem-

solving in school learning.

In the context of modern education, STEAM learning is not only understood as the integration of five disciplines, but also as a pedagogical framework that encourages the realization of authentic and student-centered learning experiences. This approach allows students to construct knowledge through exploratory, collaborative, and project-based activities relevant to real-world problems. The integration of art elements in STEAM is a crucial component because it provides space for the development of imagination, expression, and creativity, which were previously underserved in traditional STEM models. Thus, STEAM not only emphasizes logical and analytical abilities but also combines them with aesthetic and intuitive sensibilities in the problem-solving process.

Numerous studies have shown that implementing STEAM can increase student learning engagement, critical thinking skills, collaboration skills, and creativity. Furthermore, this approach contributes to an increased scientific disposition and students' courage to explore new solutions creatively. The main challenges to implementing STEAM lie in teacher readiness, systematic learning design, and the provision of adequate resources. Therefore, further study of the effectiveness, implementation models, and strengthening educator capacity in STEAM learning is crucial to support the achievement of 21st-century (Arce et al., 2022).

B. Methods

The research method used in this study is a systematic literature review (SLR). SLR is a scientific study that focuses on the use of clear and defined scientific methods to identify, select, evaluate, and summarize relevant study results (Damayanti & Bambang, 2024). This study uses SLR to determine how the STEAM approach affects the development of student creativity and critical thinking levels.

The stages in a systematic literature review consist of: 1) identifying research questions; 2) developing a systematic review research protocol; 3) data sources and search strategy; 4) screening process; 5) eligibility criteria; 6) quality assessment; 7) data extraction; 8) data analysis and synthesis. This journal was compiled using a qualitative approach using the SLR method. The data collected by the researchers were journals discussing the philosophy of science and scientific development. SLR was implemented by reviewing and identifying data sources one by one according to the specified steps and procedures (Huda et al., 2022). After obtaining various articles. Researchers found 200 articles related to the title The Impact of The STEAM Approach on The Level of Students Creativity and Critical Thinking Levels, in the Google Scholar Database search, then selected 150 articles related to the topic studied from several articles. Then 90 articles were filtered again. Then studying the article in detail and in accordance with the material The Impact of The STEAM Approach on The

Level of Students Creativity and Critical Thinking Levels, produced another 60 articles that were tested for feasibility, but 45 articles did not meet the feasibility test. After being tested for feasibility and examined in detail, 15 articles were found that were in accordance with the discussion theme, then not included in the discussion or search. 15 articles were obtained mainly in line with the research theme which will be presented in the discussion and conclusion sections. The following is the appropriate PRISMA flowchart.

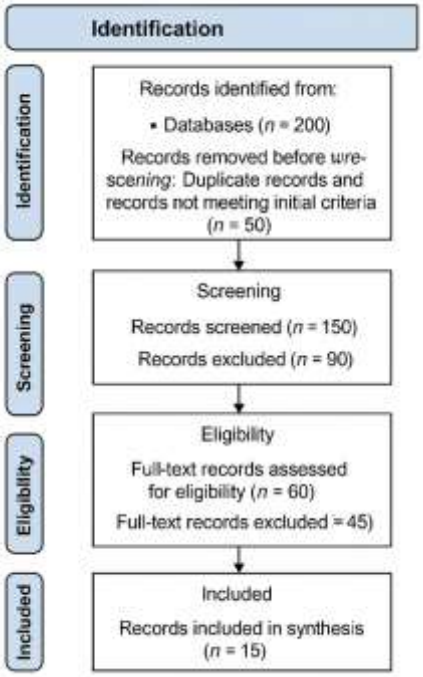

Figure 1. PRISMA Flowchart

C. Results and Discussion

Pedagogical Models that Maximize STEAM's

The synthesis of studies indicates that Project-based Learning and Problem-based Learning are the most frequently employed and consistently effective pedagogical models within STEAM implementation. Multiple quasi-experimental studies and module development projects reported substantial gains in creativity and critical thinking when STEAM was integrated into Project-based Learning and Problem-based Learning frameworks. For example, one study documented an increase in creativity from 26.92% to 73.08%, while others observed significant improvements in both creative and critical thinking abilities following STEAM-based learning modules.

Conceptually, Project-based Learning and Problem-based Learning align with the interdisciplinary essence of STEAM by providing authentic, problem-rich, and iterative learning experiences. These models enable guided exploration, collaborative

meaning-making, and engineering-design cycles—mechanisms that foster creativity and higher-order thinking. Evidence from STEAM-based e-module development further strengthens the argument that Project-based Learning offers a practical and valid structure for STEAM integration.

Despite consistent positive outcomes, most studies rely on small samples, single-school implementations, and varied assessment tools. Thus, the practical effectiveness of Project-based Learning and Problem-based Learning is strong, but broader generalization requires standardized effect size reporting and multi-site research designs.

Differential Impacts on Creativity vs. Critical Thinking

Across the studies reviewed, STEAM learning generated improvements in both creativity and critical thinking, although the magnitude and characteristics of these gains varied. Some research reported higher increases in critical thinking (e.g., +23.3%) compared to creativity (e.g., +17.2%), whereas early childhood studies showed pronounced improvements in creative dimensions—such as originality, fluency, and elaboration. These patterns suggest that STEAM affects different cognitive domains depending on developmental stage and instructional design.

Three analytical patterns emerge: STEAM tasks tend to enhance divergent thinking particularly imagination and unusual-use capacities more visibly in younger learners, where exploratory play is central. Critical thinking improvements appear stronger in upper elementary and secondary contexts, where learners engage in inquiry, evidence-based reasoning, and structured problem-solving. Moderating factors, such as students' self-esteem, were shown to influence the extent to which STEAM-PBL enhances creativity, indicating that cognitive gains are not uniform across learner profiles.

Variation in measurement instruments restricts direct comparison across studies. Future research should adopt standardized creativity and critical thinking assessments to enable clearer differentiation of STEAM's impact on the two domains. Instructional practice should explicitly tailor STEAM design tasks depending on whether the objective prioritizes creative or critical outcomes.

Applicability Across Educational Levels.

Findings across educational levels reveal age-specific manifestations of STEAM's impact: Early Childhood (Preschool/Kindergarten): STEAM activities enhanced creativity, curiosity, confidence, and exploratory initiative. These benefits stem largely from hands-on, sensory-rich, and playful integration of science and art. Primary School: Improvements were most notable in scientific creativity, motivation in science

learning, collaboration, and imagination-related creative skills. STEAM-PjBL yielded significant gains and was consistently reported as engaging and developmentally appropriate. Secondary School: Gains shifted toward cognitive performance, particularly critical thinking, conceptual understanding, and problem-solving. PBL-STEAM approaches helped students connect knowledge to real-world applications and strengthened argumentation and reasoning. While patterns appear consistent, most evidence reflects short-term interventions. Longitudinal research is still lacking, limiting conclusions about the sustained influence of STEAM across educational transitions.

Enablers and Barriers to Implementation

Teachers emerged as a pivotal factor in STEAM implementation. Several studies emphasized that STEAM requires educators to act not merely as content deliverers, but as facilitators, designers of interdisciplinary tasks, and evaluators of creative processes. Professional development particularly ongoing mentoring and collaborative lesson study was frequently identified as essential. Limited resources (materials, technology, time allocation) also appeared as barriers that diminished the quality or feasibility of STEAM activities.

An important conceptual challenge discussed in the literature relates to tensions in the underlying purpose of STEAM. Some studies noted the ambiguity between economic aims (e.g., preparing future STEM labor) and pedagogical aims (developing creativity, critical thinking, and humanistic competencies). When these aims are not aligned, implementation risks becoming superficial or overly instrumental, rather than genuinely transformative.

Table 1. Article Journal Reviewed

No.	Title	Author	Object	Result	Conclusion
1	STEAM Education	(Utaminingsih et al., 2023)	The primary focus of this article is STEAM (Science, Technology, Engineering, Arts, and Mathematics) education and its role in improving the quality of learning and student competent	STEAM can develop students' critical, logical, and systematic thinking skills, as well as their creativity and imagination. This approach also increases metacognitive engagement and provides opportunities for students to practice comprehensive problem-solving.	The article concludes that STEAM is a transdisciplinary learning approach relevant to the demands of the 21st century. STEAM enables the development of innovation, critical, logical, and creative thinking skills, and enhances students' global competitiveness.
2	The Effect of Using STEAM Approach on Motivation Towards Learning Among High School Students in Jordan	(Bedar & Al-Shboul, 2020)	32 high school students	STEAM reduces the pressure on grades because activities are more project-oriented and exploratory.	The STEAM approach has a significant influence on increasing creativity in the aspects of originality, flexibility, fluency, and elaboration.
3	Enhancing Students' Learning Creativity through a STEAM-Based Scientific Approach in Elementary Schools	(Andriana et al., 2021)	Fifth grade students of SD Negeri 16 Purwodadi	Learning creativity increased in each cycle from an average of 40% to more than 75% in cycle II.	The STEAM-based scientific approach effectively increases elementary school students' learning creativity in thematic learning.
4	Development of Project Based Learning with STEAM Approach Model Integrated Science Literacy in Improving Student Learning Outcomes	(Nuraini et al., 2023)	Object was grade X students of SMAN 2 Selong totaling 35 students with 25 female students and 10 male students	This shows that the integration of PjBL + STEAM + scientific literacy has a significant impact on improving student learning outcomes, especially on ecosystem material.	The implications of the research emphasize the need for teachers to master innovative project-based learning and STEAM to answer the demands of 21st-century learning. The PjBL learning model with a STEAM approach integrated with scientific

					literacy was successfully developed well, meeting the requirements of validity, practicality, and effectiveness.
5	The Influence of the Project-Based Learning-Based STEAM Approach on Creative and Critical Thinking Skills	(Wastiani et al., 2023)	8th grade students of Labschool Cibubur Middle School	There is a significant influence on creative (17.2%) and critical (23.3%) thinking with an effectiveness of 80% (Cohen's d = 0.88).	The PjBL-based STEAM approach has a significant influence on mathematics students' creative and critical thinking abilities.
6	The Influence of the STEAM Approach on the Critical Thinking Skills of 5–6-Year-Old Children	(Anggriani & Eliza, 2023)	Children aged 5–6 years old, Pembina 01 Air Haji Pesisir Selatan Kindergarten	The post-test score increased from 16.13 to 23.60 (sig. 0.014 < 0.05).	The STEAM approach has a significant influence on the critical thinking skills of early childhood.
7	Analysis of The Application of The STEAM Approach to Learning In Indonesia: Contributions to Physics Education	(Bin Amiruddin et al., 2022)	the application of the STEAM approach in learning in Indonesia, with a particular focus on its contribution to physics education.	STEAM can develop 21st-century skills, such as critical thinking, creativity, collaboration, and communication. STEAM increases students' interest in science, technology, and problem solving.	STEAM education is useful for understanding concepts. This study contributes to the literature by investigating the effect of STEAM education approaches on students' conceptual understanding.
8	Investigating the effectiveness of STEAM education on students' conceptual understanding of force and energy topics	(Ozkan & Umdu Topsakal, 2021)	The study sample comprised 74 7th-grade students from two different classes in a Turkish secondary school (study group and control group).	The results demonstrate that STEAM education positively affected the students' conceptual understanding and reduced or shifted the number of misconceptions. Furthermore, the study group's post-trial conceptual understanding scores were significantly	The STEAM approach effectively fosters students' curiosity and active involvement in science learning.

				higher than those of the control group. The interviewees indicated that STEAM education's support for a learner-centered environment fostered the students' conceptual understandings.	
9	Mathematical Creative Thinking Ability Reviewed from Self-Esteem in the PBL Model with the STEAM Approach	(Fitria et al., 2023)	Students of class VIII of Duta Aswaja Middle School, Kudus	PBL-STEAM effectively improves mathematical creative thinking skills, especially in students with high self-esteem.	The PBL model with a STEAM approach improves mathematical creative thinking skills, influenced by students' self-esteem.
10	STEAM-PjBL Approach to Develop Fifth Grade Students' Scientific Creativity on the Topic of Ecosystems and Magnets	(Yulia et al., 2024)	Fifth grade elementary school students in Jakarta	The increase in the scientific creativity aspect was significant, especially in the science imagination and unusual use aspects (+16.25%).	The STEAM-PjBL approach is effective in developing scientific creativity and collaboration in elementary school students.
11	The Effect of Problem Based Learning with the STEAM Approach on Students' Learning Outcomes and Critical Thinking Skills	(Cahyani & Sulastri, 2021)	High school students (science)	The application of the PBL model with the STEAM approach significantly improves students' learning outcomes and critical thinking skills compared to conventional learning.	The STEAM-PBL approach is effective in developing critical thinking skills and learning outcomes because it links concepts to real problems and interdisciplinary integration.
12	The STEAM Approach: Implementation and Educational, Social, and Economic Consequences	(Perales & Aróstegui, 2024)	Theoretical studies and implementation of STEAM in various educational contexts	STEAM has a broad impact on educational, social, and economic aspects by integrating science, technology, and the arts. It encourages a	STEAM is important as a transdisciplinary educational model that is not only economically oriented but also strengthens social and

				more humanistic and democratic education.	humanitarian values in the education system.
13	The Trouble with STEAM and Why We Use It Anyway	(Mejias et al., 2021)	A conceptual review and global education policy on STEAM	STEAM is often used ambiguously; there is a tension between economic goals (increasing STEM competitiveness) and pedagogical goals (expanding ways of learning and critical thinking).	Although STEAM has conceptual weaknesses, it remains useful as an interdisciplinary approach that connects the arts and sciences for meaningful learning.
14	STEAM Education: Student Learning and Transferable Skills	(Bertrand & Namukasa, 2025)	103 participants (teachers, instructors, students) from four STEAM programs in Ontario, Canada	STEAM enhances 21st-century skills such as critical thinking, problem solving, communication, collaboration, creativity, perseverance, and adaptability.	STEAM effectively develops transferable skills needed in the workplace and real life, and encourages interdisciplinary and continuous learning.
15	The effect of project-based STEAM activities on the social and cognitive skills of preschool children	(Başaran & Bay, 2023)	57 Children in the preschool period	the STEAM approach can be effective in preschool	the STEAM approach can be effective in preschool

D. Conclusions

This systematic literature review demonstrates that the STEAM approach plays a significant and consistent role in enhancing students' creativity and critical thinking across educational levels. By integrating science, technology, engineering, art, and mathematics within authentic and interdisciplinary learning experiences, STEAM fosters a learning environment that encourages exploration, problem-solving, and imaginative thinking. The findings across the reviewed studies show that STEAM-based instruction—particularly when implemented through Project-based Learning (PjBL) and Problem-based Learning (PBL) effectively increases students' creative expression, divergent thinking, critical reasoning, collaboration, and scientific engagement.

Evidence from early childhood to secondary education indicates that STEAM influences developmental stages differently: younger learners show substantial gains in creativity, curiosity, and exploratory abilities, while older students demonstrate stronger improvements in critical thinking, conceptual reasoning, and real-world problem-solving skills. These outcomes highlight the flexibility and relevance of STEAM as a pedagogical model that adapts to various learning needs and cognitive domains. Nevertheless, the successful implementation of STEAM depends heavily on teacher readiness, availability of resources, and coherent instructional design. Challenges such as limited facilities, inconsistent assessment tools, and conceptual ambiguities regarding the aims of STEAM underscore the need for continuous professional development and supportive educational policies.

Overall, this review affirms that STEAM is a transformative and future-oriented learning paradigm. Beyond improving academic competencies, STEAM nurtures humanistic, adaptive, and transferable skills essential for navigating complex global challenges. Therefore, STEAM deserves wider adoption and further longitudinal research to strengthen its role in shaping meaningful, innovative, and equitable education for the 21st century.

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References

Andriana, E. M., Utami, R. D., & Sehati, A. (2021). Enhancing Students' Learning Creativity Through a Steam-Based Scientific Approach in Elementary Schools. *Educatif Journal of Education Research*, *3*(4), 51–60. https://doi.org/10.36654/educatif.v3i4.82

Anggriani, D., & Eliza, D. (2023). The Influence of the STEAM Approach on the Critical Thinking Skills of 5-6 Year Old Children. *PAUDIA : Jurnal Penelitian Dalam Bidang Pendidikan Anak Usia Dini*, *13*(1), 12–27. https://doi.org/10.26877/paudia.v13i1.17241

Arce, E., Suárez-García, A., López-Vázquez, J. A., & Fernández-Ibáñez, M. I. (2022). Design Sprint: Enhancing STEAM and engineering education through agile prototyping and testing ideas. *Thinking Skills and Creativity*, *44*, 101039. https://doi.org/10.1016/j.tsc.2022.101039

Başaran, M., & Bay, E. (2023). The effect of project-based STEAM activities on the social and cognitive skills of preschool children. *Early Child Development and Care*, *193*(5), 679–697. https://doi.org/10.1080/03004430.2022.2146682

Bedar, R. W. A.-H., & Al-Shboul, M. A. (2020). The Effect of Using STEAM Approach on Motivation Towards Learning Among High School Students in Jordan. *International Education Studies*, *13*(9), 48. https://doi.org/10.5539/ies.v13n9p48

Bertrand, M. G., & Namukasa, I. K. (2025). *STEAM education : student learning and transferable skills*. *13*(1), 43–56. https://doi.org/10.1108/JRIT-01-2020-0003

Bin Amiruddin, M. Z., Magfiroh, D. R., Savitri, I., & Binti Rahman, S. M. I. (2022). Analysis of The Application of The STEAM Approach to Learning In Indonesia: Contributions to Physics Education. *International Journal of Current Educational Research*, *1*(1), 1–17. https://doi.org/10.53621/ijocer.v1i1.139

Cahyani, G. P., & Sulastri, S. (2021). The Influence of Project Based Learning with the STEAM Approach on Critical Thinking Skills in Online Learning at SMK Negeri 12 Malang. *Jurnal Pendidikan Akuntansi (JPAK)*, *9*(3), 372–379. https://doi.org/10.26740/jpak.v9n3.p372-379

Damayanti, B. W., & Bambang, B. (2024). Analysing The Adoption of Artificial Intelligence In Audit Practice. *EKOMBIS REVIEW: Jurnal Ilmiah Ekonomi Dan Bisnis*, *12*(3). https://doi.org/10.37676/ekombis.v12i3.6032

Fitria, K. N., Dwijanto, D., & Dewi, N. R. (2023). Mathematical Creative Thinking Ability Reviewed from Self-Esteem in the PBL Model with the STEAM Approach. *Jambura Journal of Mathematics Education*, *4*(2), 110–118. https://doi.org/10.37905/jmathedu.v4i2.20395

Huda, M., Yaqin, M. A., Kurniawan, R. F., & Fitra Choiri, M. W. (2022). Application of Systematic Literature Review to Survey Software Testing Strategies. *ILKOMNIKA: Journal of Computer Science and Applied Informatics*, *4*(1), 116–133. https://doi.org/10.28926/ilkomnika.v4i1.255

Mejias, S., Thompson, N., Sedas, R. M., Soep, E., Peppler, K., Roche, J., Wong, J., Hurley, M., & Bevan, B. (2021). *The trouble with STEAM and why we use it anyway*.

November 2019, 209–231. https://doi.org/10.1002/sce.21605

Nuraini, N., Asri, I. H., & Fajri, N. (2023). Development of Project Based Learning with STEAM Approach Model Integrated Science Literacy in Improving Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1632–1640. https://doi.org/10.29303/jppipa.v9i4.2987

Ozkan, G., & Umdu Topsakal, U. (2021). Investigating the effectiveness of STEAM education on students' conceptual understanding of force and energy topics. *Research in Science & Technological Education*, *39*(4), 441–460. https://doi.org/10.1080/02635143.2020.1769586

Perales, F. J., & Aróstegui, J. L. (2024). The STEAM approach : Implementation and educational , social and economic consequences. *Arts Education Policy Review*, *125*(2), 59–67. https://doi.org/10.1080/10632913.2021.1974997

Utaminingsih, E. S., Ellianawati, E., Sumartiningsih, S., & Puspita, M. A. (2023). STEAM Education. *Jurnal Ilmiah Profesi Pendidikan*, *8*(3), 1605–1612. https://doi.org/10.29303/jipp.v8i3.1566

Wastiani, R., Taufiq, M., & Wijaya, A. B. (2023). The Effect of the Steam Approach Based on Project Based Learning on Creative Thinking and Critical Thinking Skills in Mathematics Subjects of Junior High School Students at Labschool Cibubur (Quasi Experiment). *Jurnal Konatif: Jurnal Ilmiah Pendidikan*, *1*(1). https://doi.org/10.62203/jkjip.v1i1.10

Yulia, D. C., Rahmawati, Y., & Darwis, D. (2024). STEAM-PjBL Approach to Develop Fifth Grade Students' Scientific Creativity on the Topic of Ecosystems and Magnets. *Cetta: Jurnal Ilmu Pendidikan*, *7*(3), 133–146. https://doi.org/10.37329/cetta.v7i3.3416