

The Effectiveness of the STEAM Approach in Elementary Education: A Systematic Literature Review

Nukhbatul Bidayati Haka¹
Edo Wijaya,^{2*}
Ayu Shafa Salsabila³

^{1,2}Biology Education, Faculty of Tarbiyah and Teacher Training, State Islamic University (UIN) Raden Intan Lampung, Bandar Lampung, Indonesia

³Department of Chemistry, Faculty of Mathematics and Natural Sciences, University of Lampung, Bandar Lampung, Indonesia

*Correspondence author:
wijayaedo172@gmail.com

DOI:
10.26740/sjesel.1.02.2025.2

Keywords:
*Educational Innovation,
Elementary Education, Learning
Motivation, STEAM Approach.*

Publisher:
Elementary School Education
Program, PSDKU, State
University of Surabaya
(UNESA), Indonesia

Received: 24th September 2025
Revised: 9th October 2025
Accepted: 29th October 2025
Published: 30th October 2025

Abstract

This study aims to analyse the effectiveness of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in elementary education through a systematic literature review based on the PRISMA 2020 framework. Using Publish or Perish software, 996 studies were initially identified from Google Scholar, and 27 empirical articles published between 2021 and 2024 met the inclusion criteria. The analysis revealed that STEAM-based learning significantly improved students' critical thinking (N-Gain = 0.48–0.86), problem-solving ($t = 2.874 > 1.980$), creativity, and learning motivation (increase of 76–93%). The integration of STEAM with models such as Project-Based Learning (PjBL), Guided Inquiry, and Augmented Reality media enhanced contextual understanding and engagement. Findings demonstrate that STEAM is a flexible and transformative educational framework that bridges cognitive, affective, and psychomotor domains. These results contribute to curriculum innovation, offering practical implications for teachers, policymakers, and curriculum designers in promoting 21st-century learning competencies.

INTRODUCTION

Education in the twenty-first century requires learners to develop higher-order thinking competencies that include critical and creative thinking, collaboration, communication, digital literacy, and adaptive character to respond effectively to global challenges (Sudirman, 2023). However, many primary schools continue to rely on conventional instructional methods that limit students' engagement and hinder the development of such skills. The transformation of education toward innovative, interdisciplinary, and student-centered learning is therefore imperative. Within this context, the STEAM (Science, Technology, Engineering, Arts, and Mathematics) framework has emerged as an integrative pedagogical approach designed to cultivate creativity and problem-solving skills through the unification of science and the arts (Sari et al., 2021).

Unlike the traditional STEM model, the STEAM approach intentionally incorporates the arts to promote imagination, aesthetic awareness, and emotional expression alongside scientific reasoning (Razi & Zhou, 2022). This integration positions learning as a holistic process that bridges analytical and creative dimensions, enabling students to construct knowledge through authentic and contextual experience (Bancong, 2024). As a result, STEAM does not merely focus on content mastery but emphasizes learning as a process of inquiry, design, and innovation that links school subjects to real-world phenomena (Suriyana & Novianti, 2021).

In the elementary education context, STEAM plays a pivotal role in fostering balanced growth across the cognitive, affective, and psychomotor domains. Cognitively, it enhances critical and creative thinking; affectively, it strengthens motivation and curiosity; and psychomotorically, it encourages hands-on exploration and innovation (Nuragnia et al., 2021). Such integrative learning experiences are particularly effective for young learners, who are in the concrete operational stage of cognitive development and thus benefit from experiential, project-based, and inquiry-driven learning environments (Wijaya et al., 2025).

Empirical research substantiates the effectiveness of the STEAM approach in primary schools. (Wijaya et al., 2025). reported that the effect size of STEAM implementation at the elementary level (0.213, moderate) was higher than at the senior-high level (0.187, low), suggesting that younger students respond more positively to the contextual and experimental nature of STEAM. Similarly, (Triprani et al., 2023) demonstrated that the combination of STEAM and Project-Based Learning (PjBL) significantly improved problem-solving abilities, as confirmed by statistical testing ($t = 2.874$, $p < 0.05$). Furthermore, found that STEAM-PjBL interventions enhanced students' understanding of alternative energy concepts while strengthening collaboration and creativity.

Despite the increasing number of studies exploring STEAM-based pedagogy, research focusing exclusively on its effectiveness within elementary education remains limited. Most existing studies adopt experimental or product-development designs that examine isolated aspects rather than providing comprehensive evidence. Systematic syntheses that evaluate how STEAM contributes to developing 21st-century competencies among elementary students are still scarce. For instance, the meta-analysis conducted by Wijaya et al. (2025) investigated STEAM's influence on science learning across multiple educational levels but did not specifically assess its impact in primary schools (Wijaya et al., 2025).

Therefore, this study aims to fill this gap by conducting a Systematic Literature Review (SLR) on the effectiveness of the STEAM approach in elementary education. The SLR method provides a rigorous and replicable framework to evaluate existing empirical evidence comprehensively and objectively (Agus et al., 2023). By consolidating data from recent studies published between 2021 and 2024, this research offers a holistic overview of STEAM's role in enhancing learning quality, fostering motivation, and nurturing innovation among young learners. The findings are expected to enrich the theoretical discourse on interdisciplinary pedagogy and provide practical implications for educators, curriculum developers, and policymakers seeking to advance 21st-century education at the elementary level.

METHODS

This study employed the Systematic Literature Review (SLR) method with a qualitative descriptive approach to synthesize empirical findings on the effectiveness of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in elementary education. The SLR method was selected because it allows researchers to identify, evaluate, and interpret relevant studies systematically, transparently, and replicably (Romi, 2025). Data collection was conducted using the Publish or Perish software, which retrieved indexed publications from the Google Scholar database. The literature search was carried out in September 2025 and focused on articles published between 2021 and 2024 to ensure that the analysis reflected the most recent trends in STEAM-based pedagogy within the context of elementary education. The Publish or Perish software was used to retrieve data from Google Scholar.

The review process followed the PRISMA 2020 protocol, encompassing three main phases: identification, screening, eligibility, and inclusion (Riska Ramayanti, 2023). During the identification phase, a total of 996 articles were retrieved using the Publish or Perish software via Google Scholar, employing the keywords “STEAM education” and “elementary.” After removing duplicate records, 839 articles remained for further screening. In the screening phase, 157 articles were excluded due to unsuitable publication types such as conceptual papers, theoretical reviews, or non-empirical studies

while 473 articles were excluded for not focusing on the elementary education level, lacking empirical data, or being inaccessible in full-text format. Finally, at the inclusion phase, 27 empirical studies that met all inclusion and exclusion criteria were retained for comprehensive analysis.

Table 1. Inclusion and Exclusion Criteria

Category	Criteria	Description
Inclusion	Focus	Studies examining the implementation or effectiveness of the STEAM approach.
	Level	Conducted at the elementary or primary school level.
	Type	Empirical research, either quantitative, qualitative, or mixed-method.
	Year	Published between 2021 and 2024.
Exclusion	Focus	Studies that are conceptual or theoretical only.
	Level	Conducted at secondary, tertiary, or preschool levels.
	Type	Non-empirical papers or literature discussions.
	Year	Published outside 2021–2024.

The selection of articles was restricted, in this study, only articles meeting the criteria outlined in Table 1 were analyzed. Furthermore, Figure 1 below illustrates in detail the stages of article retrieval in this research, which can be described as follows:

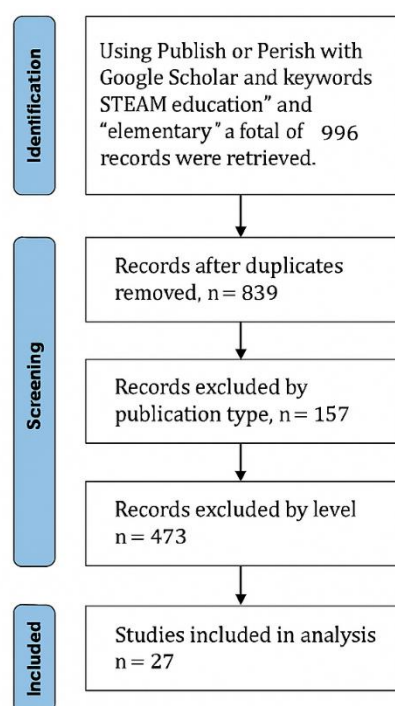


Figure 1. PRISMA Flow Diagram

Based on Figure 1 above, the process of systematically searching for articles to be analyzed is illustrated, ensuring that the selected articles meet the criteria outlined in Table 1. The article search was conducted via Google Scholar using the Publish or Perish software, accessed in September 2025, with the keywords “STEAM approach” and “Elementary School”. The initial database search yielded 996 articles,

which were then systematically analyzed, resulting in 27 articles that met the established criteria.

Following the PRISMA 2020 framework, the literature selection in this study was conducted through three principal stages: identification, screening, and inclusion. During the identification stage, an initial 996 records were retrieved using Publish or Perish software from the Google Scholar database. The search was carried out in September 2025 with the keywords “STEAM education” and “elementary”, restricted to publication years 2021–2024 to ensure the inclusion of the most recent and relevant studies on STEAM pedagogy in elementary education.

In the screening stage, 157 duplicate or redundant records were removed, resulting in 839 unique articles. Each record was evaluated based on title and abstract to assess its empirical validity and relevance to elementary education. A total of 157 records were excluded because they were non-empirical (conceptual papers, theoretical discussions, or literature reviews). Additionally, 473 articles were excluded for being conducted at levels other than elementary school (preschool, junior/senior high, or tertiary education) or lacking full-text access.

At the inclusion stage, 27 empirical studies met all eligibility criteria and were included in the final analysis. These studies comprise quantitative, qualitative, and mixed-method research focusing on the implementation or effectiveness of the STEAM approach in elementary education. The entire selection process adhered rigorously to the PRISMA 2020 checklist, ensuring transparency, reproducibility, and methodological integrity.

The following table 2 summarizes the quantitative details of each PRISMA stage.

Table 2. Summary of Article Selection Based on PRISMA 2020

Stages	Description	(n)	Reason for Exclusion
Identification	Initial search using <i>Publish or Perish</i> (Google Scholar) with keywords “STEAM education” and “elementary” covering 2021–2024.	996	Incomplete bibliographic data, inaccessible sources, or missing publication details.
Screening	Duplicate removal (n = 157), 839 unique articles reviewed. 157 excluded (non-empirical). A further 473 excluded (not at elementary level).	839	Non-empirical studies (157), irrelevant educational level (473).
Included	Final empirical studies that met all inclusion criteria (elementary level, 2021–2024).	27	Excluded if lacking methodological transparency or incomplete data.

The article selection results indicate that the systematic review process was executed rigorously and transparently to ensure only relevant, high-quality research was included. The 27 final studies serve as the empirical foundation of this review, representing diverse research designs such as quasi-experimental, research and development (R&D), and mixed-method approaches. The integration models

analyzed include Project-Based Learning (PjBL), Guided Inquiry, and Augmented Reality-based STEAM media. These variations enrich the understanding of how STEAM pedagogy contributes to the enhancement of cognitive, affective, and psychomotor learning outcomes in elementary education.

RESULTS AND DISCUSSION

An analysis of 27 empirical studies published between 2021 and 2024 revealed that the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach has been widely and effectively implemented in elementary education. The quantitative mapping presented in Figure 2 indicates a notable rise in publications, peaking in 2023 with 41% of total studies, reflecting the growing global commitment to interdisciplinary and contextual learning innovations in primary education. This trend aligns with the 21st-century education paradigm, which emphasizes the development of creativity, collaboration, critical thinking, communication, and technological literacy (Mu'minah, 2021 and Adlina, 2022).

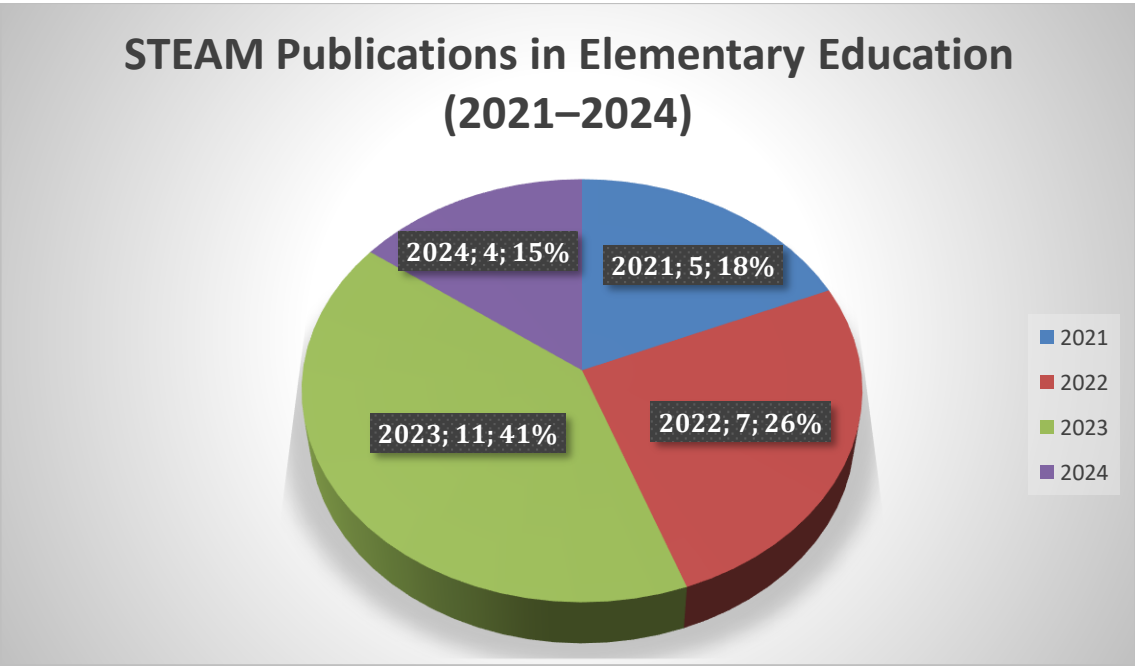


Figure 2. Publication trends on the STEAM approach in elementary schools from 2021 to 2024

Quantitative and Methodological Trends

The quantitative synthesis shows that among the 27 reviewed studies, 59% employed quasi-experimental designs, 26% used research and development (R&D) frameworks, and 15% applied mixed-method approaches. STEAM-based instruction was most frequently integrated into science and mathematics subjects, often coupled with Project-Based Learning (PjBL), Guided Inquiry, or Problem-Based Learning models. Data across these studies revealed consistent positive effects on

learning outcomes, spanning cognitive, affective, and psychomotor domains. Reported N-Gain values for critical-thinking improvement ranged from 0.48 to 0.86, reflecting moderate to high gains. Several experiments confirmed statistically significant improvements in problem-solving skills ($t(28) = 2.874, p < .05$), while creativity and motivation levels increased by 70-93%. Approximately 85% of the studies also documented enhanced engagement and positive learning attitudes among students.

As shown in Figure 3, the quantitative distribution illustrates a clear upward trend in the implementation of STEAM-based learning models, particularly between 2022 and 2023, where studies reporting high learning gains and strong affective outcomes were most prevalent. This graphical representation visually reinforces the statistical evidence that STEAM integration consistently yields meaningful improvements in multiple domains of student learning.

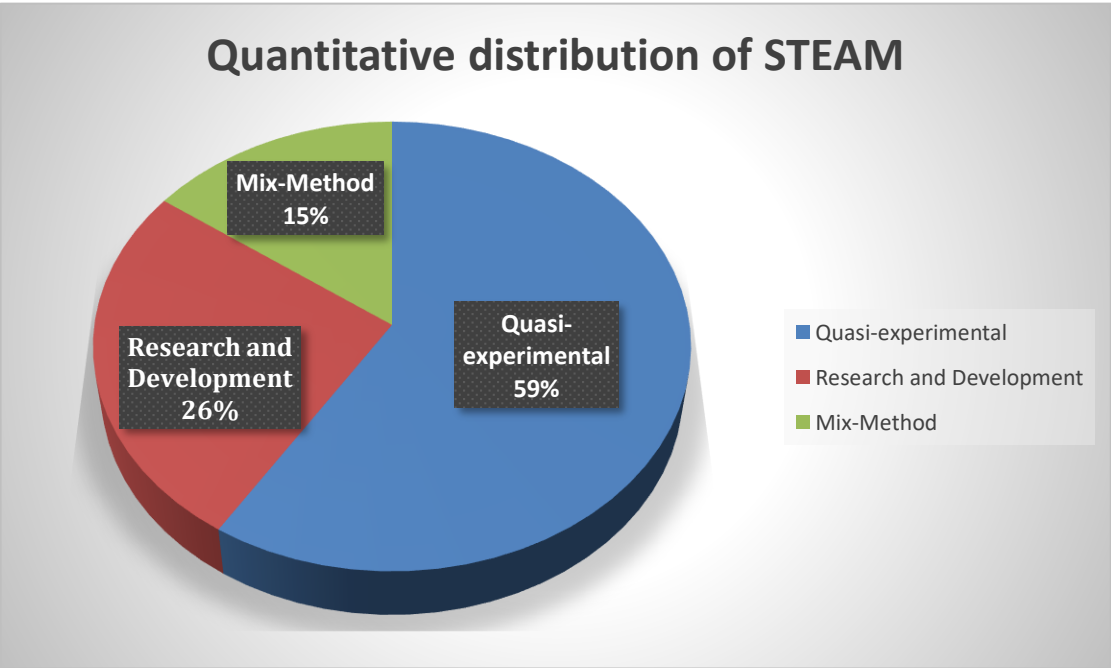


Figure 3. Quantitative distribution of STEAM-based learning outcomes across reviewed studies (2021–2024)

Most Cited Articles

Table 3. The Most Frequently Cited Article

No	Title	Authors	Journal	Citation
1	Implementation of STEAM-Based Project-Based Learning (PjBL) to Enhance Problem-Solving Skills in Alternative Energy Topics at the Elementary School Level	(Triprani et al., 2023)	Scholaria: A Journal of Educational and Cultural Studies	44

No	Title	Authors	Journal	Citation
2	The Effectiveness of STEAM-Based Augmented Reality Learning Media in Enhancing the Quality of Science Education in Elementary Schools	(Zaid et al., 2022)	Journal of Integrated Science Learning: Pelita	39
3	Development of Interactive Worksheets (LKPD) Based on the STEAM Approach for Enhancing Social Studies Knowledge Competence of Fifth-Grade Students at SD No. 3 Sibanggede	(Riyani & Wulandari, 2022)	Scientific Journal of Batanghari University, Jambi	38
4	Learning Materials with the STEAM-PjBL Approach on Theme 2: Practicing Energy Conservation	(N. P. L. K. Dewi et al., 2021)	Journal of Pedagogy and Learning	38
5	Interactive Teaching Material Based on the STEAM Approach in Social Studies for Fifth Grade Elementary School Students	(Wirawan et al., 2022)	Journal of Educational Research and Development	30
6	Implementation of Problem-Based Learning Integrated with STEAM to Enhance Students' 4C Skills	(Angga, 2022)	Journal of Didactics in Elementary Education	24
7	The Implementation of the STEAM Approach in Science Learning to Enhance Critical Thinking Skills and Scientific Literacy of Fourth-Grade Students at Anak Saleh Elementary School, Malang	(Khoiriya, R.M., 2023)	Jurnal of Teaching in Elementary Education	23
8	Development of Integrated Thematic Interactive Teaching Materials Using a STEAM-Based Lectora Approach in Grade III Elementary School	(Zulvira & Desyandri, 2022)	Journal Cakrawala Pendas	23
9	Development of STEAM-Based Diorama Media to Enhance Elementary School Students' Critical Thinking Skills	(Lailiyah & Widiyono, 2023)	BASICA Journal of Arts and Science in Primary Education	20
10	The Influence of the RADEC Learning Model Integrated with the STEAM Approach on Fourth-Grade Elementary Students' Scientific Literacy	(Putri & Zulfadewina, 2023)	Journal Elementaria Edukasia	18
11	Integration of Augmented Reality Technology Based on the SAMR Model (Substitution, Augmentation, Modification, Redefinition) in Elementary School Science Learning	(Sahronih et al., 2023)	Prima Magistra: Scholarly Journal of Educational Sciences	18
12	Development of STEAM-Based Learning Media in Integrative Thematic Learning for Grade IV Students at MI NW Ajan in the 2021/2022 Academic Year	(Parniati et al., 2021)	Tambusai Journal of Education	18

Table 3 shows information on the papers that are most often quoted about the STEAM method in primary schools. According to the table, four articles have the most citations. These include: "Implementation of STEAM-Based Project-Based

Learning (PjBL) to Enhance Problem-Solving Skills on Alternative Energy Material in Elementary Schools” by (Triprani et al., 2023), “The Effectiveness of STEAM-Based Augmented Reality Learning Media in Improving Science Learning Quality in Elementary Schools” by (Riyani & Wulandari, 2022), and, “Development of STEAM-Based Interactive Student Worksheets (LKPD) on Social Studies” by (N. P. L. K. Dewi et al., 2021).

Findings of the Article Analysis

Table 4. Results of Article Analysis

No	Title	Authors	Study Results
1	Learning Tools for the STEAM-PjBL Approach on Theme 2: Practicing Energy Conservation	(N. P. L. K. Dewi et al., 2021)	This study affirms that STEAM-PjBL-based student worksheets (LKPD) demonstrate a high level of effectiveness in supporting science learning on the theme “Always Save Energy.” Validation by experts, along with individual and small-group trials, yielded average scores ranging from 3.68 to 3.85, categorized as very good. The LKPD has been proven to facilitate the teaching process while simultaneously enhancing students’ motivation, creativity, and active participation in alignment with the demands of 21st-century curricula.
2	Development of STEAM-Based Learning Media in Integrative Thematic Learning for Grade IV Students at MI NW Ajan in the 2021/2022 Academic Year	(Parniati et al., 2021)	The study results show that using STEAM-based learning material in integrated thematic learning in grade IV SD/MI NW Ajan had good results. This medium got a "Good" rating from the media expert (score 3.62) and a "Very Good" rating from the material expert (score 4.23). The students' response was also quite positive, with 93.25% saying "YES," which shows that they were more motivated and excited to learn. Setelah direvisi, media ini dinyatakan layak digunakan karena dapat meningkatkan efektivitas pembelajaran serta mengembangkan keterampilan berpikir kritis, kreativitas, dan literasi dasar..
3	The Use of STEAM-Based Antique Bear Media in Teaching Three-Dimensional Geometry to Elementary School Students	(Khoir, 2021)	The study results indicate that the use of the STEAM-PjBL-based Beruang Antik (Antique Bear) learning media has been proven to enhance students’ engagement, creativity, and learning outcomes, while also making the learning process more interactive, enjoyable, and relevant. This media further empowers teachers and parents, fosters students’ independence and collaboration, and encourages teacher innovation, thereby promoting more adaptive teaching practices aligned with the demands of the 21st century.
4	The Implementation of Sim-Rosi Based on Project-Based	(Burhanudin, 2021)	This study demonstrates that the use of SIM-ROSI learning media, developed through Project-Based Learning (PjBL) and the STEAM approach,

No	Title	Authors	Study Results
	Learning (PjBL) and STEAM to Enhance 21st-Century Skills of Elementary School Students		effectively enhances 21st-century skills among third-grade students at SDN Langenharjo 2. The findings indicate a significant improvement in 4C activities (collaboration, communication, critical thinking and problem solving, creativity), accompanied by a highly positive response from students (average score of 87.0). This media fosters cooperation, communication, critical thinking, and creativity through mathematics and art project activities, making it a fun, effective, and relevant learning tool to support the quality of 21st-century education.
5	Learning Devices and Student Worksheets with a STEAM-PjBL Approach in Elementary School Science	(Setiawan et al., 2021)	Based on the findings of the study, the STEAM-PjBL-based student worksheet (LKPD) developed on the theme "Our Friendly Environment" for fifth-grade elementary students demonstrated a high level of effectiveness. Expert validation yielded an average score ranging from 4.55 to 4.625, which, when converted to a five-point scale, falls within the interval of $4.01 < X \leq 5.01$. This score positions the LKPD in the excellent category, thereby confirming its feasibility and appropriateness as a learning medium.
6	The Effectiveness of STEAM-Based Augmented Reality Learning Media in Enhancing the Quality of Science Education in Elementary Schools	(Zaid et al., 2022)	This study reveals that in elementary classes, STEAM-based AR improves scientific learning. SPSS analysis showed a statistically significant difference between experimental and control groups ($t\text{-value} = 2.874 > t\text{-table} = 1.980$), resulting in a high normalised learning gain of 0.72. STEAM-based AR simplifies abstract and complex scientific concepts, reduces verbalism, motivates students, fosters creativity, and improves learning. This medium is good at getting people to participate and learn in a way that meets the needs of 21st-century education since it is interactive, fun, and covers a wide range of topics.
7	Development of Interactive STEAM-Based Worksheets on Social Studies Knowledge Competencies for Fifth-Grade Students at SD No. 3 Sibanggede	(Riyani & Wulandari, 2022)	This study developed interactive STEAM-based worksheets for fifth-grade Social Studies at SD No. 3 Sibanggede and evaluated their effectiveness on student learning outcomes. Expert validation indicated quality ranging from good to excellent, while product trials from individual to field testing showed highly positive responses. Statistical analysis using a dependent-sample t-test revealed a significant improvement, with the average post-test score rising from 64 to 75. The STEAM approach proved effective in enhancing critical thinking, creativity, and problem-solving skills,

No	Title	Authors	Study Results
			while simultaneously providing an engaging and interactive learning experience.
8	Interactive Teaching Materials Based on the STEAM Approach in Social Studies for Fifth-Grade Elementary Students	(Wirawan et al., 2022)	Research findings indicate that interactive teaching materials grounded in the STEAM approach have proven to be effective for fifth-grade elementary students. They not only enhance students' understanding of the subject matter but also foster greater interest and motivation in learning. Expert evaluations and trial results further confirm the feasibility of this medium, as it provides an engaging and interactive learning experience. At the same time, it supports the development of critical thinking, creativity, and learner autonomy.
9	The Implementation of Problem-Based Learning Integrated with STEAM to Enhance Students' 4C Skills	(Angga, 2022)	Integrating Problem-Based Learning with STEAM has improved students' 4C skills (Critical Thinking, Creativity, Communication, and Collaboration). All student groups scored above 80 on collaborative projects on changes in matter states, demonstrating considerable increases in creativity and critical thinking. STEAM-based learning increased enthusiasm, engagement, academic accomplishment, and active involvement, as well as student-teacher contact.
10	The Development of Integrated Thematic Interactive Teaching Materials Using STEAM-Based Lectora in Grade III of Elementary School	(Zulvira & Desyandri, 2022)	The research shows that Lectora-created STEAM-oriented integrated theme interactive teaching materials improve third-grade primary students' knowledge. N-Gain's high score of 0.86 and 85.42% effectiveness rate showed significant improvements in students' motivation, engagement, and academic achievement. Experts verified the product, and teachers and students tested it, proving its legitimacy and usefulness. The teaching tools are feasible and effective for integrated theme learning in elementary schools.
11	Efforts to Enhance Literacy and Numeracy Skills of Elementary School Students in Jeron Village through STEAM-Based Comic Worksheets with the MIKiR Approach	(Musa Azhari et al., 2022)	The study findings demonstrate that STEAM-based comic worksheets, implemented through the MIKiR approach, proved effective in improving literacy and numeracy skills among elementary students in Jeron Village. The post-test scores increased significantly from 43.44 to 65.44. Approximately 76% of students reported heightened learning motivation, while 80% showed improved learning autonomy. This approach fosters creativity and critical thinking, while simultaneously supporting engaging and interactive learning experiences.

No	Title	Authors	Study Results
12	The Implementation of STEAM Learning through the “Make a Non-Stop Fountain” Activity to Enhance Elementary School Students’ Creativity	(Fatmawati & Mariana, 2022)	The study found that STEAM-based learning through the “Make a Non-Stop Fountain” exercise increased fifth-graders' creativity from 78% to 82% in the second cycle. This exercise made the classroom more lively, engaged students, and inspired creative, detailed, and collaborative thinking via real-world problem-based projects. Students found studying engaging, entertaining, and relevant to their daily lives.
13	Implementation of STEAM-Based Project-Based Learning (PjBL) on Problem-Solving Skills in Alternative Energy Topics at Elementary School The	(Triprani et al., 2023)	This study found that STEAM-based learning using Project-Based Learning (PjBL) increases students' alternative energy problem-solving skills. A t-test showed that the experimental class utilizing STEAM-PjBL was much different from the control class using standard teaching methods. Students used renewable energy to make basic tools during inquiry and application, showing how STEAM engineering develops problem-solving abilities. The results demonstrate that STEAM and PjBL improve problem-solving and make scientific learning more creative and interactive.
14	The Implementation of the STEAM Approach in Science Learning to Enhance Critical Thinking Skills and Scientific Literacy of Fourth-Grade Students at SD Anak Saleh Malang	(Khoiriya, R.M., 2023)	The research results show that using the STEAM method to teach science to fourth graders at SD Anak Saleh Malang was very successful in improving both their scientific literacy and their ability to think critically. The average score for critical thinking went up from 66.95% in the first cycle to 90.17% in the second cycle. Students' scientific literacy also became a lot better, especially when it came to explaining scientific ideas and using what they learnt in real-life situations. Classroom observations showed that instructional execution and student engagement had improved a lot, with average scores over 85% in the second cycle. These findings confirm that the STEAM method leads to learning experiences that are relevant, participatory, and useful.
15	Development of STEAM-Based Diorama Media to Enhance Critical Thinking Skills of Elementary School Students	(Lailiyah & Widiyono, 2023)	The research results indicate that the STEAM-based metamorphosis diorama significantly enhances the critical thinking abilities of fourth-grade primary pupils. The validation scores for media, content, and instructional design were 82%, 92%, and 90%, respectively. The percentage of students who responded positively was 86.84%. The average score on the pretest was 43%, but it went up to 72% on the posttest, with an N-gain of 0.48 (moderate), which shows that critical thinking abilities became a lot better. This material is

No	Title	Authors	Study Results
			thought to be possible to use and works well with STEAM-based learning.
16	The Influence of the STEAM-Based RADEC Learning Model on Fourth-Grade Students' Scientific Literacy	(Putri & Zulfadewina, 2023)	Findings from the study reveal that the STEAM-based RADEC learning model significantly enhances fourth-grade students' scientific literacy, with an average post-test score of 88 compared to 78 in the control group. This model actively engages students through activities such as observing, questioning, discussing, and creating, thereby enriching their learning experiences and fostering curiosity. Moreover, the integration of STEAM supports the development of communication, collaboration, creativity, and critical thinking skills, contributing to both the cognitive and affective domains of student learning.
17	Integration of Augmented Reality Technology Based on the SAMR Model (Substitution, Augmentation, Modification, Redefinition) in Elementary Science Learning	(Sahronih et al., 2023)	Findings indicate that STEAM-based science learning enhanced with Augmented Reality (AR) technology significantly improves elementary students' learning outcomes, with a high-effect score of 0.72. This approach makes the learning process more engaging and interactive, boosting students' interest and motivation by up to 90%, while also providing effective feedback at a rate of 70%. Furthermore, AR fosters the development of critical, abstract, and creative thinking skills, thereby serving as an effective solution for enhancing both academic performance and the socio-emotional growth of students.
18	Enhancing Scientific Attitudes and Students' Self-Esteem through a STEAM-Oriented Guided Inquiry Model in Elementary Science Learning	(L. G. D. P. Dewi et al., 2023)	The study found that STEAM-oriented guided inquiry enhances fifth-grade primary students' scientific attitudes and self-esteem in science. Collaborative scientific activities promote contextualized critical and creative thinking in the STEAM approach. Therefore, this strategy increases learning, enhances students' motivation and self-esteem, and makes studying relevant and exciting.
19	Implementation of a STEAM-Based Project-Based Learning (PjBL) Approach in Enhancing Mathematics Learning Outcomes	(Sartika et al., 2023)	Results reveal that STEAM-based Project-Based Learning helped SDN I Dena students improve in arithmetic. The second cycle saw 94% of pupils grasp the topic, up from 33% in the first. This strategy boosted students' academic performance and made them more driven, emotionally invested, eager to collaborate with others, brave, and confident in mastering complex arithmetic topics.
20	The STEAM (Science, Technology,	(Rilianti, A. P., Handayani,	The study also shows that STEAM in primary education develops 21st-century abilities including

No	Title	Authors	Study Results
	Engineering, Arts, and Mathematics) Approach for Developing 21st-Century Skills in Elementary School Students	M., & Nugroho, 2023)	critical thinking, problem-solving, creativity, innovation, cooperation, and communication through theme learning and creative projects. Teachers must facilitate students' own exploration while tackling constraints including inadequate resources and professional training, according to the report. STEAM develops pupils' cognitive, social, and artistic skills.
21	Student Worksheet (LKPD) Based on STEAM on the Theme of Environmental Conservation Efforts for Grade V Elementary School Students	(Novitasari et al., 2023)	The STEAM-based LKPD on Environmental Conservation Efforts for Grade V elementary children is highly valid, practical, and successful, with an N-Gain score of 0.76 and an average improvement from 56.63 to 89.50. Most pupils met the minimal mastery criterion in field trials. Even though it covered little information and distributed few products, this LKPD promoted STEAM activities, topic mastery, and practice exercises.
22	Implementation of STEAM-Based Robokids Learning Media to Enhance Learning Motivation and Academic Achievement of Elementary School Students	(Irfan Saninur Azis et al., 2023)	STEAM-based Robokids learning media increased elementary pupils' learning motivation since they enjoyed using a mobile phone-based learning medium. This great encounter gave me a thirst for knowledge. As shown by the paired-sample t-test and N-Gain score analysis, students' motivation increased academic performance.
23	Interactive Storybook Teaching Material Based on STEAM to Enhance Elementary Students' Problem-Solving Skills	(Liliana & Setyaningtyas, 2023)	Findings indicate that the interactive STEAM-based storybook is effective in improving the problem-solving abilities of third-grade students at SDN Sambirejo 148. A significant improvement was observed between pre-test and post-test scores, with an average n-gain of 0.7 categorized as high. The storybook was validated with a score of 86.4%, receiving an "excellent" evaluation, and is therefore deemed suitable as a learning medium to strengthen students' problem-solving skills and conceptual understanding of STEAM at the elementary level.
24	Development of STEAM-Based Worksheets (LKPD) to Improve Students' Science Process Skills on the Topic of Plants in Fourth Grade Elementary School	(Toyibah Toyibah et al., 2024)	The study demonstrates that the developed STEAM-based worksheets are effective in enhancing science process skills and creativity among fourth-grade students in the context of plant studies. Furthermore, the worksheets are considered feasible for classroom use, as they received positive expert evaluations and contributed to fostering students' scientific enthusiasm and capabilities.

No	Title	Authors	Study Results
25	Development of Learning Media Using Smart Apps Creator 3 Based on STEAM in Elementary School Mathematics	(Sirait et al., 2024)	The results show that the STEAM-based learning method has worked to boost students' enthusiasm, grasp of arithmetic concepts, problem-solving abilities, creativity, and ability to work with others. STEAM combines science, technology, engineering, arts, and math to make learning more interesting and useful for primary school pupils.
26	Effectiveness of the STEAM-Integrated Project-Based Learning (PjBL) Model in Improving Creative Thinking Skills and Science Learning Outcomes of Fifth-Grade Elementary Students	(Arlinda Bayu Prastiwi, 2024)	The research indicated that the integration of the Project-Based Learning (PjBL) model with STEAM was moderately effective in improving fifth-grade elementary students' creative thinking skills and science learning outcomes (IPAS), achieving an average N-Gain score of 0.60. Additionally, using this methodology made students more engaged and accountable in their learning, which had a big beneficial effect on both their creativity and their grades.
27	Implementation of STEAM-Based Project-Based Learning in Science Education to Enhance Critical Thinking and Entrepreneurial Skills of Elementary Students	(Erwinda Fitriana, Ana Fitrotun Nisa, 2024)	The results showed that implementing STEAM-based Project-Based Learning in science (IPAS) significantly improved students' critical thinking abilities, as reflected in their capacity to identify problems, analyze information, and evaluate solutions logically. Furthermore, this method was also effective in developing students' entrepreneurial skills by fostering creativity, risk-taking, innovation, and collaboration in project completion.

This study analyzed 27 articles that met the predetermined topic and inclusion criteria using the Systematic Literature Review (SLR) method guided by the PRISMA protocol. Referring to Table 3, the findings indicate that the STEAM approach is highly relevant for application in elementary education. Its implementation has been proven to enhance students' competencies. These results are consistent with the study conducted by Edo Wijaya et al. (2025), which demonstrated that the STEAM approach is more effective when applied at the elementary school level (Wijaya et al., 2025).

Furthermore, research by Luh Gede Diah Prapti Dewi et al. (2023) revealed that integrating the STEAM approach with the Guided Inquiry Learning Model significantly improved students' scientific attitudes and self-esteem in elementary science learning, as evidenced by the N-Gain Score results (L. G. D. P. Dewi et al., 2023). Another study by Wahidat Parniati et al. (2021) reported that the use of STEAM-based instructional media in thematic-integrative learning for fourth-grade students at SD/MI NW Ajan yielded positive outcomes. The media validation test received a "Good" rating from media experts (score 3.62) and a "Very Good" rating from material experts (score 4.23). Additionally, student responses were

overwhelmingly positive, with 93.25% affirming “Yes,” indicating increased motivation and enthusiasm for learning (Parniati et al., 2021).

Similarly, a study conducted by Ani Kholifatir Khoir (2021) on the use of the STEAM-based Beruang Antik media in teaching solid geometry during the COVID-19 pandemic demonstrated that the integration of this media successfully enhanced students’ learning activities, creativity, and achievement, while also fostering a more interactive, enjoyable, and contextually relevant learning experience (Khoir, 2021). Research by A.H. Burhanudin (2021) on the implementation of Sim-Rosi based on PjBL and STEAM to strengthen 21st-century skills in elementary school students was validated through a Paired Sample T-test (Burhanudin, 2021). Further research carried out by Nyoman Rudi Setiawan et al. (2021) on learning devices and student worksheets in the science subject at the elementary level indicated high effectiveness, as evidenced by expert validation results (Setiawan et al., 2021).

Meanwhile, a study by Muhammad Zaid et al. (2022) revealed that the effectiveness of STEAM-based Augmented Reality learning media in improving the quality of science learning at the elementary level was confirmed by significant differences between the control and experimental groups (Zaid et al., 2022). Similarly, research conducted by Ni Luh Veny Eka Riyani et al. (2022) on the development of interactive STEAM-based student worksheets in social studies competencies proved to be effective, as supported by the results of a dependent sample t-test (Riyani & Wulandari, 2022). In addition, I Made Putra Wirawan et al. (2022) demonstrated that interactive teaching materials developed using the STEAM approach in social studies were effective at the elementary school level, as indicated by students’ learning outcomes consistently scoring above 80 (Wirawan et al., 2022).

CONCLUSION

This systematic literature review confirms that the STEAM approach demonstrates substantial effectiveness in elementary education. Across 27 empirical studies published between 2021 and 2024, 59% employed quasi-experimental designs, 26% used R&D frameworks, and 15% applied mixed-method approaches, all consistently reporting positive outcomes. Quantitatively, N-Gain values for critical-thinking improvement ranged from 0.48 to 0.86 (moderate to high effect), while problem-solving abilities showed statistically significant gains ($t(28) = 2.874, p < .05$). Creativity and learning motivation increased by 70-93%, with over 85% of the studies documenting enhanced engagement and positive learning attitudes.

Quality-weighted interpretation indicates that studies with rigorous designs particularly those integrating Project-Based Learning (PjBL), Guided Inquiry, and Augmented Reality media produced the most robust and replicable improvements

across cognitive, affective, and psychomotor domains. These high-quality findings confirm that STEAM-based learning fosters comprehensive 21st-century competencies, including critical thinking, collaboration, creativity, and communication.

Therefore, STEAM can be regarded as an innovative and adaptable framework for elementary education, offering evidence-based guidance for curriculum development and pedagogical reform. Its integration into diverse learning contexts ensures not only measurable academic enhancement but also sustainable development of creativity, motivation, and scientific literacy among young learners.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

REFERENCES

- Adlina, N. (2022). Inovasi Pembelajaran di Masa Pandemi COVID-19 dengan Pendekatan STEAM di Era Society 5.0. *JURNAL SYNTAX IMPERATIF : Jurnal Ilmu Sosial Dan Pendidikan*, 2(6), 120. <https://doi.org/10.36418/syntax-imperatif.v2i6.134>
- Agus, A. I., Nurlim, R., Asnaniar, W. O. S., Alam, R. I., Padhila, N. I., Ernasari, E., & Ramli, R. (2023). Studi Literatur (Systematic, Narrative, Scoping, Argumentative, Theoretical). In *Eureka Media Aksara*.
- Angga, A. (2022). Penerapan Problem Based Learning Terintegrasi STEAM untuk Meningkatkan Kemampuan 4C Siswa. *Jurnal Didaktika Pendidikan Dasar*, 6(1), 281–294. <https://doi.org/10.26811/didaktika.v6i1.541>
- Arlinda Bayu Prastiwi, S. Y. (2024). Efektivitas Model Pembelajaran Pjbl Terintegrasi Steam Untuk Meningkatkan Keterampilan Berpikir Kreatif Dan Hasil Belajar Ips Siswa Kelas V Sekolah Dasar. *Jurnal Ilmiah Pendidikan Dasar*, 5(Juni), 2189–2202.
- Bancong, H. (2024). STEAM Education Konsep, Integrasi dan Masa Depan. In *STEAM Education: Theory and Practice* (Issue August).
- Burhanudin, A. (2021). Penggunaan Sim-Rosi Berbasis PjBL dan Steam untuk Meningkatkan Keterampilan Abad 21 Bagi Peserta Didik Sekolah Dasar. *Jurnal Didaktika Pendidikan Dasar*, 5(1), 47–70. <https://doi.org/10.26811/didaktika.v5i1.231>
- Dewi, L. G. D. P., Dantes, N., & Suastra, I. W. (2023). Peningkatan Sikap Ilmiah dan Self-esteem Siswa Melalui Model Pembelajaran Inkuiri Terbimbing Berorientasi STEAM dalam Pembelajaran IPA SD. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 7(2), 335–345. <https://doi.org/10.23887/jipp.v7i2.61744>
- Dewi, N. P. L. K., Astawan, I. G., & Suarjana, I. M. (2021). Perangkat Pembelajaran

- Pendekatan STEAM-PJBL pada Tema 2 Selalu Berhemat Energi. *Jurnal Pedagogi Dan Pembelajaran*, 4(2), 222. <https://doi.org/10.23887/jp2.v4i2.36725>
- Erwinda Fitriana, Ana Fitrotun Nisa, H. M. Z. (2024). Penerapan Project-Based Learning Berbasis Steam Dalam Pembelajaran Ips Untuk Meningkatkan Kemampuan Berpikir Kritis Dan Kewirausahaan Siswa Sekolah Dasar. *Encyclopedia of Computer Graphics and Games*, 09(September), 1593–1608. https://doi.org/10.1007/978-3-031-23161-2_300950
- Fatmawati, R. D., & Mariana, N. (2022). Penerapan Pembelajaran STEAM Melalui Aktivitas Make a Non Stop Fountain Untuk Meningkatkan Kreativitas Siswa di Sekolah Dasar. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, 10(6), 1248–1260. <https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/47109>
- Irfan Saninur Azis, Muniroh Munawar, & Sukamto. (2023). Implementasi Media Pembelajaran Robokids Berbasis STEAM Untuk Meningkatkan Minat Belajar Dan Prestasi Belajar Siswa Sekolah Dasar. *Jurnal Elementaria Edukasia*, 6(3), 1300–1310. <https://doi.org/10.31949/jee.v6i3.6094>
- Khoir, A. K. (2021). Penggunaan media beruang antik berbasis STEAM pada materi bangun ruang siswa sekolah dasar. *Edudikara: Jurnal Pendidikan Dan Pembelajaran Volume 6, Nomor 3, September 2021, Pp 176-186*, 6, 176–186.
- Khoiriya, R.M., et al. (2023). Penerapan Pendekatan Steam Dalam Pembelajaran Ips Untuk Meningkatkan Keterampilan Berpikir Kritis Dan Literasi Sains Siswa Kelas IV SD Anak Saleh Malang. *Jtiee*, 7(2), 142–147.
- Lailiyah, N. N., & Widiyono, A. (2023). Pengembangan Media Diorama berbasis STEAM untuk Meningkatkan Keterampilan Berpikir Kritis Siswa di Sekolah Dasar. *BASICA Journal of Arts and Science in Primary Education*, 3(1), 95–108. <https://doi.org/10.37680/basica.v3i1.3678>
- Liliana, A. G. P., & Setyaningtyas, E. W. (2023). Bahan Ajar Buku Cerita Interaktif Berbasis STEAM Untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa SD. *Jurnal Educatio FKIP UNMA*, 9(3), 1525–1533. <https://doi.org/10.31949/educatio.v9i3.5869>
- Mu'minah, I. H. (2021). Studi Literatur: Pembelajaran Abad-21 Melalui Pendekatan Steam (Science, Technology, Engineering, Art, and Mathematics) dalam Menyongsong Era Society 5.0. *Prosiding Seminar Nasional Pendidikan*, 3, 584–594.
- Musa Azhari, B., Alifia Puteri, H., Azizah, I., Kamila, N., Azifatun Nazwa, H., & Andriatna, R. (2022). Upaya Meningkatkan Kemampuan Literasi Membaca dan Numerasi Anak Usia Sekolah Dasar di Desa Jeron melalui Lembar Kerja Komik Berbasis STEAM dan MIKiR. *To Maega : Jurnal Pengabdian Masyarakat*, 5(2), 250–262. <https://doi.org/10.35914/tomaega.v5i2.1058>
- Novitasari, L., Ramli, M., & Praherdhiono, H. (2023). Lembar Kerja Peserta Didik Berbasis STEAM pada Tema Upaya Pelestarian Lingkungan untuk Peserta Didik

- Kelas V Sekolah Dasar. *Jurnal Ilmiah Pendidikan Profesi Guru*, 6(3), 593–603.
- Nuragnia, B., Nadiroh, & Usman, H. (2021). Pembelajaran Steam Di Sekolah Dasar : Implementasi Dan Tantangan. *Jurnal Pendidikan Dan Kebudayaan*, 6(2), 187–197. <https://doi.org/10.24832/jpnk.v6i2.2388>
- Parniati, W., Hadi, Y. A., Hamdi, Z., & Husni, M. (2021). Pengembangan Media Pembelajaran Berbasis STEAM pada Pembelajaran Tematik Integratif di Kelas IV MI NW Ajan Tahun Pelajaran 2021/2022. *Jurnal Pendidikan Tambusai*, 5(3), 6170–6176. <https://jptam.org/index.php/jptam/article/view/1925/1702>
- Putri, C. A., & Zulfadewina, Z. (2023). Pengaruh Model Pembelajaran RADEC berbasis STEAM terhadap Literasi Sains Siswa Kelas IV Sekolah Dasar. *Jurnal Elementaria Edukasia*, 6(3), 1162–1170. <https://doi.org/10.31949/jee.v6i3.6280>
- Razi, A., & Zhou, G. (2022). STEM , iSTEM , and STEAM : What is next ? To cite this article : STEM , iSTEM , and STEAM : What is next ? *International Journal of Technology in Education 2022*, 5(1), 1–29.
- Rilianti, A. P., Handayani, M., & Nugroho, W. (2023). Science, Technology, Engineering, Art, and Math (STEAM) Approach to Developing 21st Century Skills in Elementary School Students. *PRIMER: Journal of Primary Education Research*, 1(2), 78–85. <https://e-journal.unu-jogja.ac.id/pgsd/index.php/primer/article/view/13/10>
- Riska Ramayanti, Nurul Aisyah, Zubir Azhan, N. H. N. A. (2023). Systematic Literatur Review dan Meta-Analysis. In *Sustainability (Switzerland)* (Vol. 11, Issue 1). http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI
- Riyani, N. L. V. E., & Wulandari, I. G. A. A. (2022). Pengembangan LKPD Interaktif Berbasis STEAM pada Kompetensi Pengetahuan IPS Siswa Kelas V di SD No. 3 Sibanggede. *Jurnal Ilmiah Universitas Batanghari Jambi*, 22(1), 285. <https://doi.org/10.33087/jiubj.v22i1.2046>
- Romi, W. S. (2025). *Systematic Literature Review*. <https://doi.org/10.56442/ijble.v6i2.1195>
- Sahronih, S., Suryono, T., Maemuna, S., & Hasanah, D. (2023). Integrasi Teknologi Augmented Reality Berbasis Model Samr (Substitution, Augmentation, Modification, Redefinition) Dalam Pembelajaran Ipa Sekolah Dasar. *Prima Magistra: Jurnal Ilmiah Kependidikan*, 4(4), 619–629. <https://doi.org/10.37478/jpm.v4i4.3230>
- Sari, P. K., Saputra, D. W., Ferihen, & Winata, W. (2021). STEAM (Sains, Teknologi, Engineering, Art and Mathematics). *UMJ Press*, 1–124.
- Sartika, D., Silviana, D., & Syarifuddin. (2023). Implementasi Pendekatan STEAM Berbasis PjBL Dalam Meningkatkan Hasil Pembelajaran Matematika. *Jurnal*

- Pemikiran Dan Penelitian Pendidikan Dasar*, 7(1), 108–118.
- Setiawan, N. R., Wibawa, I. M. C., & Margunayasa, I. G. (2021). Perangkat Pembelajaran dan Lembar Kerja Peserta Didik Berpendekatan Steam-PJBL pada Muatan IPA di Sekolah Dasar. *Mimbar Pendidikan Indonesia*, 2(2), 40–54. <https://doi.org/10.23887/mpi.v2i2.37693>
- Sirait, E., Usman, H., & Angger Wardhani, P. (2024). Pengembangan Media Pembelajaran Smart Apps Creator 3 Berbasis STEAM pada Muatan Matematika Sekolah Dasar. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, 4(1), 368–376. <https://doi.org/10.51574/kognitif.v4i1.1453>
- Sudirman. (2023). Implementasi Pembelajaran Abad 21 Pada Berbagai Bidang Ilmu Pengetahuan. In CV. MEDIA SAINS INDONESIA. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI
- Suriyana, S., & Novianti, M. (2021). Efektifitas Pembelajaran Berbasis STEAM (Science, Technology, Engineering, Art, and Mathematic) terhadap Hasil Belajar pada Meteri Dimensi Tiga SMK. *Edukatif: Jurnal Ilmu Pendidikan*, 3(6), 4049–4056. <https://doi.org/10.31004/edukatif.v3i6.1199>
- Toyibah Toyibah, Yessy Yanita Sari, & Irdalisa Irdalisa. (2024). Pengembangan LKPD berbasis STEAM untuk Meningkatkan Keterampilan Proses Sains Peserta Didik Pada Materi Tumbuhan Kelas IV Sekolah Dasar. *Jurnal Kajian Penelitian Pendidikan Dan Kebudayaan*, 2(1), 31–45. <https://doi.org/10.59031/jkppk.v2i1.311>
- Triprani, E. K., Sulistyani, N., Fitri, D., Aini, N., & Malang, U. M. (2023). *Implementasi Pembelajaran STEAM Berbasis PjBL Terhadap Kemampuan Problem Solving pada Materi Energi Alternatif di SD The Implementation of STEAM-based Learning with Project-based Learning Model for Problem Solving Skills of Elementary School Students in t.* 176–187. <https://ejournal.uksw.edu/scholaria/article/download/8537/2441>
- Wijaya, E., Haka, N. B., & Oktafiani, R. (2025). *Meta-Analysis of the Impact of the STEAM Approach on Science Learning.* 05(02), 213–227.
- Wirawan, I. M. P., Wulandari, I. G. A. A., & Sastra Agustika, G. N. (2022). Bahan Ajar Interaktif Berbasis Pendekatan STEAM pada Muatan IPS Siswa Kelas V SD. *Jurnal Penelitian Dan Pengembangan Pendidikan*, 6(1), 152–161. <https://doi.org/10.23887/jppp.v6i1.45370>
- Zaid, M., Razak, F., & Alam, A. A. F. (2022). Keefektifan Media Pembelajaran Augmented Reality Berbasis STEAM dalam Meningkatkan Kualitas Pembelajaran IPA di Sekolah Dasar. *Jurnal Pelita: Jurnal Pembelajaran IPA Terpadu*, 2(2), 59–68. <https://doi.org/10.54065/pelita.2.2.2022.316>
- Zulvira, R., & Desyandri. (2022). Pengembangan Bahan Ajar Interaktif Tematik

Terpadu Menggunakan Steam Berbasis Lectora Di Kelas Iii Sd. *Jurnal Cakrawala Pendas*, 8(4), 1273–1286. <https://doi.org/10.31949/jcp.v8i4.3133>