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Implementation of STEM in Science Learning in Elementary Schools

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Abstract
This study aims to analyse the trend of STEM implementation in IPAS learning in primary schools. The research method used systematic literature review. Data collection came from google scholar and publish or perish from 2023 to 2025, from 50 articles focused on reviewing 14 articles. Data were analysed by descriptive analysis. The research procedure includes planning, conducting, and reporting. The results showed that Science, Technology, Engineering, Mathematics (STEM) education has become a major focus in efforts to improve the quality of learning at the primary school level. From the analysis of 14 studies that the application of the STEM approach shows novelty in learning methods that create more relevant and interesting learning experiences by integrating local culture, technology and art. The focus on 21st century skills, such as critical thinking, creativity and collaboration, indicates the need to adapt education to the needs of the modern world of work. The application of STEM approaches in education not only improves students' conceptual understanding but also prepares them to face challenges in the digital age. This research emphasises the importance of innovation in STEM education to create more competitive and skilled students for the future.

Keywords: science, technology, engineering, mathematics, elementary school

Introduction

Education is an important aspect in efforts to build a nation and prepare the next generation who can actively participate in meeting the needs of the global community and the development of the 21st century (Nurhaliza et al., 2024). The development of science and technology is currently increasingly rapid, resulting in the formation of increasingly tight global challenges and competition. The education sector is one of the sectors that is affected by the development of science and technology (A. N. Putri et al., 2023). So that the education sector is expected to be able to prepare the current and future generations to meet the needs of current global development. The era of 21st century

learning requires students to have complex knowledge and skills called 4C skills, namely critical thinking skills, creativity, collaboration, and communication (Ardiyanti et al., 2024; Maulidah et al., 2024; Mu'minah, 2021).

In the context of 21st century learning, there is a paradigm shift from teaching to learning. This shows that learning is no longer only centered on the role of the teacher, but more focused on students, with the teacher acting as a learning facilitator (Fadillah, 2024; Khoiriah et al., 2023). The vision of 21st century education based on the learning paradigm emphasizes the importance of learning that is oriented towards logical and rational knowledge, problem-solving skills, independence, character building, and attitudes of tolerance and cooperation.

In the Merdeka Curriculum, which is the curriculum that has been implemented recently, there are two subjects that are combined, namely Natural Sciences (IPA) and Social Sciences (IPS) to become Natural and Social Sciences which is abbreviated as IPAS in elementary schools (Dewi & Prasetyowati, 2023). The merger is because students at elementary school age are at the stage of thinking holistically, completely and concretely. The IPAS subject is a science that studies living things, inanimate objects in the universe and their interactions and studies human life as individuals, social beings who interact with their environment. Learning in the IPAS subject aims to make students able to understand the workings of the universe and its interactions with human life on earth (Adnyana & Yudaparmita, 2023).

At the elementary school level, science and science plays a crucial role in preparing students to face global challenges (Barus et al., 2024; Haratua et al., 2025). To prepare students to face challenges, a learning model based on Science, Technology, Engineering, and Mathematics (STEM) is needed. STEM has the potential to improve student competencies needed in the digital era (Dulyapit & Winarsih, 2024). STEM integrates four disciplines so that students holistically learn concepts and skills that are interrelated and relevant to real life. Through integrated and real-world problem-based learning, students can develop problem-solving skills, critical thinking, and technical and computational skills (Mustofiyah, Rahmawati, & Ghufron, 2024).

The concept of STEM is to implement integrated thematic learning models with a scientific approach. STEM learning is very suitable to be implemented in elementary schools because it is in accordance with the curriculum through the integration of several subjects and is applied in real life (Rambe et al., 2024). The implementation of STEM in

learning focuses more on solving real problems in everyday life (Rahmayani et al., 2024). Through STEM, students will be able to build their knowledge in understanding concepts to be applied in everyday life (Indrasari & Wulandari, 2024).

There are several previous studies related to the implementation of STEM in learning, namely Widiyatmoko & Darmawan, (2023) shows that: 1) The implementation of STEM in science learning in Indonesia mostly uses the Project Based Learning (PjBL) learning model, which is 87.5%, followed by Problem Based Learning (PBL) at 8.3% and discovery -PJBL at 4.16%, 2) High school education level is the level of education that most implements STEM in science learning, which is 48%, 3) The research variable that is often increased in the implementation of STEM in science learning is creative thinking skills, which is 34%.

Furthermore, Hoerunnisa et al., (2024) the results of *the literature study* and its analysis show that 1) STEM can be implemented in science learning through various methods such as learning media, learning models, learning devices including teaching materials, modules, e-modules, LKS, LKPD, E-LKPD. 2) The integration of STEM in learning has an impact on learning outcomes, critical thinking skills, creative thinking skills, science process skills and science literacy of students. With this research, it is expected to be a source of reference in implementing STEM in science learning.

Then the research Fakhrudin et al., (2023) shows that there are obstacles and challenges in implementing the Independent Curriculum, and the implementation of models or approaches has varied. Research Yuliardi et al., (2023) on the implementation of STEM and digital learning for teachers in the Cipondok Village environment, Kuningan Regency, to increase their knowledge in making and designing mathematics learning media using technology. This activity helps teachers understand the importance of using technology as a medium in mathematics learning, as well as how to use STEM and digital learning in learning. It was seen during the activity that teachers were motivated to use technology to create mathematics learning media so that they have basic 21st century skills in designing and creating learning media using technology. In addition, teachers were also helped in designing learning using STEM and digital learning. to improve their professionalism.

From several studies, the differences with this study are in (1) the most widely used methods to implement STEM in science learning in Indonesia, with a focus on higher education levels such as high school, and increasing creative thinking skills as

one of the main variables. (2) Various ways to implement STEM in science learning, including the use of media and learning tools, and their impact on students' critical and creative thinking skills. (3) Barriers to implementing the Independent Curriculum and the challenges faced by teachers in integrating STEM and digital learning into their teaching. (4) Lack of attention to the implementation of STEM at the elementary education level. While much research has been conducted on STEM implementation at the secondary level, there is relatively limited focus on STEM implementation in primary schools. Most studies tend to centre on learning methods and models implemented at higher levels, thus ignoring the potential of STEM to improve the quality of education at the primary level. Moreover, recent international literature shows that many countries have successfully integrated STEM approaches with local cultural contexts and current technologies, as revealed in several recent studies (Çiftçi & Topçu, 2023; Parno et al., 2023; Rahmatika et al., 2024; Sokha, 2024; Susanti et al., 2023). Thus, the purpose of this article is to analyze the trend of STEM implementation in science learning in elementary schools.

Method

This study uses the Systematic Literature Review (SLR) method. SLR is a literature review that attempts to collect all empirical evidence that meets predetermined eligibility criteria to answer questions based on a specific research theme (Dwijayanthi, 2022). According to C. K. Putri & Juandi, (2023), SLR aims to synthesize research results comprehensively based on specific questions using orderly, clear, and replicable steps or procedures at each stage of the process. The use of SLR in the STEM approach is useful in identifying, evaluating, and summarizing the results of studies that describe learning and teaching in STEM.

The search for data sources was carried out through Google Scholar, Publish or Perish. The inclusion criteria for this study were articles published between 2023 and 2025, indexed in the Google Scholar and Publish or Perish databases, and relevant to the theme of implementing STEM in primary school learning. Articles that were not directly related to the topic, such as those focusing on secondary or higher education, as well as publications that were not peer-reviewed, were excluded from this review.

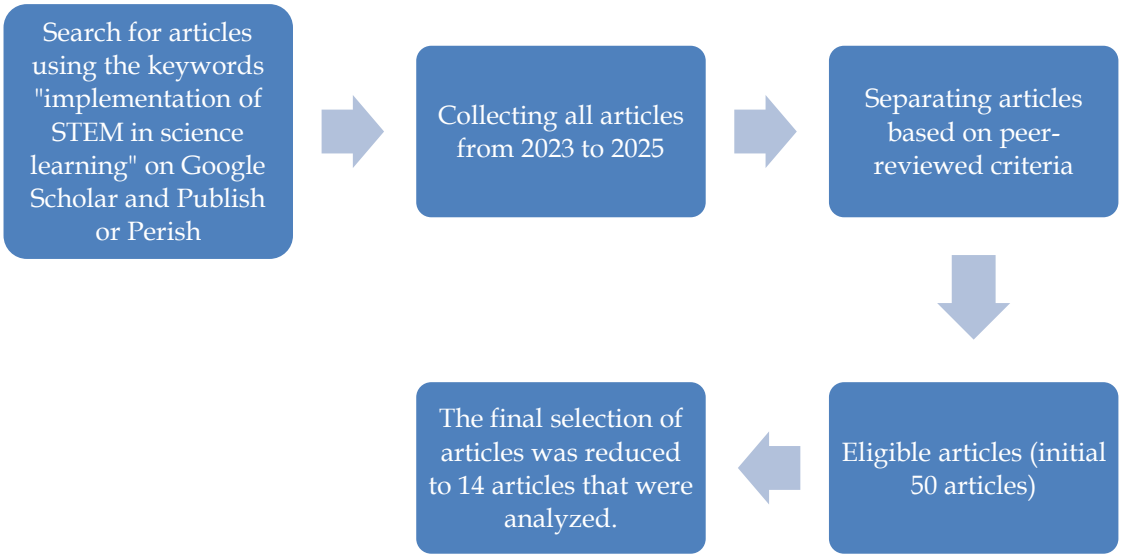

Figure 1 Outlines The Flowchart Of The Article Selection Process

Based on the article process that has been determined, the criteria for selecting articles are described in table 1.

Tabel 1 Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Year	2023-2025	Before 2023
Article Type	Peer-Reviewed	Non-peer-reviewed article
Topics	Science and STEM Learning	Focus on secondary education
Language	Indonesian and English	Other languages

Data analysis was carried out using descriptive analysis. The collected data was analyzed and then a conclusion was drawn which was used to answer the research questions. The stages carried out during data collection were planning (searching for articles that were in accordance with the topic using the keyword "implementation of STEM in science learning. The articles and journals collected were then published from the 2023-2025 period and indexed with Sinta 1-4); conducting (sorting articles related to the implementation of STEM in science learning and 50 articles were obtained and 14 articles were focused on the topic, then various research results from various literatures that had been selected were analyzed and evaluated. The data synthesis carried out in this study was in the form of a narrative); reporting (the stage of writing the SLR results in written form according to the format and rules that had been determined).

Figure 1 shows the stages carried out in this SLR research.

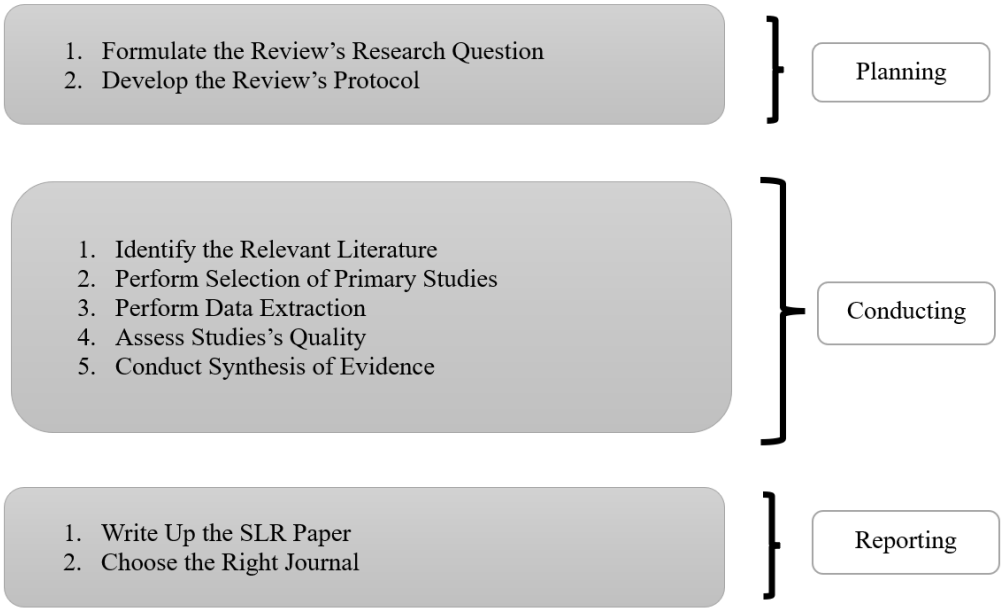

Figure 2 SLR steps

Results and Discussion

Result

After searching for articles in the publish or perish, google scholar, and sinta databases from 2023 to 2025, it was decided to review 14 selected articles from 50 articles found. Table 1 explains the results of the reviewed article data.

Table 2 *Reviewed Article Data*

No	Writer	Title	Results
1	Siti Halimah, Encep Supriatna, 2025 (S4)	The influence of the STEM approach on elementary school students' science learning outcomes	The application of the STEM method can increase students' enthusiasm for learning, critical thinking skills, and conceptual understanding. In addition, through project-based learning, this method helps students in developing their creativity and teamwork.
2	Maslikhah Qurrotul Aini, Siti Patonah, Aries Tika Damayani, 2025 (S4)	Implementation of the STEM Approach in Science Learning to Improve Literacy and Numeracy in the Life Cycle of Living Things and Efforts to Preserve Them for Grade III	The STEM approach can improve the literacy and numeracy skills of grade III students at SDN Bantal, Bancak District, Semarang Regency.

No	Writer	Title	Results
		Elementary School Students	
3	Nuris Hidayat, I Wayan Suastra, Dewa Bagus Sanjaya, 2025 (S4)	STEM Approach with the Assistance of Tri Hita Karana as a Learning Resource for Coastal Literacy and Science Learning Outcomes of Grade 5 Students	There is an influence of the STEM approach assisted by Tri Hita Karana learning resources on coastal literacy and student learning outcomes.
4	Silfa Trias Lestari, Din Azwar Uswatun, Astri Sutisnawati, 2025 (S3)	Development of Student Cognitive Assessment Instruments Based on STEM EDP in Science Subjects in Elementary Schools	By using the STEM approach with the EDP model, students are given the opportunity to improve their cognitive abilities and think critically to solve problems.
5	Salma Fauziah R, Yayan Carlian, Muhammad Rifqi Mahmud, Andinisa Rahmaniar, Siti Maryam Rohimah, 2025 (S4)	Development of LKPD Based on STEM Approach on Energy Material in Grade IV of Elementary School/Islamic Elementary School	The development of Student Worksheets (LKPD) based on the STEM approach on the science material on energy for grade IV SD/MI has been successfully completed to the development stage by adapting the ADDIE model.
6	Mariam Hoerunnisa, Shinta Purnamasari, Andinisa Rahmaniar, 2024 (S4)	Analysis of the Implementation of Science Technology Engineering Mathematics (STEM) in Natural Science Learning	1) STEM can be implemented in science learning through various methods such as learning media, learning models, learning tools including teaching materials, modules, e-modules, LKS, LKPD, E-LKPD. 2) Integration of STEM in learning has an impact on learning outcomes, critical thinking skills, creative thinking skills, science process skills and science literacy of students.
7	Arista Eka Kumalasari, Defi Shofiyani, Fayza Dwi Ega Leonida, Febrianti Dwi Anggita, Nanda Tiara Putri, Nur Ahmad,2024, (S4)	Implementation of STEM-Based Science Learning and Project Based Learning (PjBL) in the Independent Curriculum to Improve Learning Outcomes of Class V Students of SDN Mrawan 01	The pretest and posttest scores of fifth grade students of SDN Mrawan 01 increased after the implementation of Natural Science (IPA) learning based on Science, Technology, Engineering, and Mathematics (STEM) using the Project based learning (PjBL) model. This increase is not only seen from academic results, but also includes an increase in aspects of interest, enthusiasm, and student activities during teaching and learning activities.

No	Writer	Title	Results
8	Anggya Putri, Princess Juwita, 2024 (S4)	Development of STEM-Based LKPD in Improving Student Learning Outcomes in Science Learning in Class V of SD Negeri 106184 Sekip	STEM-based LKPD products on the subject of Natural Sciences, the material of magnetism, electricity, and technology for life, developed through the Canva application and published through A4-sized print media, obtained product validation data values, namely by material expert validators of 96.9% in the category "Very feasible" and by LKPD expert validators of 98.7% in the category "Very feasible".
9	Lilik Mustofiyah, Fitri Puji Rahmawati, Anik Ghufron, 2024 (S4)	STEM-Based Curriculum Development to Improve Students' Competence in the Digital Era: A Systematic Literature Review	STEM-based curriculum development strategies can be carried out in several ways, including: 1) interdisciplinary integration, 2) project and problem-based learning, 3) student-centered learning, 4) utilization of digital technology-based learning media, 5) development of 21st century competencies.
10	Arlinda Bayu Prastiwi, Sigit Yulianto, 2024 (S4)	The Effectiveness of the STEAM Integrated PJBL Learning Model to Improve Creative Thinking Skills and Science Learning Outcomes of Grade V Elementary School Students	The results of the hypothesis test show that the sig. value (2-tailed) is smaller than α, namely 0.000 <0.05, which indicates that the use of the STEAM integrated PjBL learning model has a significant influence in improving creative thinking skills and student learning outcomes.
11	I Gusti Ayu Ngurah Kade Sukiastini, 2024 (S4)	Literature Review: Integration of Science Learning Models with Digitalization and Local Wisdom to Face Future Challenges	Digitalization in science education can improve critical thinking skills, creativity, and students' understanding of the material through the SETS (Science, Environment, Technology, and Society), STEAM (Science, Technology, Engineering, Art, Mathematics) approaches, hybrid learning, and e-learning.
12	Arief Muttaqiin, 2023 (S4)	STEM (Science, Technology, Engineering, Mathematics) Approach to Science Learning to Train 21st Century Skills	The STEM approach to science learning is often combined with various learning models so that there are systematic steps. The STEM approach applied in the classroom has a positive impact on students' 21st century skills. The application of the STEM approach to the curriculum in

No	Writer	Title	Results
			Indonesia in order to improve students' 21st century skills through learning models that stimulate students' high-level thinking skills, especially in science subjects.
13	Asmi Listiyana, Muhammad Zidan Arya Bima, Nashikhatul Khusna, Pambayun Wardani Candra Dewi, Shianindra Rahmani Putri, Yeni Yuniarti, Rendi Restiana Sukardi, 2023 (S4)	Implementation of STEM-Oriented Learning Strategies on Science Literacy Skills in Elementary School Students	The implementation of STEM-oriented learning has been proven to have an impact on the scientific literacy skills of elementary school students.
14	Diteana Rahmadani, Kartika Chrysti Suryandari, Moh Salimi, 2023 (S4)	STEAM (Science, Technology, Engineering, Art, and Mathematics) Approach to Science Subjects Regarding Local Wisdom	The implementation of the STEAM approach has 5 aspects, namely science carried out through interviews, observing phenomena around the environment, and watching information videos, technology with the Canva and PowerPoint applications, engineering with explanations and teacher guidance in learning project assignments, art by designing works through imagination and decorating mini fans, and mathematics by calculating the time units of the roof tile process, Ebeg dance performances, and the length units of mini fans.

Discussion

Article Halimah & Supriatna, (2025) explains the effect of implementing the STEM (Science, Technology, Engineering, Mathematics) approach on student learning outcomes in Natural Sciences (IPAS) subjects in elementary schools. Research shows that the STEM method not only increases student enthusiasm but also critical thinking skills and conceptual understanding. Through project-based learning, students are helped to develop creative skills and teamwork. Article Aini et al., (2025) application of the STEM approach in science learning for grade III at SDN Bantal. Research shows that this approach can significantly improve students' literacy and numeracy skills. By using

materials about the life cycle of living things and preserving them, students feel a real increase in their understanding.

Article Hidayat et al., (2025) This article discusses the influence of the implementation of the STEM approach assisted by Tri Hita Karana learning resources on coastal literacy and student learning outcomes. Research shows that the integration of local culture in STEM learning can improve students' understanding of the environment and concepts in science, especially regarding coastal ecosystems. The article Lestari et al., (2025) discusses the development of a STEM-based student cognitive assessment instrument using the Engineering Design Process (EDP) model. Research shows that this method provides students with the opportunity to improve their critical thinking skills and cognition in solving problems, making learning more effective and interesting.

Article Carlian et al., (2025) focuses on the development and implementation of Student Worksheets (LKPD) based on the STEM approach to energy material for grade IV SD/MI. By using the ADDIE model (Analyze, Design, Develop, Implement, Evaluate), the study showed success in developing LKPD that is relevant and interesting for students. Article Hoerunnisa, Purnamasari (2024) explores the analysis of STEM learning implementation in science. The study found that the application of STEM through various media and learning devices can improve students' critical thinking skills, creativity, and science literacy, thus providing a more in-depth learning experience.

The focus of the research Kumalasari et al., (2024) is the implementation of STEM-based science learning and Project Based Learning (PjBL) in the curriculum. The results of the study showed a significant increase in academic learning outcomes and student engagement, which is not only seen from academic scores, but also in student interest and enthusiasm when participating in learning. Article A. Putri & Juwita, (2024) explains the development of STEM-based LKPD products in the subject of science that focuses on magnetism, electricity, and technology. Through the Canva application and print media, the developed learning products were successfully validated by experts with a very high level of feasibility, demonstrating their potential effectiveness in teaching.

Article Mustofiyah, Rahmawati, & Ghufron (2024) discusses STEM-based curriculum development strategies to improve student competency in the digital era. The study concluded that interdisciplinary integration, project-based learning, and the

use of digital technology can make education more relevant and prepare students to face future challenges. The study Prastiwi & Yulianto, (2024) evaluate the effectiveness of the Project Based Learning (PjBL) learning model integrated with STEAM in improving creative thinking skills and student learning outcomes. The results of the hypothesis test show that the sig. (2-tailed) value is smaller than α (0.000 <0.05), which indicates that the application of this learning model has a significant effect on improving creative thinking skills and student learning outcomes in grade V. The study shows that a project-based approach that combines art disciplines with science and technology can create a more interesting and interactive learning environment, so that students become more motivated to learn and participate more actively in the learning process.

Article Sukiastini, (2024) is a literature review that discusses the impact of digitalization in science education on students' critical thinking skills, creativity, and understanding. This study highlights various approaches, including SETS (Science, Environment, Technology, and Society) and STEAM, as well as hybrid and e-learning methods. The results of the review indicate that the integration of technology in learning can help students develop the skills needed to face future challenges, as well as improve their understanding of the academic content being taught. Article Muttaqiin, (2023) discusses the application of the STEM approach in science learning, which is often combined with various learning models to ensure systematic steps. Research shows that the application of STEM in the education curriculum in Indonesia has a positive impact on students' 21st century skills, such as critical thinking skills and problem-solving skills. This study proposes that the application of the STEM approach can stimulate higher-order thinking among students, especially in science subjects.

Study Listiyana et al., (2023) examined the implementation of STEM-oriented learning strategies that have been proven to have a positive influence on the science literacy skills of elementary school students. Efforts to apply this method show that students involved in STEM-based learning are able to improve their literacy skills, including understanding science concepts, applying scientific methods, and analytical skills. The results of this study indicate that the STEM approach contributes to improving students' learning outcomes and interest in science subjects. Article Rahmadani et al., (2025) discusses the application of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach involving five aspects: science, technology, engineering, arts, and mathematics. This study shows how learning is

carried out through observation of phenomena, application of technology using tools such as Canva and PowerPoint, and art activities involving student design and creativity. This learning method is considered effective in improving conceptual understanding and student engagement through collaborative and interactive projects. The application of STEAM in science learning, especially regarding local wisdom, helps students understand their cultural and environmental context better.

STEM learning is very suitable to be integrated with science learning at the elementary school level, because through this approach it can improve the quality of learning and develop essential 21st century skills for students. Wardani & Ardhyantama, (2021) states that STEM is one of the potential learning to be used to build 21st century skills known as 4C competencies which are carried out through the process of providing skills. The use of media in STEM learning forms students to improve their understanding and critical and creative thinking. STEM learning is learning that combines science, technology, engineering, and mathematics which is expected to produce work so that elementary school students are educated from an early age about technological developments (Riawati et al., 2022). With STEM learning, students can conduct investigations to solve problems in elementary school and a more complete understanding of material concepts (Davidi et al., 2021). By producing each work at the meeting, students will be more enthusiastic about the learning designed by the teacher, and make students critical, creative, and innovative. According to Khoerunnisa et al., (2022), STEM education can develop students' problem solving, make students become inventors, think logically, be technologically literate, and be able to relate the knowledge learned in school to the world of work or in general the real world.

Of the 14 articles analyzed, there are a number of significant innovations in the approach and practice of STEM education. One prominent innovation is the integration of the STEM approach with local culture, as demonstrated by Nuris Hidayat et al., who included Tri Hita Karana learning resources, making learning materials more relevant and increasing students' environmental awareness. In addition, the development of technology-based Student Worksheets (LKPD), carried out by Anggya Putri and Putri Juwita, shows the innovative application of digital technology such as Canva in creating interesting and dynamic teaching materials, encouraging student engagement. The article by Arlinda Bayu Prastiwi and Sigit Yulianto also presents a Project Based Learning (PjBL) learning model integrated with STEAM, combining art elements that

are usually less explored in STEM, in order to attract students' interest holistically. In a modern context, I Gusti Ayu Ngurah Kade Sukiastini's article highlights the relationship between digitalization and STEM learning, emphasizing the importance of digital media and e-learning as an integral part of education that prepares students to face technological developments. Furthermore, the emphasis on developing 21st-century skills, such as critical thinking, creativity, and collaboration seen in Arief Muttaqiin and Asmi Listiyana's research, shows the relevance of STEM education to the needs of today's workforce. Finally, innovation is also present in the development of STEM-based cognitive assessment instruments explored by Silfa Trias Lestari, which uses the Engineering Design Process (EDP) to change the assessment paradigm from traditional tests to project-based evaluation and student performance. Overall, these innovations make a positive contribution to improving the quality of education and the relevance of teaching materials to the needs of the times, equipping students with the tools and skills needed to succeed in the future.

The implementation of the STEM approach in education has a positive impact on improving students' skills and learning outcomes. The novelty in these articles, such as the integration of STEM with local culture, the use of technology in developing LKPD, the integration of art in STEM learning, and the focus on 21st century skills, indicates that education must be adaptive and relevant to the times. In addition, the transformation of cognitive assessment methods to project-based evaluation reflects a positive change in educational methods. This approach not only improves students' conceptual understanding but also prepares them to face challenges in the digital era, making them more competitive and skilled in the future. These diverse and innovative implementations show that STEM education, when implemented effectively, can create more engaging, relevant, and impactful learning experiences.

Conclusion

The implementation of the STEM approach in education, as expressed in the 14 articles studied, has proven itself as an effective strategy in improving students' skills and learning outcomes. Through the integration of local culture, the use of technology, and the incorporation of art elements, STEM education not only becomes more relevant but also prepares students to face the challenges of the 21st century. The innovations found in these studies show that education must adapt to the times, and prioritize the

development of critical thinking skills, creativity, and collaboration among students. The transformation in assessment methods to project-based also reflects a positive change in the way of evaluation that is in line with today's learning needs.

While STEM implementation shows great potential in improving students' skills and learning outcomes, there are some challenges that need to be addressed. Lack of teacher training and understanding of STEM approaches can hinder teaching effectiveness. Many teachers are still used to traditional methods that focus on direct teaching, making it difficult to adapt more interactive and project-based learning methods. Limited resources, such as appropriate teaching materials and supportive facilities, are also a common barrier in primary education. Primary schools in remote areas often do not have adequate access to the technology and learning tools needed to effectively implement STEM. There are also challenges in adapting the curriculum to an integrated STEM approach. While the implementation of STEM in primary schools is promising, there is a need for stronger support from the government, continuous training for teachers and provision of adequate resources to ensure the success of this approach. Collaborative efforts between educators, educational institutions and communities are also crucial to overcome these barriers and create more effective and inclusive learning environments.

For further research, it is recommended that researchers explore more deeply the implementation of the STEM approach in various contexts and levels of education, including secondary and higher education. Research should also include longitudinal studies to assess the long-term impact of this approach on students' skill development. In addition, it is important to conduct research on the effectiveness of various learning media and technologies used in STEM education, as well as how social and cultural factors influence the implementation of these strategies. Researchers are also expected to develop innovative and holistic learning models that take into account the diversity of student backgrounds to ensure the accessibility of STEM education for all groups. Collaboration between educators, educational institutions, and industry needs to be improved to create a curriculum that is more relevant and in accordance with the needs of the world of work.

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