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Stimulation of Early Childhood Creativity through STEAM Learning Based on Loosparts Media: A Systematic Narrative Review

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Abstract

The integration of STEAM (Science, Technology, Engineering, Art, and Mathematics) learning in Early Childhood Education is increasingly recognized as essential for cultivating 21st-century skills. This systematic narrative review explores how STEAM learning, when combined with loose parts media, stimulates creativity in early childhood. A total of 515 articles were initially identified through four databases (ProQuest, ERIC, Open Knowledge Map, and Elicit) covering the years 2019–2024. After applying strict inclusion and exclusion criteria, eight peer-reviewed studies were selected for analysis. These studies vary in method, including qualitative, quasi-experimental, and review-based designs, and focus on children aged 3–6 years. The review reveals that loose parts media flexible, open-ended materials enhance key dimensions of creativity such as imagination, originality, problem-solving, collaboration, and innovation when implemented within the STEAM framework. Children engaged in these activities exhibit higher levels of critical thinking and exploratory learning. The findings also highlight the importance of teacher facilitation, cultural context, and long-term developmental impact. This review enriches both practical and theoretical understanding of creative learning strategies based on loose parts within the STEAM framework in early childhood education. It contributes new insights by synthesizing studies that explicitly connect both components, which are often examined separately. Educators and policymakers are encouraged to incorporate this integrative approach into early learning environments to maximize children's cognitive and creative growth.

Keywords: Creativity; Loose Parts; STEAM

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INTRODUCTION

Early childhood education (ECE) is a crucial phase in a child's development, where creativity and critical thinking skills begin to form. In education, digital technology has become a tool that facilitates the teaching and learning process between teachers and students (Rahmawati et al., 2024). Learning media are tools that support children in constructing knowledge and provide interactive feedback (Antika et al., 2025). In this context, the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach is gaining traction as it integrates multiple disciplines in engaging and meaningful ways. Meanwhile, loose parts media open-ended, movable materials that can be combined and manipulated offer children opportunities to explore, innovate, and construct meaning independently.

Despite the increasing popularity of STEAM learning in early childhood education, most

studies have tended to focus either on the implementation of STEAM alone or the use of loose parts media in isolation. For example, Cabello et al., (2021) investigated the "Pequeños Científicos" STEAM program, which increased children's interest and creativity but did not explore the use of loose parts. Similarly, Dewi et al., (2024) demonstrated the benefits of loose parts on creativity, but overlooked their integration into collaborative STEAM-based learning environments. This reveals a research gap in integrated investigations that combine both STEAM and loose parts media, especially in a systematic review format.

Cultural relevance also plays an important role. Learning activities grounded in local contexts such as environmental exploration or traditional play have shown to enhance fluency, originality, and elaboration in creative expression (Saputri et al., 2024; Mamma & Cenderawasih, 2021). However, many children are still exposed to digital distractions that reduce fine motor activity and imaginative play (Shenita et al., 2022), compounded by weak family and community engagement (Jamal & Sugiarti, 2022). This calls for an urgent innovation in learning design that holistically stimulates creativity in children.

This article aims to narratively examine the relationship between the STEAM approach based on loose parts media and the stimulation of creativity in young children. The focus is to understand how hands-on, exploratory learning with loose parts in STEAM contexts fosters creativity, as well as what specific aspects of creativity are most affected. Unlike previous studies that only examined loose parts or STEAM separately, this study combines both as an integrated approach to stimulating children's creativity. This dual focus is the novelty of this review, which also takes a broader look at cultural and contextual factors affecting implementation.

The objectives of this review are to (1) Identify how loose parts media are used in STEAM learning for early childhood. (2) Explain the benefits of this approach for various aspects of child development, particularly creativity. (3) Examine the scope of existing literature and provide recommendations for future educational practices.

To guide this systematic review, the following research questions are posed (1) How can the application of STEAM learning based on loose parts media improve early childhood creativity?. (2) What aspects of creativity are most stimulated through the use of loose parts media in STEAM learning in early childhood?

METHODS

The method used in this research is Systematic Literature Review (SLR) also known as systematic literature review is the process of finding, assessing, and interpreting all available research evidence with the aim of providing answers to specific research questions. Systematic Literature

Review (SLR) is a structured approach to synthesizing research evidence, aimed at answering specific research questions by evaluating the existing literature. This method involves a comprehensive search, assessment and interpretation of relevant studies, which ensures a careful analysis of the topic under discussion. (Sekhon et al, 2024) This study conducted a systematic literature review to explore and evaluate the evidence regarding the effect of loose part-based media in steam learning on enhancing creativity in early childhood, especially ages 3 to 6 years.with a search for four reliable and very well indexed data bases by obtaining literature sources namely ProQuest, ERIC, Open Knowledge Map and Elicit to identify, evaluate, and interpret research results relevant to specific research questions, or topic areas, or phenomena of concern. the search process took 1 month from October 05 to November 05, 2024. search with keywords and booleans used by the author in the search, namely: "looseparts" and 'children", "looseparts" and "nature" and "creativity childhood", "looseparts" and "independence" and "creativity childhood", "steam" and "creativity childhood", steam and early childhood, steam and creativity and preschool, "looseparts" and "creativity" and "early childhood", and looseparts and preschool.

The search data used articles published from 2019 to 2024. The results of this search can be seen in table 1.

Table 1.

Types of (Electronic) Literature Databases

Types of Literature	***Online Database Search***
Peer-reviewed journal articles	- ProQuest
	- ERIC
	- Open Knowledge Map - Elicit

The search data with keywords and booleans used by the author in the search are: "looseparts" and 'children", "looseparts" and "nature" and "creativity childhood", "looseparts" and "independence" and "creativity childhood". "steam" and "creativity childhood", steam and early childhood, steam and creativity and preschool, "looseparts" and "creativity" and "early childhood", and looseparts and preschool.

Table 2.

Search Data with Bolean

ProQuest	**"loosepart" AND "children"** **"Loosepart" AND "nature" AND "childhood creativity"**
ERIC **Open Knowledge Map**	"loose parts" AND "independence" AND "childhood creativity" "STEAM" AND "childhood creativity" STEAM AND early childhood
Elicit	STEAM AND creativity AND preschool "looseparts" AND "creativity" AND "early childhood" loosepart AND Preschool

Eligibility criteria

This review includes studies that explore children's creativity and pedagogical approaches to developing thinking skills in young children. A systematic process leading to data generation. The scope of the review was carried out by developing specific inclusion criteria that would allow us to select relevant research studies. Four electronic databases were used for data sources (Table 1). Search strings were developed to identify keywords in the early years literature (Table 2).

Inclusion and exclusion/exclusion criteria

While these criteria are designed to ensure the selection of focused and relevant studies, it is important to consider that overly strict criteria may limit the diversity of perspectives and findings that could enrich the understanding of STEAM education in early childhood settings. (Cabello et al., 2021). Population Inclusion Criteria: The study must focus on children aged 3-6 years. Study Interventions should address STEAM content learning models applicable to early childhood. Outcomes The study should explore the impact of loose parts media and Steam-based learning on enhancing creativity in early childhood. Document Type: only research journal articles will be included. Year of Publication: Research published between 2019 and 2024 is eligible. Language: Studies must be in English or Indonesian.

Exclusion Criteria Population Studies involving children beyond the age range of 3-6 years will be excluded. Intervention Studies that do not address STEAM learning models for early childhood will be excluded. Outcomes Studies that do not focus on the loose parts of STEAM media and learning for creativity enhancement will be excluded. Types of Documents: Non-journal articles, such as books, will not be considered. Year of Publication: Studies published before 2019 will be excluded. Language: Studies in languages other than English or Indonesian will be excluded. The search with both inclusion and exclusion criteria is illustrated in table 3 below:

Table 3.

Inclusion and Exclusion Criteria

NO	Criteria	Inclusion	Exclusion
1	Population	Study focuses on early childhood 3-6 years	Study was conducted outside the range of 3-6 year old children
2	Intervention	Research discusses STEAM content learning models that can be used in early childhood	Research does not discuss STEAM content learning models that can be used in early childhood.
3	Outcome	Research that discusses loose parts media and STEAM-based learning to improve early childhood creativity	Research that does not discuss loose parts media and STEAM-based learning to improve early childhood creativity
4	Document Type	Research Journal / Article	Not journal articles: Book
5	Year of Publication	Year 2019-2024	Before 2019
6	Language	English and Indonesian	Besides English and Indonesian

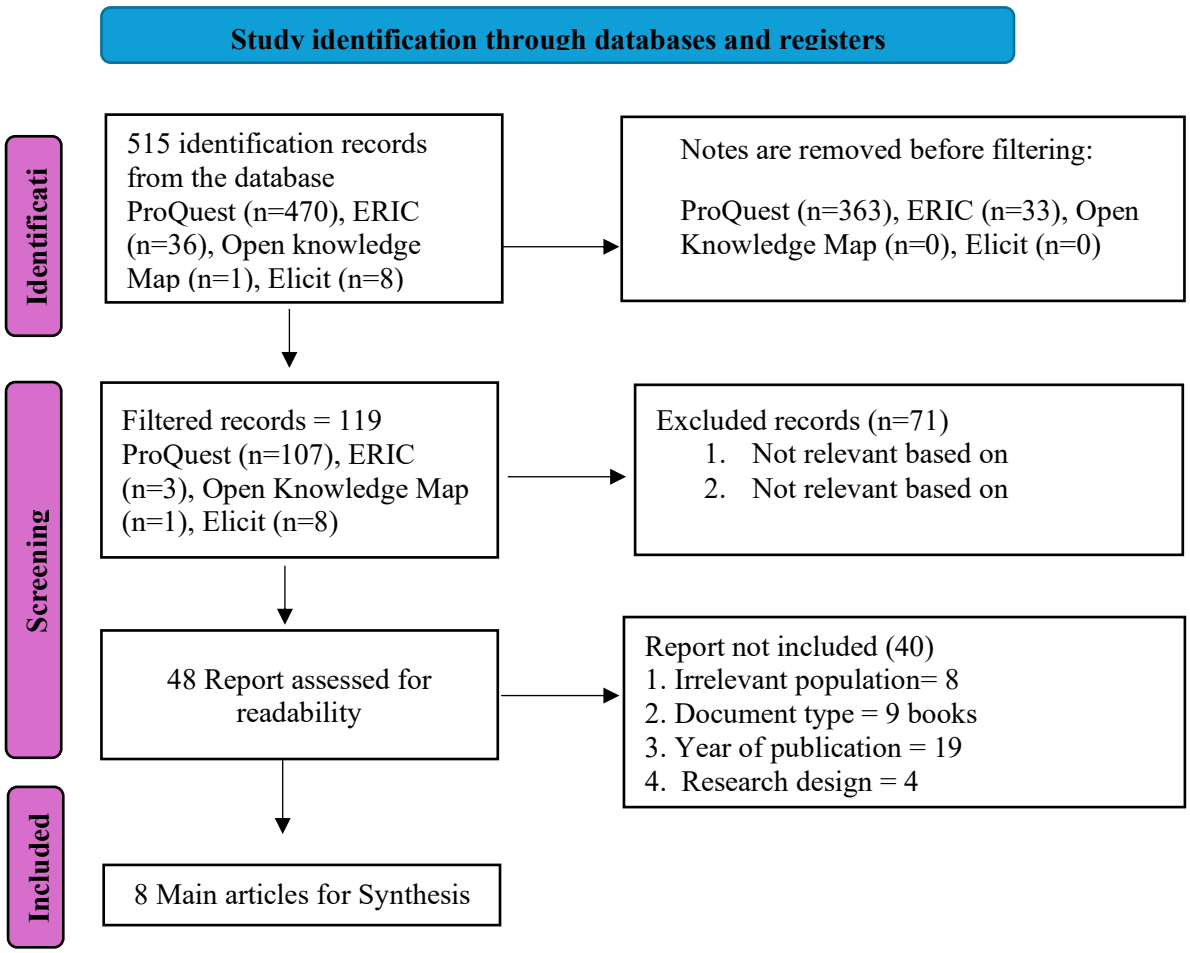

Figure 1. Prism Screening process

Search strategy

The search process began with an initial search on ProQuest, followed by a structured exploration across four different databases as detailed in Table 2. This selection of electronic literature sources was guided by the framework provided by (Wibowo & Putri, 2021). Throughout the search, keywords and related synonyms connected to the research questions were consistently applied across all databases.

Filtering

As shown in Table 2, the article screening was carried out in two main phases: an initial review of titles and abstracts, followed by a full-text review. The first stage was led by the primary author, with all three authors participating in the validation process. The lead researcher initially filtered out articles that did not meet the set criteria. To ensure reliability, a random selection of 48 out of the 119 articles was re-evaluated by two of the three authors. The inter-rater agreement was notably high; for instance, among the 10 papers reviewed, two underwent detailed discussion, and one was excluded because two reviewers agreed it failed to meet the inclusion criteria. To maintain rigor and uphold quality, the assessment of article quality followed the guidelines established by Gough (2007) (see Table 4).

Table 4.

Criteria for assessing the weight of evidence

Level	Methodology Quality	Relevance of Methodology	Topic Relevance
1. Outstanding	Excellent research approach and method quality	Use of an excellent research design to answer the research question	Clear research answers. Refers to cognitive about children
2. Good	Good relationship between several review elements	Use of a good research design	Useful, related to the research question
3. Satisfactory	Seems logical and relatable	Broadly matches elements of the research question	Broadly relevant to the research question
4. Inadequate	Research design or analysis is not clearly stated	Not suitable for research questions	Did not answer the research question

Data extraction and analysis

Details of each study were recorded in an excel spreadsheet, this included: author, country, year of publication, sample size and age of participants, research question, duration, context, methods, findings and comments. Two types of data analysis were used to organize and synthesize relevant data findings. First, descriptive analysis was conducted and the following data were recorded: reference, research focus, key, and context. Second, a thematic analysis was employed, involving the

identification, analysis, and reporting of patterns or themes within the data (Braun & Clarke, 2014). Thematic coding was conducted systematically, in which relevant content from the selected studies was extracted, categorized, and interpreted according to the predetermined research questions. This approach allowed the researchers to synthesize findings across diverse studies and highlight recurring patterns, key concepts, and emerging insights related to the use of loose parts media in STEAM learning.

Limitations

This review has several limitations. One is the limited number of studies included, largely due to the strict selection criteria set by the systematic review protocol. Additionally, the studies reviewed explored a wide range of thinking skills, adding to the variability. It is also worth noting that the data analysis was carried out independently, without being influenced by any specific theoretical or conceptual framework.

Table 5.

Geographical location of the study.

Country	Number of Articles	Country	Number of Articles
Indonesia	14	Chile	1
Europe	1	United States of America	1

RESULTS AND DISCUSSION

Types of Loose Parts Media in a STEAM Context

The use of loose parts in STEAM (Science, Technology, Engineering, Arts, and Mathematics) education has drawn considerable interest, particularly within early childhood learning settings. Loose parts, which consist of various natural or man-made materials without fixed functions, allow children to explore, create, and use their imagination freely. According to research conducted by Novita Ananda et al (2023), highlights that incorporating loose parts into learning activities can greatly enhance children's creativity. Their findings showed that children participating in these loose parts activities demonstrated notable gains in both critical thinking and problem-solving abilities.

The positive impact of using loose parts media is also seen in children's collaboration skills. When children play with loose parts, they often work in groups, which encourages social interaction and communication. This is in line with findings from (Maghfirotul Qiromah et al., 2024) , which noted that children who engaged in collaborative activities with loose parts showed improvements in their social skills. Thus, loose parts media not only play a role in the development of individual creativity,

but also in building social skills that are important for children's development.

The use of loose parts in a STEAM context also provides room for exploration and experimentation. Children are encouraged to try different combinations and shapes, which allows them to learn from mistakes and find alternative solutions. For example, in a study conducted in Gunungsitoli City, children who used loose parts media in STEAM learning showed better ability to understand science and technology concepts (Sudarso et al., 2024), showing that loose parts can be an effective tool to teach complex concepts in a fun and interactive way.

In addition, the long-term impact of using loose parts media in STEAM learning is also worth noting. Research shows that children who engage in loose parts-based learning tend to have higher curiosity and greater interest in science and art when they enter formal education (Dewi et al., 2024) . This suggests that early stimulation through loose parts media can form a strong foundation for future learning.

Overall, the analysis of loose parts media in the context of STEAM shows that using this media not only enhances children's creativity, but also strengthens their social skills, critical thinking ability and interest in science and art. Thus, it is important for educators to consider the integration of loose parts media in their curriculum to support the holistic development of young children.

Influence of Social and Cultural Context

Social and cultural contexts play a significant role in the effectiveness of STEAM learning based on loose parts media. Each community has different values, norms and practices that can influence how children learn and interact with their environment. For example, in some cultures, collaboration and cooperation are highly valued, which can enhance the effectiveness of loose parts-based learning. Research by (Nipriansyah et al., 2021) shows that children who come from cultural backgrounds that support collaboration show greater improvements in creativity and social skills when engaging in STEAM activities.

On the other hand, a less supportive social context can be a barrier to effective learning. For example, in communities where access to media loose parts is limited, children may not have the opportunity to participate in activities that stimulate their creativity. This can lead to inequities in the development of STEAM skills among children from different backgrounds. Therefore, it is important to consider social and cultural factors when designing STEAM learning programs.

In addition, the impact of the family environment cannot be ignored. Families who are actively involved in their children's education and encourage creative exploration can enhance the effectiveness of STEAM learning. A study by (Purwati et al., 2024) showed that children who were supported by parents in creative activities using loose parts showed better results in terms of problem solving and

innovation. This suggests that collaboration between school and family is essential to achieve optimal learning outcomes.

Overall, the influence of social and cultural context on STEAM learning based on loose parts media is complex. Educators need to understand and appreciate differences in social and cultural contexts to design effective and inclusive programs. By paying attention to these factors, STEAM learning can become more relevant and beneficial to all children, regardless of their background.

STEAM Learning and Long-term Impact.

The STEAM Learning Model which consists of incorporating Science, Technology, Engineering, Arts and Math in a holistic manner and has become popular worldwide, especially in developed countries. However, STEAM education programs are still new to developing countries in Latin America, and many early childhood and primary school educators are unaware of them. Chile's pioneering education program "Pequeños Científicos" aims to empower gender and provide extracurricular academic enrichment for students aged 3 to 10 years. (Cabello et al., 2021)

Research results related to the long-term impact of STEAM learning based on loose parts media have been the focus of research in recent years. The results show that early experiences in STEAM learning can have a significant influence on children's future academic and life skills development. For example, a study by (Cabello et al., 2021) found that children who engaged in STEAM programs at an early age performed better in science and math subjects when they entered primary education

In addition, STEAM learning involving loose parts media also contributes to the development of critical and creative thinking skills. Children who are familiar with exploration and experimentation using loose parts tend to be more able to face complex challenges and think beyond conventional boundaries. This is supported by research conducted by (Sukardjo et al., 2023) which shows that children who engage in loose parts-based learning have better critical thinking skills compared to those who do not engage in such activities.

Another long-term impact is an increase in children's interest and engagement in STEAM fields. Research shows that children who have positive experiences in STEAM learning at an early age are more likely to choose careers in science, technology and the arts as adults. A study by Wised, (2024) highlights that children who are exposed to early STEAM learning show greater interest in continuing their education in these fields, which in turn can help address future labor shortages in STEAM fields.

Thus, the long-term impact of STEAM learning based on loose parts media is significant. Educators and policy makers need to recognize the importance of providing quality learning experiences at an early age to prepare children for future challenges. Through the right approach, STEAM learning

can be a strong foundation for children's personal and academic development throughout their lives.

The Educator's Role in STEAM Learning

The role of educators in STEAM learning based on loose parts media is crucial to create a learning environment that supports children's creativity and exploration. The pedagogical approaches applied by educators can influence the extent to which children engage in learning activities and how they develop STEAM skills. One effective approach is project-based learning, where children are encouraged to work in groups to complete a specific challenge or project using loose parts.

In this context, educators function as facilitators who provide support and guidance to children without directing them directly. According to research by Munawar et al., (2019) this approach allows children to take initiative and develop a sense of ownership of their learning process. By giving children the freedom to explore and create, educators can help them develop the critical and creative thinking skills required in STEAM learning.

In addition, educators also need to create a safe and inclusive environment where all children feel valued and encouraged to participate. This can be achieved by applying the principles of child-centered learning, where educators pay attention to children's individual interests and needs. Research by (Sardi & Mayar, 2023) shows that a positive and supportive learning environment can increase children's motivation and engagement in STEAM learning.

Educators should also continue to develop themselves and update their knowledge on best practices in STEAM learning. This includes attending relevant trainings and workshops, as well as sharing experiences and strategies with their peers. By doing so, educators can remain relevant and effective in teaching children in this ever-changing era.

Overall, the role of educators in STEAM learning based on loose parts media is very important. By applying the right pedagogical approach, creating a supportive environment and continuously developing themselves, educators can help children develop the skills necessary for future success.

Integration of Technology in Learning

Technology integration in STEAM learning based on loose parts media has become a topic of interest in early childhood education. Technology can serve as a tool that enriches children's learning experience, giving them access to explore STEAM concepts in a more interactive and engaging way. For example, the use of apps and software that support science and math learning can help children understand complex concepts in a simpler and more fun way.

Research by Rahardjo (2019) shows that the use of technology in STEAM learning can increase

children's motivation and engagement. Children who engaged in activities that combined technology with loose parts media showed greater interest in exploration and experimentation. This suggests that technology can serve as an amplifier for existing learning experiences, helping children to be more engaged and active in the learning process.

However, it is important to remember that technology should be used as a support tool, not as a substitute for hands-on experience with loose parts media. Research by (Trina et al., 2024) highlights that learning experiences involving physical interaction with loose parts media remain important for the development of children's fine motor skills and creativity. Therefore, educators need to find the right balance between the use of technology and hands-on learning experiences.

In addition, educators also need to consider the accessibility of technology for all children. In some communities, access to technology devices may be limited, which can create gaps in learning. Therefore, it is important for educators to design inclusive programs and ensure that all children have the opportunity to engage in STEAM learning, whether through the medium of loose parts or technology.

Thus, technology integration in STEAM learning based on loose parts media has great potential to enhance children's learning experience. However, educators need to be judicious in applying technology, ensuring that it is used to support and enrich learning, not replace hands-on experiences that are essential to children's development.

Table 6.

Matrix

No	Author Name	Journal Name Journal Identity Year	Title	Sample & Data Collection Technique	Research Variables	Main Analysis	Research Findings
1	Munawar, M., Roshayanti, F., & Sugiyanti, S.	CERIA 2(5), 2019	Implementation of STEAM-Based Early Childhood Education Learning in Semarang City	Preschool teachers in Semarang City, interview and observation	STEAM learning implementation	Descriptive qualitative	STEAM learning enhances children's creativity and engagement in class.
2	Nipriansyah, N., Sasongko, R. N., Kristiawan, M., et al.	Al-Athfaal 4(1), 2021	Increase Creativity and Imagination of Children Through Learning	Early childhood, quasi-experiment	Creativity, children's imagination	Quantitative statistical analysis	Loose parts significantly enhance children's creativity and

			STEAM with Loose Parts Media				imaginatio n.
3	Novita Ananda, Parwoto, P., & Ilyas, S. N.	Heart Fruit Journal 10(2), 2023	Effectiveness of STEAM-based Learning with Media LooseParts on Early Childhood Creativity	Early childhood, experiments with control and experimental groups	Effectiveness of STEAM learning based on loose parts	Test statistics	There is a significant increase in children's creativity after using loose parts in STEAM learning.
4	Rahardjo, M. M.	JPUD 13(2), 2019	How to use Loose-Parts in STEAM? Early Childhood Educators Focus Group Discussion in Indonesia	Preschool teachers in Indonesia, focus group discussion	Utilization of loose media parts in STEAM learning	Qualitative analysis	Teachers understand how to integrate loose parts into STEAM learning to promote creativity.
5	Siti Fitriyani, D., Gandini, S., Hidayah, S., et al.	Murhum 5(1), 2024	Stimulating Early Childhood Creativity through Loose Parts Media	Early childhood, observation and interview	Media loose parts and children's creativity	Qualitative analysis	Media loose parts provide a positive stimulus for early childhood creativity.
6	Trina, N. A., Monsur, M., Cosco, N., et al.	Education Sciences. 2024 Jun 11;14(6):627.	How Do Nature-Based Outdoor Learning Environments Affect Preschoolers ' STEAM Concept Formation? A Scoping Review	Early childhood, scoping review	Nature-based learning environment in STEAM learning	Literature analysis	Nature-based environments support the formation of STEAM concepts in early childhood.
7	Wahidah Fauziah, N.	Thematic	Application of STEAM Learning Method with Loose Parts Materials to Improve Early Childhood Creativity	Early childhood, classroom action experiment	STEAM Learning Method and Children's Creativity	Classroom action analysis	STEAM method with loose parts effectively enhances children's creativity.

8	Dewi, A. C., Alif Laini, Sri Intan Wahyuni, & Mega Cahya Dwi Lestari	Aṭfālunā Journal of Islamic Early Childhood Education, 7(1), 31-46	Enhancing early childhood creativity through loose-parts media based on STEAM learning	Qualitative	Observation, interview	Enhanced creativity	STEAM-based loose-parts media effectively enhances creativity in early childhood education.

From the findings of previous research, this can answer the first research question, namely: How can the application of STEAM learning based on loose parts media improve early childhood creativity?

The application of STEAM learning through loose parts media significantly enhances early childhood creativity by fostering an environment that encourages exploration, problem solving and imaginative play. This approach integrates various disciplines of science, technology, engineering, art and mathematics by utilizing everyday materials, which encourages active engagement and creativity in early childhood. Environmental engagement by using Loose parts materials, such as twigs, stones, plastic parts, and others that are easily available and can be transformed into educational tools, thus increasing creativity and environmental awareness (Sudarso et al., 2024) , where Nature-Based Learning by utilizing nature-based loose parts has been shown to improve creative thinking skills, with significant improvements in children's imaginative abilities observed over several cycles. (Maghfirotul Qiromah et al., 2024) . And combining differentiated learning with loose parts media has been shown to significantly improve creative imagination skills, especially when social skills are also developed (Purwati et al., 2024) .

The second research question is: What aspects of creativity are most stimulated through the use of loose parts media in STEAM learning in early childhood?

The aspect of creativity that is most stimulated through the use of loose parts media in STEAM learning early childhood significantly improves various aspects of creativity in early childhood education. This approach encourages children to actively engage with their environment, fostering skills such as active exploration, curiosity, imagination and innovation and problem-solving skills. The following section outlines the key aspects of creativity stimulated through the medium of loose parts that encourage children to explore their environment, leading to increased curiosity and engagement with materials. Stimulation of Creativity on research shows that loose parts media can increase children's creativity from 6.9% in the pre-cycle assessment to 80.42% at the end of the third cycle (Dewi et al., 2024) . On Imagination and Innovation Children show high levels of imagination as they

manipulate the loose parts, which allows them to express thoughts and feelings spontaneously (Susanti et al., 2023) . For the open nature of the parts encourages innovative thinking, which allows children to create unique structures and solutions (Sukardjo et al., 2023) . Additionally playing with loose parts can help children develop critical thinking as they learn to overcome challenges during play (Maghfirotul Qiromah et al., 2024) . With observations showing that children become adept at experimenting and trying new approaches, which enhances their creative problem-solving skills (Sardi & Mayar, 2023) . Although loose parts media significantly enhance creativity, some educators may argue that structured learning environments are equally important for enhancing creativity in early childhood.

Comparative Synthesis

The reviewed studies demonstrate a consistent agreement that the integration of loose parts into STEAM learning contributes significantly to the stimulation of creativity in early childhood. However, the studies differ in their methodological approaches, emphasis on outcomes, and scope of impact.

Some studies, such as those by Dewi et al., (2024) and Novita Ananda et al (2023), focus on short-term improvements in creativity through structured interventions. These works highlight measurable increases in children's creative output, problem-solving skills, and engagement through repeated cycles of classroom application. Dewi et al. reported an increase in creativity scores from 6.9% to over 80% after three intervention cycles using STEAM-based loose parts learning, while Novita Ananda et al. emphasized significant gains in critical thinking and active participation.

Other research, such as Trina et al., (2024) and Sukardjo et al., (2023), explores how engagement with loose parts especially within nature-based or differentiated learning contexts supports concept formation and development of 21st-century skills. Trina et al. found that children in outdoor STEAM environments with access to natural loose parts showed more robust cognitive engagement and retention of scientific concepts. Meanwhile, Sukardjo et al. identified the emergence of collaboration, creativity, communication, and critical thinking (4Cs) through such experiential learning.

Several studies, including Cabello et al., (2021) and Wised (2024), extend the findings to examine the long-term impacts of early STEAM experiences on children's academic orientation and future aspirations. Cabello et al. demonstrated that participation in integrated STEAM programs improved children's performance in mathematics and science in primary education, while Wised noted that early exposure to STEAM environments contributes to stronger interest in STEAM-related careers and enhanced critical thinking dispositions.

In contrast, studies like Munawar et al., (2019) and Rahardjo (2019) place more emphasis on pedagogical aspects and educator roles. These studies underscore how teacher facilitation styles, such

as project-based learning and child-centered guidance, influence the depth of creative exploration and initiative in young learners. They further suggest the need for teacher training in using loose parts as effective tools within integrated learning environments.

This synthesis illustrates that while all reviewed studies support the use of loose parts in enhancing creativity within STEAM learning, the focus ranges from short-term classroom outcomes to broader developmental impacts, including long-term learning motivation and educational trajectory. Furthermore, the findings collectively emphasize the importance of contextual design, educator facilitation, and consistent exposure to exploratory learning experiences in maximizing the potential of STEAM-loose parts integration.

CONCLUSION

This systematic review shows that the integration of loose parts into STEAM (Science, Technology, Engineering, Art, and Mathematics) learning environments provides a powerful stimulus for early childhood creativity. Loose parts offer children exploratory freedom, enabling them to engage in imaginative play, experimentation, and problem-solving without predetermined outcomes. Meanwhile, the STEAM framework provides a thematic and interdisciplinary structure that channels this exploration into purposeful learning aligned with 21st-century competencies.

The findings across the reviewed studies reveal that the combination of loose parts and STEAM learning enhances various aspects of children's creativity such as fluency, originality, elaboration, collaboration, and critical thinking. In addition, sustained exposure to such environments can increase interest in science, art, and innovation, with potential long-term benefits for children's educational trajectories and life skills.

Theoretical implications of this review suggest the need to further conceptualize the intersection between open-ended play materials (loose parts) and structured integrative models like STEAM. This combination bridges constructivist theories of learning with interdisciplinary curriculum approaches, reinforcing the importance of active, inquiry-based experiences in early childhood education.

Practical implications emphasize the role of educators in designing flexible, child-centered STEAM activities using accessible loose parts. Schools and early childhood institutions should facilitate environments that balance freedom and structure, while also training teachers in facilitative strategies and curriculum integration. The importance of cultural context also emerged as a key factor, suggesting that loose parts and STEAM materials should be locally sourced and contextually relevant.

Recommendations for future research include the development and evaluation of integrative STEAM-loose parts models that incorporate local cultural elements, sustainability principles, or

inclusive education frameworks. Further longitudinal studies are also needed to explore the sustained impact of this approach on children's development beyond early childhood. From a policy perspective, education authorities should consider incorporating STEAM-loose parts learning into early childhood curriculum guidelines and teacher training standards to ensure widespread and equitable implementation.

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