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IMPLEMENTING STEAM EDUCATION THROUGH LOOSE PARTS TO FOSTER COGNITIVE DEVELOPMENT IN EARLY CHILDHOOD A QUALITATIVE STUDY AT PAUDIT DURRATUL ISLAM MAGELANG

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Abstract *This study examines how STEAM education using loose parts was implemented to support the cognitive development of children aged four to five years at PAUDIT Durratul Islam, Magelang. The study was motivated by the need for learning strategies that provide young children with opportunities to explore, create, question, and solve problems through direct experiences rather than relying mainly on teacher-directed activities or worksheets. A descriptive qualitative approach was employed, involving the principal, teachers, parents, and twenty children from Group A. Data were collected through participatory observation, in-depth interviews, and documentation of learning activities and children's work. The data were analyzed through data condensation, data display, and conclusion drawing, while the credibility of the findings was strengthened through source and technique triangulation. The findings indicate that STEAM learning with loose parts was implemented through contextual project activities that integrated observation, classification, construction, artistic creation, counting, and reflection. Children demonstrated greater curiosity, logical reasoning, problem-solving ability, independence, and creative expression during the learning process. The study suggests that loose parts can function as meaningful and flexible learning media for early childhood STEAM education when supported by careful teacher planning, open-ended questioning, safe material selection, and parental involvement.*

Keywords: *STEAM; Loose parts; Cognitive development; Early childhood; qualitative study*

Abstrak Penelitian ini mengkaji penerapan pembelajaran STEAM berbasis loose parts dalam mendukung perkembangan kognitif anak usia empat hingga lima tahun di PAUDIT Durratul Islam, Magelang. Kajian ini dilatarbelakangi oleh kebutuhan terhadap strategi pembelajaran yang memberi anak kesempatan untuk mengeksplorasi, mencipta, bertanya, dan memecahkan masalah melalui pengalaman langsung, bukan hanya melalui kegiatan yang berpusat pada guru atau lembar kerja. Penelitian ini menggunakan pendekatan kualitatif deskriptif dengan melibatkan kepala sekolah, guru, orang tua, dan dua puluh anak kelompok A. Data dikumpulkan melalui observasi partisipatif, wawancara mendalam, dan dokumentasi aktivitas pembelajaran serta hasil karya anak. Analisis data dilakukan melalui kondensasi data, penyajian data, dan penarikan kesimpulan, sedangkan keabsahan data diperkuat melalui triangulasi sumber dan teknik. Hasil penelitian menunjukkan bahwa pembelajaran STEAM menggunakan loose parts diterapkan melalui kegiatan proyek kontekstual yang mengintegrasikan pengamatan, klasifikasi, konstruksi, kreasi seni, berhitung, dan refleksi. Anak menunjukkan peningkatan rasa ingin tahu, penalaran logis, kemampuan memecahkan masalah, kemandirian, dan ekspresi kreatif selama proses pembelajaran. Penelitian ini menunjukkan bahwa loose parts dapat menjadi media pembelajaran yang bermakna dan fleksibel dalam pendidikan STEAM anak usia dini apabila didukung oleh perencanaan guru yang matang, pertanyaan terbuka, pemilihan material yang aman, serta keterlibatan orang tua.

Kata Kunci: STEAM; Loose parts; Perkembangan kognitif; Anak usia dini; penelitian kualitatif

1. PENDAHULUAN / INTRODUCTION

Early childhood is a fundamental stage in human development because it provides the foundation for cognitive, social-emotional, language, and motor growth. During the ages of four to five, children begin to demonstrate more complex thinking abilities, such as observing objects, comparing quantities, classifying information, remembering experiences, asking questions, and solving simple problems. These abilities develop more effectively when children are given opportunities to interact directly with their environment through play, exploration, communication, and the use of concrete materials. Therefore, learning in early childhood should not only focus on the completion of tasks but also provide meaningful experiences that allow children to construct knowledge actively (UNICEF & LEGO Foundation, 2018).

In practice, however, early childhood learning activities are still often dominated by teacher-centered instruction, worksheets, and manufactured educational toys with limited functions. Although these activities may support children in recognizing symbols or following instructions, they may not provide sufficient space for children to experiment, make decisions, negotiate meaning, and develop original ideas. When learning is too structured, children may become dependent on examples provided by teachers and have fewer opportunities to explore alternative solutions. This situation indicates the need for a more flexible and child-centered learning approach that encourages children to think, create, and solve problems through direct experience.

One learning approach that can respond to this need is STEAM education. STEAM integrates Science, Technology, Engineering, Arts, and Mathematics into meaningful and contextual learning experiences. In early childhood education, STEAM does not refer to teaching complex scientific or mathematical concepts. Instead, it emphasizes activities that allow children to observe phenomena, use simple tools, design and build objects, express ideas creatively, count, compare, classify, and reflect on their work. Through STEAM-based activities, children are encouraged to connect different areas of learning while developing curiosity, reasoning, collaboration, creativity, and problem-solving skills (Sardi & Mayar, 2023)

The use of loose parts is highly relevant to STEAM learning in early childhood. Loose parts are open-ended materials that can be moved, arranged, combined, separated, redesigned, and used in various ways according to children's ideas. These materials may include natural and recycled objects, such as stones, leaves, twigs, bottle caps, cardboard, fabric pieces, wood blocks, and other safe materials from the surrounding environment. Unlike toys with fixed functions, loose parts provide children with the freedom to create different forms and meanings from the same materials. This flexibility supports children's imagination, symbolic thinking, classification skills, logical reasoning, and divergent thinking (Rahardjo, n.d.)

Loose parts also allow children to learn through trial and error. When children build a house, road, vehicle, garden, or other object using loose materials, they are required to observe the characteristics of each material, decide which object is suitable for a particular purpose, test their ideas, and revise their work when problems occur. For example, children may discover that a structure cannot stand firmly, that some materials are heavier than others, or that certain shapes are more suitable for creating specific objects. These experiences support cognitive development because children are not only receiving information from teachers but also building understanding through direct manipulation of objects (Piaget, 1952).

In the context of early childhood education, teacher facilitation plays an important role in ensuring that loose parts activities become meaningful learning experiences. Teachers need to prepare safe and

varied materials, design activities that are connected to children's daily experiences, and provide open-ended questions that stimulate thinking. Questions such as "What can make this structure stronger?", "Why did this object fall?", "Which material is bigger?", or "How many objects do you need?" can encourage children to observe, compare, predict, and reason. In this way, teachers do not simply direct children's work but guide them to think more deeply and make their own decisions. This type of guided interaction is important because children can develop higher levels of thinking when they receive appropriate support from adults and peers (Vygotsky, 1978).

Initial observations at PAUDIT Durratul Islam, Magelang, showed that children needed more opportunities to engage in exploratory and creative learning activities. Some children still required support in completing creative projects independently, choosing strategies to solve simple problems, and using objects from the surrounding environment as learning resources. This condition shows the importance of implementing learning activities that are flexible, contextual, and developmentally appropriate. STEAM learning using loose parts is considered a potential strategy because it allows children to explore familiar materials while developing cognitive skills through concrete experiences.

Based on this background, this study aims to describe the implementation of STEAM education using loose parts to support the cognitive development of children aged four to five years at PAUDIT Durratul Islam, Magelang. This study focuses on how teachers plan STEAM learning activities with loose parts, how children interact with the materials during the learning process, and how these activities support cognitive development, particularly in terms of curiosity, classification, logical reasoning, problem-solving, independence, and creative expression.

2. METODE PENELITIAN / RESEARCH METHOD

This study employed a descriptive qualitative approach to examine the implementation of STEAM education using loose parts in supporting the cognitive development of children aged four to five years. This design was considered appropriate because the study focused on understanding learning processes, children's responses, teacher facilitation, and the meaning of classroom activities in a natural educational setting. Rather than measuring learning outcomes statistically, this study aimed to describe how STEAM learning with loose parts was planned, implemented, and experienced by children, teachers, and parents.

The research was conducted at PAUDIT Durratul Islam, Magelang. The research participants consisted of twenty children from Group A, classroom teachers who implemented the learning activities, the school principal who supervised the program, and selected parents who provided information about children's learning behavior at home. The participants were selected purposively because they were directly involved in the STEAM learning process using loose parts. This selection allowed the researcher to obtain relevant and detailed information from individuals who had direct experience with the learning activities.

Data were collected through observation, interviews, and documentation. Participatory observation was conducted during classroom activities to identify how children explored, selected, classified, arranged, counted, combined, and redesigned loose parts. The observation also focused on children's cognitive responses, such as curiosity, problem-solving, logical reasoning, symbolic representation, independence, and communication during the learning process.

In-depth interviews were carried out with teachers, the principal, and parents. Interviews with teachers explored how they planned the activities, selected loose parts materials, integrated STEAM elements, guided children's exploration, and responded to learning challenges. Interviews with the principal focused on the school's support for the implementation of STEAM learning. Meanwhile, interviews with parents were used to understand whether children showed continuity of learning at home, such as collecting safe materials, retelling classroom activities, or using environmental objects for play.

Documentation was used to strengthen the data obtained from observations and interviews. The documents included lesson plans, learning notes, photographs of classroom activities, and children's work products. These documents helped the researcher confirm whether the planned activities were consistent with the learning process and children's cognitive responses during STEAM activities.

The research instruments consisted of observation guidelines, interview guidelines, and documentation checklists. The observation guidelines focused on indicators of cognitive development, including curiosity, classification, counting, reasoning, problem-solving, memory, symbolic thinking, and independence. The interview guidelines were designed to obtain information about teacher strategies, the use of loose parts, parental involvement, and perceived changes in children's learning behavior. The documentation checklist was used to organize supporting evidence from learning materials, children's products, and classroom records.

The data were analyzed using the interactive model proposed by Miles et al. (2014), which includes data condensation, data display, and conclusion drawing. Data condensation was conducted by selecting and simplifying information related to the implementation of STEAM learning, the use of loose parts, teacher facilitation, and children's cognitive development. Data display was organized into descriptive themes so that patterns from observations, interviews, and documentation could be compared systematically. Conclusion drawing was carried out by interpreting the relationship between learning activities, children's interaction with loose parts, and the development of cognitive indicators.

To ensure the credibility of the findings, this study used source and technique triangulation. Source triangulation was conducted by comparing information obtained from teachers, the principal, parents, and children's classroom activities. Technique triangulation was carried out by comparing data from observation, interviews, and documentation. Through this process, the researcher was able to verify the consistency of the findings and reduce the possibility of relying on a single source of information.

3. HASIL DAN PEMBAHASAN / RESULT AND DISCUSSION

The findings indicate that STEAM education using loose parts at PAUDIT Durratul Islam, Magelang, was implemented through contextual project-based activities. The learning process was not carried out as a rigid instructional activity, but as a flexible exploration process in

which children were encouraged to observe, select, classify, arrange, count, construct, revise, and reflect on their work. Teachers played an important role in preparing materials, designing meaningful themes, providing guiding questions, and supporting children when they encountered difficulties.

Overall, the implementation of STEAM learning using loose parts contributed to children's cognitive development by providing direct experiences with concrete materials. Children were not only involved in play activities but also practiced cognitive processes such as observation, classification, comparison, symbolic representation, logical reasoning, problem-solving, and decision-making. The findings are discussed in four main themes

a. Teacher Planning in STEAM Learning Using Loose Parts

Teacher planning was an essential component in the implementation of STEAM learning using loose parts. Before the activities began, teachers selected learning themes that were familiar and meaningful to children, such as houses, vehicles, animals, gardens, and objects in the surrounding environment. These themes were chosen because they were close to children's daily experiences and could help them connect classroom activities with real-life situations.

Teachers also prepared various loose parts materials that were safe, accessible, and easy for children to manipulate. The materials included bottle caps, leaves, twigs, stones, cardboard, fabric pieces, wooden blocks, and other objects from the surrounding environment. These materials were placed in open containers so that children could choose and combine them independently based on their own ideas. This arrangement created a learning environment that encouraged exploration rather than imitation.

The learning design integrated STEAM elements in a simple and developmentally appropriate way. Science appeared when children observed the characteristics of materials, such as texture, shape, size, weight, and function. Technology was introduced through the use of simple tools, such as scissors, glue, rulers, and containers. Engineering emerged when children designed, arranged, and tested the strength of their structures. Arts appeared when children created visual forms based on imagination and aesthetic choices. Mathematics was involved when children counted objects, compared quantities, recognized patterns, and grouped materials by color, size, or shape.

This finding shows that teacher planning did not limit children's creativity. Instead, it provided a clear learning direction while still allowing children to make choices and develop their own ideas. This supports Rahardjo's view that loose parts can help teachers create open-ended learning experiences that connect mathematical concepts with exploration. The finding is also consistent with Muhu et al. (2024), who emphasize that teacher preparation is important in STEAM learning because teachers need to design activities that are meaningful, flexible, and appropriate to children's developmental stages.

In this study, planning functioned as a bridge between curriculum goals and children's spontaneous exploration. Without teacher planning, loose parts might only become ordinary

play materials. However, when teachers prepared themes, questions, and learning objectives, the materials became tools for developing children's observation, reasoning, creativity, and problem-solving skills.

b. Children's Exploration and Interaction with Loose Parts

Children showed active engagement when they were given opportunities to choose and use loose parts independently. They observed objects, touched different textures, compared shapes, grouped materials, and arranged them into meaningful forms. Some children arranged bottle caps into patterns, while others used twigs, stones, leaves, and cardboard to create houses, roads, gardens, or vehicles. These activities show that children were able to transform simple materials into symbolic representations.

The exploration process also showed that children were involved in more than free play. They practiced classification when grouping materials by color, size, and shape. They practiced counting when deciding how many objects were needed to complete a structure. They practiced prediction when estimating whether a structure would stand or collapse. They practiced reasoning when explaining why certain materials were more suitable for specific parts of their work. These behaviors indicate that loose parts supported children's cognitive processes through direct interaction with materials.

Loose parts encouraged children to produce different works even when they used similar materials. This shows that open-ended materials can stimulate divergent thinking because children are not limited to one correct answer or one fixed model. For example, bottle caps could become wheels, flowers, roof decorations, or counting objects depending on the child's idea. This flexibility allowed children to build meaning through imagination, experimentation, and repeated modification.

The findings are in line with Cankaya et al. (2023), who explain that loose parts play supports cognitive development because it involves reasoning, exploration, self-regulation, and flexible thinking. The findings also support Daly and Beloglovsky's idea that loose parts provide children with opportunities to create, redesign, and reinterpret materials in various ways. In the context of this study, children's interaction with loose parts reflected an active learning process in which knowledge was constructed through observation, manipulation, and reflection.

From a constructivist perspective, the use of loose parts is relevant because children learn by interacting directly with concrete objects. This is consistent with Piaget's theory that children construct knowledge through hands-on experiences with their environment. When children tested materials, observed the results, and revised their work, they were developing understanding through active exploration rather than simply following teacher instructions.

c. Development of Problem-Solving, Reasoning, and Independence

One of the most visible findings in this study was the development of children's problem-solving ability, logical reasoning, and independence. During the learning activities, children

encountered simple problems related to material selection, balance, structure, size, and arrangement. For instance, some children found that their house structures could not stand firmly, their vehicle designs were not balanced, or their patterns were incomplete. These situations encouraged children to think, test new strategies, and revise their work.

Instead of immediately asking the teacher for answers, several children tried to solve the problems by rearranging materials, replacing objects, adding support, or asking peers for suggestions. This process showed the emergence of trial-and-error thinking and persistence. Children began to understand that a problem could be solved through experimentation and adjustment. Such behavior reflects an important aspect of cognitive development because children were learning to analyze situations, make decisions, and evaluate the results of their actions.

Children also showed reasoning skills through the questions they asked and the explanations they gave. They asked why certain objects could stand, why some materials rolled, why one object was heavier than another, and why some shapes were more suitable for building certain structures. These questions indicate that children were beginning to connect observation with logical thinking. They were not only using materials but also trying to understand the relationship between material characteristics and the results of their work.

Teacher scaffolding played an important role in strengthening children's reasoning and problem-solving. Teachers did not directly correct children's work or provide ready-made answers. Instead, they used open-ended questions such as, "What can make it stronger?", "Which material is bigger?", "Why did it fall?", and "How many objects do you need?" These questions encouraged children to observe more carefully, compare alternatives, and make decisions independently.

This finding is consistent with Vygotsky's view that children can achieve higher levels of thinking through guided interaction with adults and peers. Teacher support in this study did not reduce children's independence. Rather, it helped children think more systematically while still allowing them to develop their own strategies. The findings also align with Erol and Basaran (2023), who found that STEAM activities can improve young children's problem-solving and creativity skills.

Thus, the implementation of STEAM learning using loose parts helped children move from simple manipulation of objects to more complex cognitive activities. Children learned to identify problems, test solutions, revise ideas, and explain their reasoning. These processes are important foundations for cognitive development in early childhood.

d. Teacher and Parent Involvement in Supporting Learning Continuity

The implementation of STEAM learning using loose parts also depended on teacher and parent involvement. Teachers reported that loose parts were practical learning media because they were affordable, accessible, and flexible. The materials could be obtained from the surrounding environment and adjusted to different learning themes. This made loose parts

suitable for early childhood classrooms, especially in schools that need meaningful learning media without relying heavily on expensive manufactured toys.

However, the use of loose parts still required careful preparation. Teachers needed to ensure that all materials were safe, clean, and appropriate for children's age. They also needed to organize the classroom, prepare guiding questions, manage group activities, and provide reflection after the learning process. This shows that loose parts learning requires active teacher facilitation. The materials may be simple, but the learning process must be intentionally designed.

Parents also played an important role in supporting learning continuity. Interview results showed that some children began to show interest in collecting safe objects at home and using them for play. They also retold classroom activities and tried to create similar objects using materials available in their home environment. This finding indicates that STEAM learning with loose parts can extend beyond classroom activities and become part of children's daily experiences.

The connection between school and home is important because cognitive development in early childhood is strengthened through repeated stimulation. When children continue to explore materials at home, they have more opportunities to observe, remember, classify, compare, and express ideas creatively. Parent involvement therefore helps reinforce the learning experiences that children receive at school.

This finding is consistent with Sardi and Mayar (2023), who found that loose parts activities can encourage children to become more active, creative, curious, and able to solve simple problems. It also supports Aisyah et al. (2025), who reported that project-based learning with loose parts can support cognitive, motor, and social development through exploratory and collaborative activities.

In this study, parent involvement strengthened the impact of STEAM learning because children were able to connect classroom experiences with their home environment. This continuity helped children understand that learning does not only occur in the classroom but also through everyday objects and experiences around them.

e. Overall Analysis of STEAM Learning Using Loose Parts

Overall, the findings show that STEAM learning using loose parts contributed to children's cognitive development through three main mechanisms. First, loose parts provided concrete and flexible materials that allowed children to explore directly. Through these materials, children could observe, compare, classify, count, design, and modify objects based on their own ideas.

Second, STEAM activities encouraged children to connect different areas of learning. Science appeared through observation, technology through the use of tools, engineering through construction, arts through creative expression, and mathematics through counting and

classification. This integration made learning more meaningful because children did not experience each subject as separate content but as part of one connected activity.

Third, teacher scaffolding and parental support strengthened the learning process. Teachers helped children think more deeply through open-ended questions, while parents supported continuity by encouraging children to explore safe materials at home. These two forms of support helped children develop curiosity, reasoning, problem-solving, independence, and creativity.

The findings suggest that loose parts are not merely play objects but can function as meaningful pedagogical tools when integrated into well-planned STEAM activities. The success of implementation depends on the teacher's ability to prepare materials, design contextual activities, guide children's thinking, and involve parents in supporting learning beyond the classroom.

Table 1. Main Findings of STEAM Learning Using Loose Parts

Research Aspect	Main Finding	Cognitive Meaning
Teacher planning	Teachers prepared contextual themes, safe loose parts, guiding questions, and reflection activities.	Learning became structured but still flexible for children's exploration.
Children's exploration	Children selected, classified, counted, arranged, and redesigned materials independently.	Children practiced observation, classification, symbolic thinking, and logical reasoning.
Problem-solving	Children revised structures, replaced materials, and tested new arrangements when facing difficulties.	Children developed persistence, strategy selection, and cognitive flexibility.
Teacher scaffolding	Teachers used open-ended questions rather than direct correction.	Children received support to think, reason, and make decisions.
Parent involvement	Parents observed children using environmental materials for play at home.	Learning continuity helped strengthen memory, curiosity, and creative expression.

Overall, the implementation of STEAM education using loose parts contributed to cognitive development because it gave children concrete opportunities to observe, compare, classify, count, design, test, and communicate ideas. The approach also helped teachers shift from instruction-centered learning to facilitative learning. Nevertheless, successful implementation requires material safety control, clear learning objectives, reflective questioning, and collaboration between teachers and parents.

4. KESIMPULAN / CONCLUSION

This study concludes that the implementation of STEAM education using loose parts at PAUDIT Durratul Islam, Magelang, was carried out through contextual, exploratory, and project-based learning activities. The learning process integrated science, technology, engineering, arts, and mathematics in a simple and developmentally appropriate manner. Children were encouraged to observe materials, use simple tools, design and construct objects, express creative ideas, count, classify, compare, and reflect on their work.

The findings show that loose parts can support the cognitive development of children aged four to five years by providing flexible and concrete learning experiences. Through direct interaction with loose parts, children demonstrated curiosity, classification ability, symbolic thinking, logical reasoning, problem-solving skills, independence, and creative expression. Children were not only involved in play but also engaged in meaningful thinking processes, such as making decisions, testing ideas, revising structures, and explaining their choices.

Teacher facilitation played an important role in the success of STEAM learning using loose parts. Teachers prepared safe and varied materials, designed contextual themes, provided open-ended questions, and guided children without limiting their creativity. This type of facilitation allowed children to explore freely while still receiving appropriate support to develop higher levels of thinking. In addition, parental involvement helped extend children's learning experiences beyond the classroom, as children were able to use familiar materials at home for exploration and creative play.

The study implies that loose parts can be used as accessible, low-cost, and meaningful learning media in early childhood education. However, effective implementation requires careful planning, safe material selection, purposeful teacher guidance, and collaboration with parents. Future research may examine the use of STEAM-based loose parts learning through a longer observation period or a mixed-method approach to measure specific aspects of children's cognitive development more systematically.

The implementation of STEAM education using loose parts at PAUDIT Durratul Islam, Magelang, was carried out through contextual project activities that integrated science, technology, engineering, arts, and mathematics in simple early childhood learning experiences. Teachers prepared themes, safe materials, guiding questions, and reflection activities, while children were given opportunities to explore and create based on their own ideas.

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