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Strategies for Enhancing Early Childhood Science Literacy Through STEAM Education

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Abstract: The primary objective of this study is to enhance young children's comprehension of scientific concepts by implementing the STEAM approach within the context of Early Childhood Education (PAUD). The STEAM (Science, Technology, Engineering, Art, and Mathematics) pedagogy for preschoolers emphasizes dynamic learning, stimulates cognitive engagement, facilitates problem-solving, nurtures structured and methodical reasoning, and enhances critical thinking skills. Conducted using the Classroom Action Research method guided by the Kemmis cycle model, this study involves a cohort of 15 participants from group B, aged 5-6 years, and spans across preliminary cycles, Cycle I, and Cycle II, comprising phases of planning, execution, observation, and reflection. The comprehensive deliberation's outcome establishes the potential for enhancing scientific literacy among young children through the implementation of STEAM education. This advancement in scientific understanding is facilitated through captivating balloon experiments, utilizing colors that resonate with children's preferences. The attainment of scientific knowledge, as evident through the STEAM approach, manifests at a rate of 10% during the Pre-Cycle, 26% during Cycle I, and an impressive 72% during Cycle II. The cumulative findings unequivocally underscore the profoundly positive role of STEAM pedagogy in augmenting scientific cognizance during the formative years of early childhood.

Keywords: Early childhood; Scientific knowledge; STEAM education

Introduction

Early Childhood Education should be able to develop various areas of growth, namely self-habituation and basic skill development. In the development of self-habituation, it includes spiritual attitudes, social attitudes, knowledge, and skills, while in basic skill development, it encompasses six aspects of development: religious and moral values, physical motor skills, cognitive abilities, socio-emotional skills, language, and arts. Among all aspects of child development, the cognitive aspect is the most significant as it can influence other aspects' progress. Cognitive skills play a crucial role in a child's learning success, as all activities or learning activities are connected to problem-solving, remembering, and thinking. The aim of cognitive development is to enhance a child's thinking abilities through science, language, and mathematics education (Bujuri, 2018; Ismaniar et al., 2023; Veronica, 2018).

According to Jelita et al. (2023) science is a natural science field, encompassing matter and energy, both present in living and non-living things, focusing mostly on the natural world (natural science) like physics, chemistry, biology. Science education emphasizes knowledge-seeking processes rather than knowledge transfer. Children are regarded as learning subjects who need to be actively involved in the learning process, while teachers are facilitators who guide and coordinate children's learning (Maulidiyah et al., 2023).

Science education for early childhood emphasizes process skills rather than products. Process skills should be developed for children as meaningful experiences. Suyanto in Amalia et al. (2018) suggests that introducing science to kindergarten children should focus more on the process than the product, and these science process

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skills should be taught in a simple manner through play, involving exploration of various objects around them. Science education for young children is beneficial for enhancing cognitive development, including understanding scientific concepts and their relevance to daily life, possessing process skills and learning activities to develop knowledge about the surrounding environment, and applying scientific methods to solve problems while being more aware of the grandeur and power of the creator of the universe (Hapidin et al., 2023)

Based on observations in the field, the science knowledge imparted to young children tends to focus solely on their cognitive aspects. The teaching methods employed by educators often involve lectures and assignments, making the learning process less engaging for the children in terms of paying attention to the teacher's explanations. Efforts by teachers to enhance children's science knowledge are relatively limited in variety, often confined to activities such as writing, coloring, counting, and drawing. Additionally, the instruction often remains teacher-centered, with limited opportunities for children to conduct experiments on their own, thereby hindering their optimal process skill development (Nuraini et al., 2023)

Furthermore, teachers are insufficiently applying diverse teaching methods. Underdeveloped science process skills in children can result in difficulties for them in developing cognitive, affective, psychomotor, critical thinking, and creative abilities (Kamil et al., 2023). Many strategies and methods can be employed by teachers to enhance children's science knowledge. One such approach is utilizing Science, Technology, Engineering, Art, and Mathematics (STEAM)-based teaching, integrated within Early Childhood Education (PAUD). According to Wan et al. (2021), STEAM-based learning can encourage critical and comprehensive thinking in children, stimulating them to solve problems. In STEAM-based learning, "loose parts" play a crucial role. Loose parts refer to open-ended materials easily found in our surroundings. Our environment is filled with loose parts like branches, seeds, stones, shells, dry leaves, flowers, and other natural (Wahyuningsih et al., 2020). STEAM is employed to emphasize the integrated nature of science, technology, art, and mathematics, and their significance in the long-term academic success of children (Rusni et al., 2023).

Therefore, STEAM-based teaching methods can be implemented to enhance children's science knowledge. This method aims to nurture children's creativity and apply active and creative learning models, where children play an active role in discovering new information about themselves through their environment (Wahyuningsih et al., 2020). The interconnections between science, technology, engineering, art, and mathematics enable children to think critically, seek answers, and tackle challenges on their own through conducting their own experiments. In the learning process, children are provided with opportunities to experience, participate, observe, analyze, verify, and draw their own conclusions about various situations or processes (Rusni et al., 2023).

Considering the existing issues, the researcher is motivated to conduct a classroom action research and enhance the quality of education through STEAM-based teaching methods, with the goal of augmenting children's science knowledge concerning the concept of the "magic balloon." Thus, the researcher will undertake a study with the title "Enhancing Early Childhood Science Knowledge through STEAM Education."

Method

The research methodology employed in this study utilizes the Action Research (AR) method. Before delving into the concept of Action Research, it is crucial to comprehend its underlying principles. As per (Ng et al., 2022), action research embodies a form of reflective and collaborative investigation conducted by researchers within a social context to enhance their practical social reasoning. The hallmark feature of action research lies in its specific interventions or treatments geared towards enhancing real-world performance.

The action research process unfolds through the following stages (Johnston et al., 2022). Planning: this entails devising a program for improvement based on the researcher's ideas or concepts. Action: it involves executing treatments or interventions in line with the researcher's planned strategies. Observation: this phase encompasses data collection through observation, aiming to evaluate the effectiveness of the implemented actions or to gather insights into potential shortcomings or deficiencies within the interventions. Reflection: this stage entails scrutinizing the observation results to derive fresh programs or planning strategies. The research subjects comprise children from group B at PAUD, totaling 15 children, including 6 boys and 9 girls. The execution of the classroom action transpired through the sequential phases of planning, action, observation, and reflection.

Result and Discussion

Result

Based on the research conducted at PAUD, observations on science knowledge through the magic balloon experiment in the Pre-Cycle phase revealed that early childhood engagement in STEAM learning. The graph above illustrates the observed results at PAUD concerning science knowledge among early childhood during the Pre-Cycle. The graph indicates that some children are classified as "not yet developed," accounting for 50%. Meanwhile, there are children categorized as "beginning to develop," comprising 20%. Additionally, there are children categorized as "developing as expected," constituting 20%, and children categorized as "developing very well," amounting to 10%. Consequently, the findings suggest that the average level of science knowledge among children aged 5-6 years remains modest. Regarding the success of the STEAM learning process, children exhibited a 10% improvement in their understanding of scientific concepts.

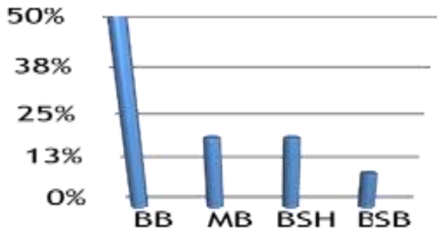

Figure 1. Observation results before the implementation of science learning through STEAM education

The results indicate that there is room for improvement in the science knowledge of children aged 5-6 years through STEAM-based learning. The observations suggest that a significant portion of the children has not yet reached the desired level of development in their science knowledge. This suggests the importance of enhancing the effectiveness of the STEAM approach to further promote children's engagement and comprehension of scientific concepts. The relatively low average score signifies a need for more focused and interactive teaching strategies to stimulate children's curiosity and critical thinking skills.

The varying levels of development observed among the children emphasize the need for targeted interventions and personalized approaches in the classroom. Educators can use this data to identify specific areas where children require additional support and tailor their teaching methods accordingly. By addressing individual learning needs and utilizing more dynamic STEAM-based activities, educators can aim to elevate the overall science knowledge of early childhood students (Hickey-Moody et al., 2019; Imaduddin et al. 2021; Rahma et al., 2022).

It is important to note that the research's limitations, such as sample size and duration, may have influenced the results. Further studies with larger and more diverse samples could provide deeper insights into the effectiveness of STEAM-based learning in enhancing science knowledge among young children.

The graph above illustrates the results of observations on early childhood science knowledge through STEAM education in Cycle I. From these findings, it can be deduced that 25% or 3 children fall into the category of not yet developed, while 14% or 2 children are classified as beginning to develop. Moreover, 35% or 6 children are categorized as developing as expected, and 26% or 4 children are labeled as developing very well. These observations indicate positive changes and progress in the science knowledge of children aged 5-6 years during Cycle I. However, the desired research and teacher's targets have not been fully achieved yet. As a result, additional measures will be undertaken in Cycle II to ensure further enhancement.

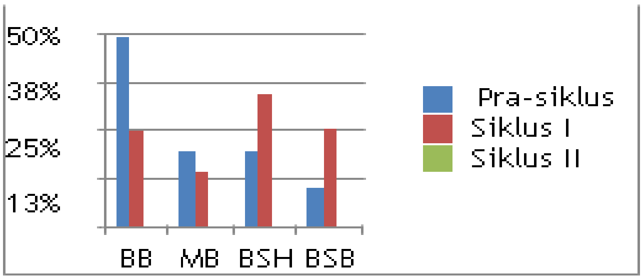

Figure 2. Observation results of science knowledge in early childhood through STEAM education cycle I

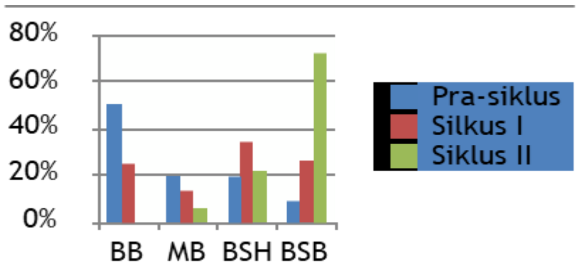

Figure 3. Observation results of science knowledge in early childhood through STEAM education cycle II

The results presented in the above graph lead to the conclusion that in early childhood science knowledge, particularly in Cycle II, there is an absence of children falling into the category of not yet developed, amounting to 0%. Meanwhile, children categorized as beginning to develop account for 6%, or a total of 2 children. Those categorized as developing as expected constitute 22%, or 3 children, while those classified as developing very well make up 72%, or a total of 10 children. Therefore, it can be deduced that the science knowledge of young children through STEAM education has demonstrated a noteworthy improvement.

Discussion

Based on the presented research data, it is evident that the utilization of the STEAM teaching method can effectively enhance the science knowledge of young children within the context of the magic balloon experiment. This finding aligns with the viewpoint of Wahyuningsih et al. (2020) which emphasizes that STEAM-based early childhood education nurtures children's creativity and applies active and creative learning models, enabling children to take an active role in exploring new information within their environment.

The application of STEAM-based teaching to enhance the science knowledge process provides children with opportunities to independently seek and discover knowledge through investigation. This approach fosters children's engagement and active participation in the learning process. This perspective is consistent with Morrison's standpoint (Siregar et al., 2020), asserting that learning through the STEAM approach aims to cultivate problem-solving abilities, recognize relevant discoveries, and promote creativity in designing and implementing solutions. It encourages self-reliance, confidence-building, time management, logical thinking, and mastery of skills not only in science but also across various other learning domains.

Throughout this science learning process, children are guided to independently seek and acquire new knowledge, placing significant emphasis on their active involvement. This viewpoint resonates with Putra's assertion Santi et al. (2021) that science learning prioritizes the process of knowledge acquisition rather than mere knowledge transfer. Children are considered active learners who need to be engaged in the learning process, while teachers serve as facilitators who guide and coordinate children's learning activities.

In conclusion, the remarkable improvement in children's science abilities across Pre-Cycle, Cycle I, and Cycle II is noteworthy. This progress is evident in each phase, including Cycle I and Cycle II. In Cycle I, the third meeting yielded results categorized as moderate. While aspects like observation and classification demonstrated improvement compared to the first meeting, other aspects such as communication and prediction had not fully developed. This was evident in the experimental activities during Cycle I, where some children struggled to follow instructions and classify objects based on their types. Additionally, certain children faced challenges in making accurate predictions, and their communication of experiment results and processes in front of the class showed signs of hesitation and shyness.

To address these shortcomings and sustain the success achieved in Cycle I, the following recommendations from other teachers are suggested for implementation in Cycle II: 1) Provide clearer and more engaging explanations to capture children's attention. 2) Introduce variety in the learning atmosphere, such as incorporating clapping or singing to prevent monotony. 3) Display higher enthusiasm and excitement while delivering explanations and instructions. 4) Offer reinforcement and appreciation to children for their efforts. 5) Enhance classroom management, particularly during experiment execution. 6) Foster enthusiasm in children to make predictions and draw conclusions from experiments. 7) Provide praise to motivate children to confidently communicate their experiment outcomes.

After implementing these recommendations from other teachers, the results of Cycle II observations, specifically the third meeting, indicated that children achieved good results on average. The science abilities of the children across aspects like observation, classification, prediction, conclusion, and communication had fully developed. This progress was observed in a group of 15 children in Group B of PAUD.

The experimental activities during Cycle II reflected children's independent practice in various aspects. In the observation aspect, children were observed conducting experiments without assistance and providing answers based on their understanding of the teacher's explanation and the experiment process. Children effectively classified objects by their types, made preliminary predictions about experiment outcomes, and drew meaningful conclusions from their observations. Furthermore, children demonstrated enthusiasm in communicating experiment results and processes without fear or shyness (Hickey-Moody et al., 2019).

The STEAM-based learning approach not only enhances children's science knowledge but also introduces them to other subjects such as technology, engineering, art, and mathematics, as they are interconnected. Children learn from science, technology introduces them to tools like spoons, funnels, plastic bottles, and more. Through engineering lessons, children learn about the technical aspects of the magic balloon experiment. Artistic elements are incorporated as children personalize their experiments by selecting balloon colors. Mathematics concepts are integrated as children count and categorize objects by quantity, color, and shape. This comprehensive approach ensures that children's holistic development encompasses all six aspects of early childhood development while focusing on science knowledge (Hapidin et al., 2022).

In conclusion, the observed results are highly satisfying, with significant improvements achieved in children's science knowledge through STEAM education. The process demonstrated a continuous increase in achievement: Pre-Cycle 10%, Cycle I 26%, and Cycle II 72%. The approach undertaken was practical, devoid of challenges or difficulties faced by the children upon attaining the desired developmental outcomes. The science learning experience was characterized by children's enthusiasm, enjoyment, and the absence of monotony, creating an engaging and pleasant learning environment.

Based on the conducted research with Group B at PAUD, it can be concluded that science education through the STEAM approach enhances scientific abilities, particularly demonstrated in the magical balloon experiment. The noticeable improvements encompass various aspects, including observation, classification, communication, and prediction. The utilization of the STEAM framework intertwines science, technology, engineering, art, and mathematics, extending beyond mere STEAM integration. The development of all six aspects, namely religious and moral values, physical motor skills, language, cognitive abilities (Munawar et al., 2020).

Conclusion

Based on the results of the conducted research within Group B at the Early Childhood Education (PAUD) institution, it can be concluded that science education with a foundation in STEAM enhances scientific proficiency through the magical balloon experiment. Evidently, children have demonstrated progress in observation, classification, communication, and prediction skills. The utilization of the STEAM approach establishes interconnectedness between science, technology, engineering, art, and mathematics. Furthermore, this approach extends beyond STEAM alone, encompassing all six developmental aspects: moral and religious values, physical motor skills, language, cognition, and art. This natural integration of various aspects occurs unintentionally or without explicit direction during the educational process. As a result of these observations, a high level of satisfaction is attained due to the positive impact of the implemented processes and stages. The evidence suggests that these activities effectively contribute to enhancing children's scientific knowledge through STEAM-based education. This progression is evident from the percentage outcomes: Pre-Cycle 10%, Cycle I 26%, and Cycle II 72%. These outcomes affirm that each cycle of STEAM-based learning brings about improvements in the scientific knowledge of 5 to 6-year-old children within Group B of the Early Childhood Education institution.

Authors Contributions

All authors contributed to writing this article.

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Conflicts of Interest

No conflict interest.

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