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Geometry Introduction Learning Assessment Through Smart Books at Almawaddah IT Kindergarten

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ABSTRACT

This study aims to develop and implement appropriate geometric educational teaching aids for early childhood (PAUD) and measure their influence on the understanding of the concept of plane figures (triangle, square, rectangle, circle, quadrilateral, pentagon, and hexagon). The study used a Research & Development (R&D) approach with the following stages: (1) designing props made of felt, (2) limited trials in PAUD classes, and (3) evaluation through comprehension and observation tests. The results showed that the use of props significantly increased students' understanding scores compared to before use as well as increased motivation and learning activities. These findings indicate that well-designed, interactive, and kinesthetic geometric teaching aids can be an effective medium for geometry learning in PAUD. The practical implications for PAUD teachers and learning media developers are outlined.

Keywords: Educational Teaching Aids, Geometry, Early Childhood Education, Flat Shapes, Visual Kinesthetic Learning.

I. INTRODUCTION

Geometric learning is a basic competency that needs to be introduced from an early age, as it serves as the foundation for the development of children's mathematical abilities and logical thinking. Geometric concepts, such as shape, size, spatial relationships, and comparisons, are part of the structure of mathematical thinking that develops gradually from childhood (Clements & Sarama, 2011). At this stage, children need to be introduced to concrete learning experiences that support their comprehensive cognitive development. However, in practice, geometry learning in kindergarten often occurs in an abstract manner and lacks meaning for children. This is because learning is still predominantly based on lecture methods or worksheet assignments without the support of concrete learning media, making it difficult for children to understand geometric shapes in real contexts (Jones et al., 2013). This condition impacts children's low ability to recognize basic shapes, such as circles, squares, triangles, and other shapes that are often found in everyday environments.

The limited use of learning media and teaching aids appropriate for the developmental characteristics of early childhood contributes to the low achievement of geometric recognition. Early childhood understands concepts better through direct experience, manipulation of concrete objects, and active interaction through play, in accordance with the characteristics of the pre-operational stage according to Piaget (Lestari & Yudhanegara, 2017). Therefore, learning media that are visual, manipulative, and kinesthetic are very important for supporting the understanding of basic mathematical concepts, including geometry, because these media allow children to form mental representations of the objects being studied (Akhtar & Sengupta, 2020). Learning that integrates elements of play and learning is also considered relevant because it is more appropriate for the child's developmental stage, increases learning engagement, and helps build meaningful experiences.

Based on actual conditions in the field, geometry learning at TK IT Almawaddah is not yet optimal. The media use is still limited and cannot encourage children to actively learn and build knowledge through direct interaction. Furthermore, teachers lack systematic and integrated assessment instruments to objectively measure children's abilities. However, assessment in early

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childhood education plays a crucial role in monitoring learning progress, identifying obstacles, and providing the basis for appropriate interventions (Nurhayati, 2021). Therefore, an assessment strategy that is accurate, authentic, and integrated into the learning process is necessary.

One solution is the use of Geometry Smart Books, a manipulative learning medium that allows children to learn through concrete activities such as cutting, arranging shapes, pasting, matching patterns, and identifying the characteristics of plane figures. This medium not only helps visualize abstract concepts, but can also serve as an authentic performance-based assessment instrument, where assessments are based on students' actual activities (Widiasari, 2022). This allows teachers to evaluate children's cognitive aspects, fine motor skills, motivation, and learning participation more comprehensively than in conventional assessments.

Previous research has shown that the use of manipulative media can improve geometry understanding in early childhood; however, studies specifically integrating creative learning media with activity-based assessment models are still limited (Hakim & Rachmawati, 2020). This opens up space for further research to fill this gap, while making a tangible contribution to the development of PAUD learning strategies that are appropriate to student characteristics. Therefore, this study was conducted to assess the effectiveness of the Geometry Smart Book in improving shape recognition skills through authentic assessments implemented throughout the learning process.

This study assessed the geometry recognition skills of early childhood children at TK IT Almawaddah with the hope of producing a clear picture of the media's effectiveness in improving the understanding of basic shapes. Furthermore, the research results are expected to serve as a reference for educators to develop more authentic, holistic, and developmentally appropriate learning assessments. This research is also expected to provide practical benefits for schools by providing learning media that are educational, economical, easy to implement, and relevant to the needs of 21st-century learning (Suryo & Amalia, 2019).

This study begins with the need to develop geometry learning media that are appropriate for the characteristics of early childhood in PAUD. This study seeks to answer several main questions, namely, how to design appropriate geometric educational teaching aids that are appropriate to the cognitive development of early childhood, and how to implement these teaching aids in classroom learning activities on plane figures. In addition, this study also examined the extent to which the use of teaching aids can influence children's understanding of the concept of plane figures. Not only from the learning achievement perspective, this study also explores how children and teachers respond to the developed teaching aids, both from an educational perspective, functionality, psychological comfort, creativity and innovation of media forms, and economic considerations in the context of implementation in PAUD.

In line with the problem formulation, the main objective of this study is to design geometric educational teaching aids that are appropriate for the needs and developmental stages of early childhood. This study also aims to apply these media to the learning process of plane figures so that their use can be directly observed in a real learning context. In addition, this study measured the extent of the media's influence on improving children's understanding of geometric concepts through authentic and measurable assessments. This study also aims to obtain an overview of teacher and child responses to the quality of the developed media, both from educational, physical, functional, psychological, creativity, innovation, and cost-effectiveness perspectives, so that the media can be further developed sustainably.

The expected benefits of this study include both theoretical and practical benefits. Theoretically, this research contributes to enriching scientific studies on the development of learning media, particularly those related to geometry teaching aids for early childhood. Practically, this research is useful for early childhood education (PAUD) teachers as an alternative learning medium to make the learning experience more engaging and meaningful. For media developers, this research can serve as a reference for creating creative, effective, and relevant learning tools for early childhood education (PAUD) curricula. For early childhood, developed media is expected to help improve the understanding of geometry easily and enjoyably through concrete, active learning experiences that are appropriate to their developmental stage.

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II. LITERATURE REVIEW

Geometric learning in Early Childhood Education (PAUD) is an important part of developing mathematical and spatial thinking skills. Children must be introduced to plane figures, solid figures, and the concept of spatial relationships through concrete experiences to support optimal cognitive development (Clements & Sarama, 2011). At this early age, children's thinking skills are in the preoperational phase; therefore, abstract concepts such as shape, angles, and size must be presented through activities that can be seen, touched, and manipulated directly (Lestari & Yudhanegara, 2017). Therefore, meaningful geometry learning must facilitate the exploration of shapes, observation of geometric characteristics, and applications in real-world contexts.

In the learning process, media use plays a crucial role in clarifying concepts, increasing motivation, and facilitating a more immersive learning experience for children. The learning theory suggests that visual, kinesthetic, and multimedia media can help children build better mental representations of the concepts being learned (Akhtar & Sengupta, 2020). Visual media helps children grasp the shape and structure of objects and supports learning through the movement and manipulation of concrete objects, while multimedia helps stimulate more senses through a combination of images, colors, and engaging learning activities. Therefore, selecting the right medium will impact the quality of the learning process and the child's level of understanding.

Educational teaching aids are among the most effective media used in early childhood education (PAUD). Teaching aids are defined as physical learning media that children can use to explore concepts through manipulative activities and hands-on learning experiences (Widiasari, 2022). Good teaching aids possess several important characteristics, including educational aspects that help achieve learning objectives, physical aspects that are safe and engaging for children, and functional aspects that provide space for children to explore. Furthermore, good teaching aids also consider psychological aspects such as children's comfort and confidence, creativity, and innovation to encourage exploration of new activities and economic aspects that allow the media to be produced and implemented efficiently in schools (Nurhayati, 2021). With these characteristics, teaching aids can overcome the limitations of conventional assignment-based learning.

Previous research has shown that the use of educational props positively influences early childhood geometry comprehension. Hakim and Rachmawati (2020) found that children who learned using manipulative media demonstrated a better understanding of plane shapes than those who learned using lecture methods did. Jones et al. (2013) noted that manipulative-based learning experiences and structured play can improve the understanding of shapes, side relationships, and geometric shape classification skills. This strengthens the argument that the use of concrete media can accelerate the internalization of abstract concepts in early childhood.

Based on these studies, the conceptual framework of this study posits the use of geometric educational aids as the independent variable, whereas early childhood understanding of geometric concepts is the dependent variable. Furthermore, children's learning motivation and engagement in kinesthetic activities can act as intervening or moderating variables that strengthen the relationship between media use and learning outcomes. Therefore, this study examined the extent to which educational aids can enhance children's understanding through concrete and enjoyable learning experiences.

Based on a quantitative research framework, the hypothesis proposed in this study is that the use of geometric educational props significantly improves early childhood children's understanding of plane figures compared with conventional learning methods that do not utilize concrete media. Thus, this study provides empirical evidence regarding the effectiveness of creative media in supporting basic mathematics learning in early childhood education.

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III. RESEARCH METHODS

This study uses the Research and Development (R&D) method combined with a quasi-experimental approach. This model was chosen because it allows researchers to develop educational products in the form of geometry teaching aids and simultaneously test their effectiveness through pre- and post-treatment measurements. This approach is widely used in the development of learning media in Early Childhood Education (PAUD) because it provides quantitative data on the improvement of children's abilities, as well as qualitative data on the implementation process in the classroom (Sugiyono, 2019). In addition, the study complemented qualitative studies in the form of analysis of teacher and student responses to obtain a comprehensive picture of media use and its benefits in learning.

The study population consisted of all 6-year-old PAUD students at TK IT Almawaddah, while the research sample consisted of 35 children who were purposively selected based on their involvement in geometry learning at school. Purposive selection was conducted so that the sample was in accordance with the research objectives and characteristics of the designed learning (Creswell, 2014). PAUD teachers were also involved as informants to assess aspects of the learning media, such as educational, functional, creative, psychological comfort, and cost-effectiveness. By involving teachers as evaluation partners, the media development process can be assessed objectively and relevant to class needs.

The research instruments consisted of several forms, according to the type of data to be collected. Test instruments were used to measure the children's understanding of geometric shapes through visual and verbal questions before and after media use. Additionally, questionnaires and observation sheets were used to determine children's and teachers' responses to media use in terms of learning engagement, motivation, active object manipulation, and media's educational value (Widiasari, 2022). Additional instruments, such as photographic documentation and product descriptions, were used to assess the physical quality and procedures for using the teaching aids so that the research results could be replicated by other educators.

The research procedure was conducted in three main stages: design, trial, and evaluation. In the design stage, researchers created a prototype teaching aid using a flannel as the main material, which was safe and easy for children to manipulate. The next stage was a limited trial for two weeks of learning, during which children engaged in various activities, such as arranging flat shapes, matching shapes based on the number of sides, and creating symmetrical patterns. At this stage, observations were made of the children's learning activities and responses to the use of to manipulative media (Hakim & Rachmawati, 2020). The final stage was evaluated through the implementation of pre- and post-tests as well as questionnaires by teachers to assess the overall effectiveness of the media.

Data analysis was performed by combining quantitative and qualitative analyses. Quantitative data were analyzed using a statistical t-test or Wilcoxon signed rank test if the data were nonparametric with a significance level of 0.05, to see the difference in children's abilities before and after treatment (Creswell & Creswell, 2018). Qualitative data were analyzed descriptively through the categorization of themes based on teacher and student responses related to aspects of media appeal, learning benefits, and comfort of use. This combined analysis aimed to provide a comprehensive picture of the effectiveness of teaching aids as a learning medium and authentic assessment in geometry learning in early childhood education.

IV. RESEARCH RESULT

The teaching aid developed in this research is a Geometry Smart Book designed using a brightly colored flannel. This material was selected based on safety and comfort considerations for children, as the flannel is soft, not sharp, lightweight, and easy to hold. The media size is designed proportionally to be easy to use by young children's hands, as well as practical for opening, storing, and moving. Inside the book, various flat shapes such as triangles, squares, circles, and rectangles can be removed and reattached to facilitate manipulative activities. This media supports various forms of

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learning activities, including arranging flat shapes based on shape, matching patterns based on the number of sides, solving simple puzzles, and playing symmetry games to strengthen children's spatial abilities.

In the implementation of learning, teaching aids are used by children to conduct several explorations and learning tasks. Children were invited to arrange shapes in the provided patterns, group plane shapes based on the characteristics of their sides and angles, and match shapes with pictures of real objects around them. This activity not only stimulates the understanding of geometric concepts, but also involves fine motor skills, concentration, and active involvement of children during the learning process. Responses emerging from observations indicate that children appear to enjoy learning activities due to the interactive nature of the media, allowing them to touch, pick up, move, and manipulate shapes directly.

From the quantitative measurement results, the scores obtained for the ability to recognize flat shapes through the pre-test and post-test showed a significant increase after the use of the media. The average pre-test score of the children was 60, while the average post-test score increased to 80, resulting in an increase of 33%. The results showed a significance value of $p < 0.05$, indicating that the increase was statistically significant. These findings confirm that the Geometry Smart Book is effective in improving early childhood understanding of the concept of flat shapes through manipulative-based learning and direct experience.

In addition to quantitative data, this study yielded qualitative findings based on observations and responses from students and teachers. Children responded positively, demonstrating high levels of enthusiasm throughout the activity. Many children expressed their enjoyment of being able to touch, arrange, and play with geometric shapes directly, making their learning feel like a game. Teachers also stated that this media could increase children's focus, interest in learning, and active engagement during the learning process. Furthermore, teachers assessed that this teaching aid was easy to use, safe, and cost-effective, making it highly feasible to incorporate into everyday learning.

However, the teacher also provided several notes as constructive feedback to improve the media. Some parts of the shapes were deemed slightly too small, making them easily lost or difficult for children with larger hands to reach. Furthermore, the use of flannel material makes some components easily deformed or damaged with frequent use. Based on this feedback, the researcher recommended improvements such as adding a stronger adhesive, using thicker flannels, and increasing the size of several elements to make them more ergonomic for young children. These findings serve as the basis for further development to make media stronger, safer, and more durable for intensive classroom use.

V. DISCUSSION

The results show that the use of geometric teaching aids significantly improves children's understanding of plane figures. This improvement occurs because the media used transforms learning from abstract to concrete, allowing initially difficult-to-imagine geometric concepts to be understood through direct experiences. Children can touch, manipulate, arrange, and compare geometric shapes, thus allowing the process of constructing knowledge to occur more naturally. Learning is no longer simply receiving verbal explanations but rather develops into an active learning experience that facilitates a deeper understanding.

These findings align with visual and kinesthetic learning theory, which emphasizes the importance of sensory involvement in the learning process. Early childhood is in the pre-operational stage and requires concrete stimuli to build clear mental representations of the concepts being learned. The educational teaching aids used in this study support this theory because they provide opportunities for children to learn through direct interactions, experimentation, and play activities. Furthermore, the media adheres to the basic principles of educational teaching aids: simplicity, ease of use, ease of understanding, and design tailored to the developmental characteristics of early childhood.

When viewed from various media aspects, the teaching aids used have been proven to comprehensively meet learning needs. From an educational perspective, these media help children to

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understand the characteristics of flat shapes in a concrete way through exploratory activities. From a physical perspective, the use of a flannel makes the teaching aid safe, non-sharp, and attractive in terms of color and texture. Functionally, these media provide opportunities for children to actively participate in various activities such as arranging shapes, matching patterns, and comparing the number of sides. From a psychological perspective, these media triggers increased motivation and enthusiasm for learning because children feel happy and directly involved. In addition, these media also encourage creativity and innovation because children can construct new shapes according to their imagination, even from simple pieces of flannel. From an economic perspective, these teaching aids are relatively easy to make, do not require large costs, and can be used repeatedly for a long time.

When compared with previous research, the results of this study are consistent with findings that suggest that manipulative media can improve early childhood understanding of geometric concepts. Previous studies have reported that learning based on the manipulation of concrete objects helps children recognize shapes, characteristics, and spatial relationships better than conventional learning, which relies on lectures and worksheets. Therefore, this study reinforces the view that the use of teaching aids contributed significantly to the quality of basic mathematics learning in early childhood education.

This study also offers several practical implications for early childhood education (PAUD) teachers and learning media developers. Teachers can use teaching aids as engaging and easily implemented alternative media in classroom instruction, making learning interactions more interactive and enjoyable. Media developers can use the findings of this research as a basis for further development; for example, through the provision of learning modules, the development of spatial-based media, or the digitalization of media to make it more varied and adaptable to technological developments.

Despite these positive results, this study had several limitations. It was conducted in only one school with a limited sample size, and the implementation period was relatively short; therefore, the results cannot be widely generalized. Furthermore, this study focused on plane figures and did not include spatial figures or advanced spatial abilities. Therefore, further research should be conducted with a larger sample size, over a longer period, and encompass more complex aspects of geometry to allow for a more in-depth and comprehensive examination of children's understanding.

VI. CONCLUSIONS AND SUGGESTIONS

Based on the results, it can be concluded that the use of geometric educational teaching aids designed with educational, physical, functional, psychological, creative, and economic aspects can significantly improve early childhood understanding of the concept of plane figures. This learning medium has been proven to provide a more concrete, interactive, and meaningful learning experience, helping children understand geometric shapes through direct exploration and manipulation. In addition, this teaching aid not only improves children's cognitive abilities but also influences motivation, interest, and engagement during the learning process. With its simple, practical, and easy-to-apply form, this medium can be an effective alternative to geometry learning in early childhood education.

In line with these findings, several suggestions can be considered for the development and implementation of further learning media. First, early childhood education (PAUD) teachers are advised to routinely integrate these teaching aids into the mathematics learning process to enhance children's learning experiences, thereby enhancing their learning experience. Second, media developers can improve and expand the design of these teaching aids by, for example, adding material to geometric shapes or developing digital versions to meet the needs of modern learning. Third, schools or PAUD administrators are expected to provide budgets and support for material procurement, teacher training, and ongoing media development. Finally, future researchers could employ more robust experimental designs, such as involving a control group and extending the duration of media use, to enhance comprehensive and generalizable research results.

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