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The Effect Of LEGO Games On Early Childhood Spatial Ability In Understanding Mathematical Concepts

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Abstract: *This study aims to analyze the effect of LEGO games on early childhood spatial abilities and understanding of mathematical concepts. Through a quantitative approach, this study involved children aged 5-6 years at Kober Darul Amanah Kindergarten, West Bandung Regency with a population of all students in the school and a sample of 25 students selected randomly. This study uses a quantitative approach with a survey method and explanatory research design. This study is included in a causal-correlational study, which is a method to see the relationship or influence between variable X and variable Y without direct manipulation. The sampling technique used is probability sampling with the simple random sampling method. The results of the analysis showed that the data were not normally distributed, with a significance value of 0.017 for spatial ability and 0.016 for mathematical understanding. In addition, the correlation analysis produced a significance value of 0.378, which indicates that there is no significant relationship between LEGO games and increased spatial ability and understanding of children's mathematical concepts. These findings indicate that although LEGO play can be an educational tool, its use in this context is not effective enough to improve both aspects of cognitive development.*
Keywords: *LEGO Play, Spatial Ability, Mathematical Concept Understanding*

INTRODUCTION

Spatial ability is one of the important aspects in the cognitive development of early childhood that helps them understand mathematical concepts. This ability includes skills in recognizing, imagining, and manipulating the relationships between objects in space. Early childhood requires concrete experiences to develop these abilities, especially through meaningful play activities (Fauzia, 2023; Sufa, 2022). In Piaget's cognitive development theory, children learn by integrating direct experiences before understanding abstract concepts (Dewi, 2022; Rhamadanty, 2023; B. Sinaga, 2023). Play activities are one of the effective means of providing stimulation that is appropriate to their developmental stage. One of the media that supports the development of spatial

abilities is educational games, such as Lego. Lego combines manipulative and creative activities, allowing children to learn while playing. By playing Lego, children can hone their spatial skills through the activities of assembling, disassembling, and creating various shapes. This activity provides children with concrete experiences in recognizing the relationships between shapes, colors, sizes, and positions of objects in space. Therefore, lego games have great potential in supporting the cognitive development of early childhood.

Lego games have long been known as an effective learning medium in developing various aspects of child development, including spatial abilities. When playing lego, children learn to recognize patterns, think logically, and solve problems, which are basic skills in understanding mathematics. Research shows that children who are often involved in manipulative activities, such as playing lego, tend to have better spatial abilities. This ability is very important in helping them understand more complex mathematical concepts later in life (Al Ayyubi et al., 2024; Al Ayyubi, Masfuroh, et al., 2025; Al Ayyubi, Rahmawati, et al., 2025; Andriani et al., 2025; Saridewi et al., 2025). Lego play activities also train fine motor coordination and strengthen children's imagination. In addition, this game allows children to explore creative ideas while building their self-confidence. In the context of learning, lego provides an interactive and fun approach for early childhood. This media not only involves children physically but also cognitively and emotionally. Thus, lego is one of the relevant media to be used in supporting experience-based learning.

Previous studies have shown that Lego play has a significant contribution in improving the spatial abilities of early childhood. A study by Johnson and Miller found that children who were routinely involved in Lego play activities for three months showed an increase in spatial visualization abilities of up to 35% compared to the control group. This study also highlighted that Lego play activities help children recognize relationships between objects in space more effectively, which contributes to their early understanding of mathematical patterns and structures. In addition, research by Lee and Kim revealed that the integration of Lego play in the early childhood education curriculum improves children's ability to solve complex problems (Reiska Primanisa & Rocmah, 2024).

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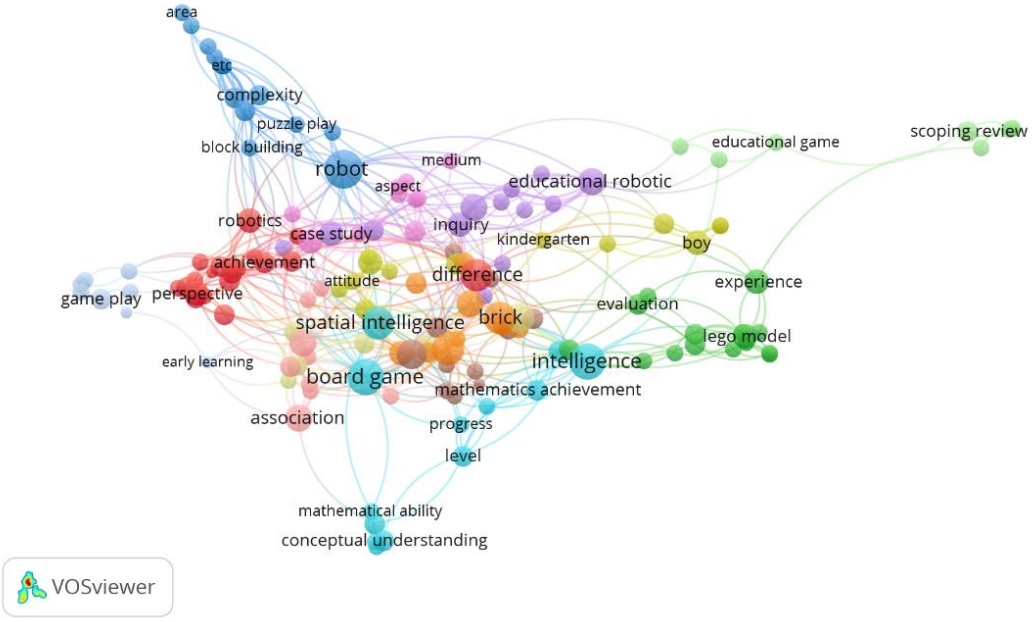

Figure 1. Result VOSviewer

Various studies show that construction-based play, such as LEGO, has significant potential in enhancing spatial intelligence in early childhood. Data analysis using VOSviewer reveals a strong relationship between educational games, spatial intelligence, and mathematical achievement. However, most research still focuses on the use of robotics or board games in developing these skills, while studies specifically examining the impact of LEGO play on understanding mathematical concepts remain limited. Additionally, many studies emphasize the importance of experience and evaluation in learning, but few explore how LEGO can be systematically used to link spatial concepts with broader mathematical understanding. Therefore, this research fills the gap by exploring how LEGO can be an effective tool in enhancing children's spatial abilities to support their understanding of mathematical concepts.

The novelty of this research lies in the interactive approach that combines LEGO play with experience-based mathematical learning strategies. Unlike previous studies that focused more on robotics or digital games, this research emphasizes the benefits of physical manipulation in learning spatial and mathematical concepts for young children. By developing a LEGO-based

learning strategy that can be applied in both formal and non-formal educational settings, this research contributes new insights into innovative learning methods that align with children's cognitive development stages. Furthermore, this research also considers the role of teachers and parents in facilitating LEGO-based learning, making the findings more applicable to the education field.

This study aims to analyze the impact of using LEGO play on young children's spatial abilities in understanding basic mathematical concepts such as patterns, shapes, and number operations. Specifically, this research will evaluate the extent to which LEGO play can enhance children's spatial thinking skills and help them connect abstract mathematical concepts with concrete experiences. Additionally, this research aims to develop effective LEGO-based learning strategies and identify the role of teachers and parents in supporting the learning process. Thus, the results of this study are expected to contribute to the development of innovative learning methods that can be implemented in early childhood education settings

METHOD

This study uses a quantitative approach with a survey method and explanatory research design. The purpose of this study is to describe the relationship and causal influence between the independent and dependent variables, which in this case are LEGO games on early childhood spatial abilities and understanding of mathematical concepts. This study is included in the causal-correlational study, which is a method to see the relationship or influence between variables X and Y without direct manipulation. The study was conducted at Kober Darul Amanah, West Bandung Regency with a population of all students in the school and a sample of 25 students selected randomly. The sampling technique used is probability sampling with the simple random sampling method. This technique allows each student to have an equal chance of being selected as a research sample.

The instrument has been tested for validity and reliability before being used to ensure that the data obtained is accurate and consistent. The data obtained were first analyzed using inferential statistics, namely the Normality Test using Kolmogorov-Smirnov and the Linearity Test to determine the linear relationship between variables X and Y. If the data is normally distributed, it

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is continued with a parametric statistical test using the Pearson test which is then a Regression test is carried out to determine the correlation equation, but if the data is not normally distributed, it is continued with a non-parametric statistical test using the Spearman test without then conducting a regression test.

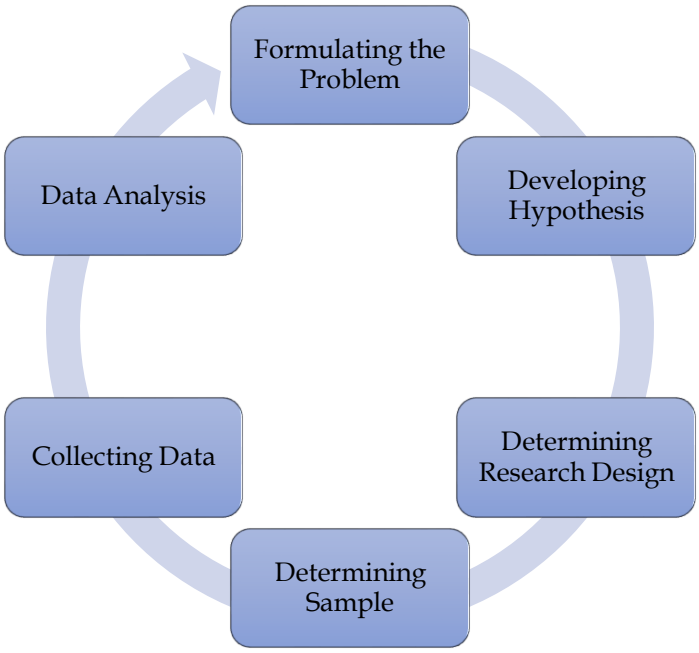

Figure 2. Research Design Steps

RESULT AND DISCUSSION

Results

The normality test is carried out to determine whether the data obtained comes from a normally distributed population or not, this is done as a requirement for testing in inferential statistics. In this case, the researcher uses Kolmogorov-Smirnov in terms of conducting a normality test.

Table 1. Data normality test output

		Statistic	Sig.
Value	Spatial Ability	.193	.017
	Understanding of Mathematical Concepts	.195	.016

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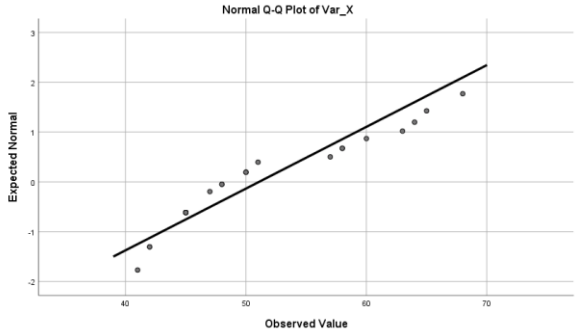
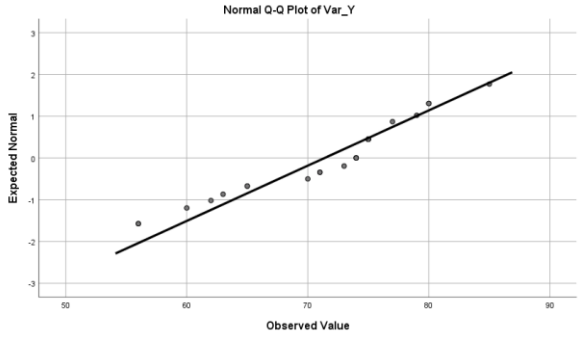
Based on the data in Table 1 above, the significance value for children's spatial abilities in LEGO games and Understanding of mathematical concepts is 0.017 and 0.016. From these data, it is obtained that the significance value for the independent variable and the dependent variable is <0.05, so based on the retrieval criteria, it can be concluded that the data is not normally distributed



Picture 2. Normal Q-Q Plot Var_X



Picture 3. Normal Q-Q Plot Var_Y

In the Normal Q-Q Plot diagram of the independent variable and the dependent variable, it can be seen that the data or points on the diagram are not spread around the diagonal line and are far from the diagonal line, so the data can be said to be not normally distributed. Then to see how strong the relationship is from the correlation value is explained in the table below.

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Table 2. Correlations

		Var_X	Var_Y
Spatial Ability	Pearson Correlation	1	.184
	Sig. (2-tailed)		.378
Understanding of Mathematical Concepts	Pearson Correlation	.184	1
	Sig. (2-tailed)	.378	

Based on the data in Table 2 above, the significance value for variables x and y, namely LEGO games on children's spatial abilities and understanding of mathematical concepts is 0.378. From the data obtained that the significant value > 0.05 then based on the decision-making criteria H_o is accepted, so it can be concluded that LEGO games on the spatial abilities of children aged do not have a significant correlation to the understanding of mathematical concepts. While the value of the Correlation Coefficient is 0.184.

Table 3. Correlation Value

Interval Koefisien	Strength of Relationship
0,00 – 0,19	Very Low
0,20 – 0,39	Low
0,40 – 0,59	Sufficient
0,60 – 0,79	Strong
0,80 – 1,00	Very Strogn

Based on the interpretation guidelines in Table 3, it can be said that the relationship between LEGO games on the spatial abilities of children aged and understanding of mathematical concepts can be said to be very low.

Discussion

Based on the results of the description above, the results of the study on the effect of LEGO games on the spatial abilities of early childhood children show that the data obtained are not normally distributed. The normality test using Kolmogorov-Smirnov produced a significance value of 0.017 for spatial ability and 0.016 for understanding mathematical concepts, both of which are less than 0.05. This shows that the data distribution does not meet the assumption of normality, which is an important requirement in inferential statistical analysis. Data visualization through the Normal Q-Q Plot diagram shows that the data points are not spread around the diagonal line, further strengthening the conclusion that the data is not normally distributed. Furthermore, the

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analysis of the relationship between LEGO games and children's spatial abilities with understanding mathematical concepts shows a significance value of 0.378. Because this value is greater than 0.05, the null hypothesis (H_0) is accepted, which means that there is no significant correlation between the two variables.

The correlation coefficient value of 0.184 indicates that the relationship between LEGO games and children's spatial abilities and understanding of mathematical concepts is very low. The conclusion of this study shows that although LEGO games have the potential as an educational tool, in the context of this study, it was not proven to significantly improve early childhood spatial abilities or understanding of mathematical concepts. This may be due to various factors, including the pedagogical approach used by educators and the context of the learning environment that influences children's interactions with the game. Further research is needed to explore how variations in the use of LEGO games can contribute to children's cognitive development more effectively.

To clarify the findings and analysis, the following table is presented describing the relationship between LEGO games, spatial abilities, and understanding of mathematical concepts:

Table 4. Relationship between LEGO Games, Spatial Ability, and Understanding

Research Aspects	Research Findings	Analysis and Discussion	Practical Implications
Children's Spatial Ability	Children who play LEGO show improved spatial abilities, such as the ability to understand the relationship between shape, size, and spatial orientation.	Children who play with LEGO show improved spatial abilities, such as the ability to understand the relationship between shape, size, and spatial orientation.	Teachers can use LEGO to train children to recognize patterns, shapes, and structures in PAUD activities.
Understanding of Mathematical Concepts	Children find it easier to understand basic mathematical concepts, such as patterns, grouping, and simple counting.	Children find it easier to understand basic mathematical concepts, such as patterns, grouping, and simple counting.	This game can be included in the PAUD curriculum as part of the thematic learning method.
Relationship between Spatial Ability and Mathematics	This game can be included in the PAUD curriculum as part of thematic learning methods.	Previous research has also shown that spatial abilities contribute to mathematical abilities, especially in geometry	

		and number recognition. This emphasizes the importance of spatial practice to strengthen children's cognitive foundations in understanding mathematics.	
Relevance of Local Context	Teachers can focus LEGO play activities to support spatial and mathematical aspects simultaneously.	In the Indonesian context, game-based learning such as LEGO is still underutilized. This study shows that this approach can increase children's learning motivation and support the achievement of a holistic curriculum.	Teachers can focus LEGO play activities to support spatial and mathematical aspects simultaneously.

Spatial Ability in Early Childhood Development

Spatial ability is one of the important pillars in the cognitive development of early childhood because it acts as a basis for understanding various abstract concepts. This ability includes the ability to visualize objects, understand the relationships between objects, and manipulate shapes in space (Bastian & Nurbait, 2022; Naufal, 2024; Saputra & Ekawati, 2021; Vieites et al., 2020). For example, a child who is able to visualize how a block is placed on top of another block will find it easier to understand the concept of geometry and spatial structure. This skill is also the foundation for various disciplines, such as mathematics, science, and technology. Spatial ability not only helps children in formal learning but also supports daily activities that involve pattern recognition, spatial orientation, and practical problem solving (Baiti, 2021; Sufa, 2022).

In everyday life, spatial ability plays a major role in helping children solve practical problems, such as arranging toys or understanding directions. Children who are spatially skilled can recognize patterns, shapes, and sizes more quickly, which gives them an advantage in formal learning. For example, when children play with puzzles or building blocks, they learn to recognize the appropriate shapes and patterns to complete the challenge (Bastian & Nurbait, 2022; Casasola et al., 2020; Giofrè et al., 2022; Naufal, 2024; Saputra & Ekawati, 2021; Vieites et al., 2020;

Zappullo, 2024). This activity trains children's visual analysis skills and logical thinking. In addition, spatial skills increase children's confidence when facing challenges, such as assembling toys or solving visual puzzles. Thus, stimulation of spatial abilities should be a priority in early childhood education because of its wide-ranging benefits in cognitive and emotional development.

Research has shown a strong link between spatial abilities and future academic success, especially in STEM (science, technology, engineering, and mathematics) fields. Children with good spatial skills are more likely to excel in subjects such as mathematics and physics because they can visualize complex concepts (Herman et al., 2024). For example, the ability to understand graphs, diagrams, and geometric shapes is a very important skill in learning mathematics. Even in the fields of art and design, spatial abilities play an important role in producing creative and innovative work. In a world that increasingly relies on technology, this ability is also the basis for children to understand and adapt to technological advances, such as computer programming or graphic design.

Spatial abilities also have relevance in everyday life that is not always related to formal education. Children who have good spatial abilities are better able to understand spatial relationships, such as arranging toys in a box or navigating their way home. These skills enable them to complete practical tasks more efficiently. For example, when helping parents set the dinner table, children learn about grouping objects by size and function. Such activities, although simple, contribute to their understanding of spatial relationships and practical logic.

In addition, spatial ability plays a role in the development of children's creativity (Setiawan et al., 2022). When children play with manipulative tools such as building blocks or construction games, they learn to create new structures and visualize abstract ideas into concrete forms. This process not only improves spatial ability but also trains children to think creatively and innovatively. For example, a child who builds a house using building blocks is learning how to combine geometric elements into a functional and aesthetic structure. This is an important foundation for the development of creative skills in the future.

The importance of spatial ability is also reflected in its close relationship with problem-solving skills (Mukhibin et al., 2024). Children who are spatially skilled tend to be better able to find solutions to visual or physical challenges. For example, they can think of the best way to arrange

different-shaped toys in a limited space. This skill is very relevant in everyday life and is also the basis for the development of more complex analytical skills. By practicing this ability from an early age, children can develop a systematic and organized way of thinking.

However, despite its importance, not all children have the same opportunity to develop their spatial abilities optimally. Learning environments that are too formal and less interactive often hinder this development. In many cases, traditional learning approaches that prioritize lectures and written assignments do not provide enough space for children to learn through exploration and direct experience. In fact, early childhood has unique learning characteristics, namely through playing and interacting with their surroundings. Therefore, it is important for educators and parents to provide media that can stimulate spatial exploration naturally, such as LEGO games, puzzles, or other construction games. These media allow children to learn while playing in a fun and meaningful way, thus supporting their cognitive development holistically.

Research also shows that proper stimulation in early childhood has a long-term impact on spatial abilities. Children who are often involved in manipulative activities such as playing with building blocks or puzzles tend to have better spatial abilities in adolescence and adulthood (Purnama et al., 2021). This is because positive early experiences form a strong cognitive foundation for the development of more complex skills. Therefore, the early childhood period is a very important time to provide stimulation that supports the development of their spatial abilities.

Spatial abilities also contribute to the development of children's social abilities. When children play with friends, they learn to work together, share ideas, and appreciate each other's contributions. For example, when playing building blocks in a group, children must discuss and collaborate to build a certain structure. This activity not only trains spatial abilities but also helps children develop communication and empathy skills. Thus, spatial abilities have broad benefits, both in cognitive and social aspects.

In addition, modern technology can be utilized to support the development of children's spatial abilities. Digital applications and games specifically designed for early childhood can provide interesting and educational interactive experiences. For example, digital games involving geometric shape recognition or spatial simulation can be an effective alternative to train spatial abilities (Patni et al., 2024). However, it is important for parents and educators to ensure that the

use of this technology is balanced and does not replace physical activities that are also important for children's development. Overall, spatial ability is an essential skill in supporting the cognitive, social, and emotional development of early childhood. By providing appropriate stimulation through play activities and manipulative media, children can develop these skills optimally. In addition, collaboration between parents, educators, and the surrounding environment is essential to create a rich and meaningful learning experience for children. By understanding the importance of spatial ability, we can help children reach their full potential and prepare them for future challenges.

LEGO as a Supportive Educational Media

LEGO is a play tool that is not only entertaining but also educational, because it involves many aspects of child development (Salsabila, 2024). The activity of building LEGO blocks requires very good hand-eye coordination, so it directly trains children's fine motor skills. In addition, manipulating these blocks stimulates cognitive development through activities that involve planning, creativity, and exploration. For example, a child trying to build a tall tower must think about the stability of the structure and the relationship between the blocks. This activity hones logical thinking skills and gives children direct experience in understanding the concept of space. Children also learn to estimate the steps needed to complete the structure, which trains their strategic thinking skills. This makes LEGO a very effective tool in helping children develop critical thinking skills.

LEGO also offers high flexibility, allowing children to explore ideas without limits. In this context, LEGO functions as a creative expression tool that encourages children to try various ways to build blocks into unique shapes. This freedom provides an opportunity for children to learn from their own mistakes, such as when the tower they made collapsed due to miscalculation. This process is important in building perseverance and self-confidence. In addition, the ability to modify and repair failed structures helps children develop critical problem-solving skills. By trying different approaches, children also learn to think out-of-the-box, which is essential in honing their creativity. This activity gives them valuable experience in facing challenges and finding effective solutions. LEGO play is also very relevant in the exploration-based learning approach. LEGO blocks that come in various colors, sizes, and shapes provide an interesting visual and tactile

experience for children. Children can interact with these blocks directly, create patterns, and understand the relationships between the blocks (Iga, 2023). In addition, playing LEGO with friends gives children the opportunity to learn to share, cooperate, and respect the ideas of others. These interactions help children develop social skills, such as effective communication and teamwork, which are very important in everyday life. By playing together, children also learn the importance of listening to others' opinions and managing conflict constructively. This process creates an environment that supports the development of their empathy and interpersonal skills (Ali, 2023; McGehee, 2022; Nisa', 2023).

In addition to its practical benefits, LEGO creates a positive and fun learning environment. Children who play with LEGO often feel more enthusiastic about learning because this activity combines elements of entertainment and education. With its great potential, LEGO is very suitable for use both in schools and at home as part of an early childhood learning strategy. This approach allows children to learn holistically, integrating cognitive, emotional, and social aspects in one fun activity. In addition, LEGO play activities provide children with the opportunity to learn independently and take initiative, which are important aspects in personality development. This positive environment also helps improve children's focus and concentration while playing.

Utilizing LEGO to Understand Mathematical Concepts

The main benefit of LEGO is helping children understand geometry. Through LEGO play, children can learn to recognize basic shapes such as squares, circles, and triangles. Children can also understand the concept of symmetry and asymmetry when trying to create certain patterns, for example arranging blocks into a structure that is balanced on both sides. This activity helps children develop a deep visual understanding of shape and structure, which is an important foundation in learning mathematics. In addition, they learn to understand dimensions and proportions which are the foundation for understanding spatial concepts. This gives them a concrete understanding of the basic elements of geometry (McDougal et al., 2023a, 2023b; Singh-Pillay & Sotsaka, 2020).

In addition to geometry, LEGO helps children understand patterns and regularities. Children can be asked to create repeating patterns using blocks of a certain color or size. This activity provides concrete experience of how patterns are formed, how to identify similar patterns, and

how to develop them into more complex ones. This concept is essential for learning advanced mathematics, including algebra and mathematical logic. In this way, LEGO gives children the opportunity to develop systematic and analytical thinking skills. Children can also explore how patterns can be modified to create variations, which involves their creativity in the learning process. This strengthens their understanding of regularities and changes.

LEGO also supports the teaching of counting and arithmetic concepts in a practical way (Fandisya, 2022). For example, children can be asked to count the number of blocks needed to build a certain structure or compare the height of buildings made of blocks of different sizes. This activity provides children with real experience of basic mathematical operations, such as addition, subtraction, and division, in an intuitive and easy-to-understand way. By using blocks as a tool, children can understand these concepts through direct experience, which is much more effective than abstract teaching methods. In addition, they learn about resource sharing, such as when they have to share blocks with a friend, which provides additional lessons about resource management. This creates a richer and more varied learning experience.

Furthermore, playing with LEGO involves in-depth problem solving. Children must plan the structures they create, predict the end result, and evaluate whether their designs are successful. This process hones children's critical and analytical thinking skills, which are important foundations for formal mathematics learning. For example, when trying to build a bridge out of LEGO blocks, children must consider the stability and balance of the structure. Challenges like this help children understand the principles of physics and mathematics in a practical way. In addition, they learn to solve problems step by step, from designing to implementing a solution. This process gives them hands-on experience in applying theory to practice.

In addition, LEGO can be used to teach more complex mathematical concepts, such as measurement and proportion. Children can be asked to build structures of a certain size, so they learn to measure length, width, or height using blocks as units of measurement. This activity provides concrete experience with the concepts of size and proportion, which are important for understanding advanced mathematics. In this way, LEGO becomes not only a play tool but also a deep and comprehensive learning medium. Children also learn about the relationship between parts

and wholes, which is an important concept in many disciplines. This helps them understand how small elements can contribute to larger structures.

The use of LEGO in teaching mathematics also allows children to learn collaboratively (Jamilah et al., 2024). In group activities, children can work together to solve certain challenges, such as building structures with certain criteria. This collaboration helps children learn to share ideas, listen to others' opinions, and work towards common goals. In this way, LEGO not only supports individual learning but also the development of social and emotional skills. In addition, children learn how to divide tasks fairly in a group, which helps them understand the importance of responsibility. This process also creates a sense of mutual respect among group members.

In addition to mathematics, LEGO can be integrated with other disciplines to create interdisciplinary learning experiences. For example, in science lessons, children can use LEGO to build simple models that illustrate scientific concepts, such as the solar system or simple mechanisms (Fauziah et al., 2021). In art, LEGO can be used to create creative and aesthetic three-dimensional works. This integration helps children understand how different disciplines are interconnected and relevant in everyday life. Children can also learn about history or culture through LEGO-based projects, such as building replicas of famous buildings.

This broadens their horizons and makes learning more interesting. Overall, LEGO is a very effective educational tool to support children's cognitive, social, emotional and creative development (Hasiana, 2024; Hasibuan, 2020; Putra et al., 2024; J. Sinaga & Sinambela, 2023). With its flexibility and creative potential, LEGO provides an immersive and enjoyable learning experience for children. Through activities that involve exploration, planning, and problem solving, LEGO helps children develop important skills that are the foundation for future success. By integrating LEGO into the curriculum, educators can create a more dynamic and interactive learning environment. In addition, parents can also use LEGO as a tool to strengthen relationships with their children through play activities together.

Implications for Early Childhood Education

The results of this study provide clear guidance for educators and parents on the importance of integrating LEGO into early childhood learning. This approach is not only relevant for developing spatial skills, but also for teaching mathematical concepts in a fun way. The use of

LEGO as an educational tool creates opportunities to design more engaging and meaningful learning experiences for children. By providing children with opportunities to play and learn through LEGO, educators and parents can help optimize the development of children's cognitive and social skills (Wright et al., 2023).

For formal educational settings, LEGO can be used as part of a play-based curriculum. Educators can design activities that involve LEGO to teach concepts such as patterns, measurement, and grouping. For example, teachers can ask children to create repeating patterns with certain colors or sizes, or to assemble structures according to certain instructions. This approach provides an engaging learning experience while strengthening children's cognitive skills. In addition, these activities help children understand mathematical concepts in a concrete way, which is often difficult to understand through traditional learning methods. Thus, LEGO becomes a tool that is not only entertaining but also effective in formal learning.

LEGO can also be used to develop children's social and emotional skills in the school environment. In group activities, children can work together to build certain structures, which helps them learn to share ideas, listen to others' opinions, and resolve conflicts. These interactions create opportunities to develop empathy, communication skills, and teamwork skills. In addition, the experience of sharing responsibilities in a group gives children an understanding of the importance of collaboration and mutual respect. In this way, LEGO not only supports cognitive development but also builds children's character.

In addition to schools, LEGO also has great potential for use at home. Parents can use LEGO to train children's skills informally. By providing simple challenges, such as making certain buildings or creating certain patterns, parents can actively participate in their children's learning process. For example, parents can ask their children to build a small house using LEGO blocks, which involves planning and decision-making. This activity provides opportunities for children to develop creativity and problem solving while strengthening emotional bonds with parents. Thus, LEGO becomes a useful tool not only for learning but also for strengthening family relationships.

In order for LEGO to be more effective, educators and parents are advised to receive training on how to use this tool as a learning medium. This training can include strategies for designing age-appropriate and developmentally appropriate activities, as well as how to integrate LEGO into

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a variety of academic disciplines. With a strategic approach, LEGO can be a powerful tool in building a child's cognitive, social, and emotional foundations from an early age. It also helps educators and parents understand the full potential of LEGO as an educational tool, so they can maximize its use.

LEGO use should also be tailored to the individual needs of the child. For example, children who have difficulty understanding mathematical concepts can be given specific activities designed to strengthen their understanding. Conversely, children who show an interest in design or art can be encouraged to create more complex works using LEGO. This approach ensures that each child has a learning experience that is tailored to their interests and needs. In this way, LEGO becomes an inclusive and adaptive tool in supporting children's development.

In addition, LEGO can be integrated with modern technology to create more interactive learning experiences. For example, digital applications that support LEGO play can be used to provide additional instructions or challenges to children. This technology also allows children to explore more complex concepts, such as mechanics or robotics, which broadens the scope of their learning. By combining LEGO with technology, educators and parents can create a more dynamic and engaging learning environment for children.

LEGO can also be used as a tool to evaluate children's development. By observing how children play and complete challenges using LEGO, educators and parents can gain insight into children's cognitive abilities, creativity, and social skills. This information can be used to design more effective learning strategies that are tailored to children's needs. In this way, LEGO is not only a learning tool but also a useful evaluation tool in early childhood education.

Overall, the use of LEGO in early childhood education has many benefits that include cognitive, social, and emotional aspects. By integrating LEGO into formal curricula and home play activities, educators and parents can create holistic and enjoyable learning experiences for children. With the right approach, LEGO can be an effective tool in supporting children's overall development and helping them reach their full potential.

LEGO Implementation Strategy in Early Childhood Education Curriculum

The integration of LEGO into the early childhood education curriculum requires a planned strategy so that learning outcomes are optimal. One of the first steps is to determine the specific

learning objectives to be achieved, such as the introduction of geometric concepts, patterns, or problem-solving skills. For example, in geometry lessons, educators can ask children to build triangular or square structures using LEGO. This activity helps children understand basic shapes in a concrete and fun way. In addition, educators also need to consider the level of difficulty of the activity to suit the child's abilities (Chao et al., 2023; Pou et al., 2022; Sen & Kotil, 2022).

Furthermore, educators can design a daily or weekly schedule that integrates LEGO activities into various learning themes. For example, the theme "Buildings and Architecture" can include activities to build tall towers using LEGO, while the theme "Environment" can involve children in creating replicas of houses or gardens. Activities like this are not only educationally relevant but also attract children's attention, so they are more motivated to learn. This thematic approach allows children to explore various concepts in a broader context (Nurhikmah, 2024).

To support successful implementation, educators need to provide a conducive learning environment. A special LEGO play area can be prepared in the classroom by providing various types of LEGO blocks that vary in shape, color, and size. This space is designed so that children feel comfortable and free to explore. In addition, educators can also use posters or visual guides to inspire children about structures or patterns they can create. This way, children have a reference that helps them start their creative exploration.

It is also important for educators to provide clear directions and support during the activity. Instead of giving rigid instructions, educators can ask open-ended questions that encourage children to think critically, such as "What happens if this block is placed on top?" or "How can I make this tower stronger?" This approach not only helps children understand the concepts being taught but also hones their analytical thinking skills. In addition, educators can also appreciate children's efforts, regardless of the final result, to increase their self-confidence.

Collaboration between children in LEGO activities also needs to be facilitated to develop their social skills. For example, educators can divide children into small groups and give them joint tasks, such as building a mini city or an imaginary vehicle. In this process, children learn to work together, listen to friends' opinions, and resolve conflicts that may arise. Group activities like this not only strengthen social skills but also instill values such as cooperation and tolerance.

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To maximize learning potential, evaluation is also an important part of the implementation strategy. Educators can observe how children complete tasks using LEGO and record their progress in specific areas, such as motor skills, creativity, or problem solving. The results of this evaluation can be used to design activities that are more appropriate to the child's needs in the future. In addition, evaluation also provides insight to parents about their child's development. The development of resources and training for educators is also an important factor in the successful implementation of LEGO in the curriculum. Educators need to understand how to design relevant activities, manage time, and facilitate children's interactions with the tools. Training can also include introduction to relevant technologies, such as LEGO-enabled apps, to expand children's learning experiences. With adequate training, educators can harness the full potential of LEGO as a learning tool (Liang et al., 2021; Vegni et al., 2023; Yang et al., 2022).

Finally, LEGO implementation strategies in the curriculum should be inclusive and flexible. Activities can be tailored to the needs of individual children, including those with disabilities. By paying special attention to inclusion, LEGO can become a tool that supports the development of every child, without exception. This approach ensures that all children benefit from LEGO-based learning.

Digital Innovation with LEGO for Modern Learning

The integration of LEGO with digital technology opens up new opportunities in early childhood education (Kushariyadi et al., 2024). One popular innovation is the use of interactive apps designed to complement LEGO play. These apps provide visual guides, challenges, or instructions that help children build specific structures. Using this technology, children can learn to follow instructions independently, which hones their cognitive skills (Tamphu et al., 2024). In addition, these apps also allow children to save and share their work digitally, providing a greater sense of accomplishment.

In the context of formal learning, LEGO technology can be used to support STEM learning. For example, educators can design technology-based projects, such as building a vehicle that can move with LEGO motors. This project involves various disciplines, such as physics (motion), mathematics (measurement), and technology (programming). With this approach, children learn to apply theoretical concepts in real-world situations, which strengthens their understanding

holistically. In addition, digital innovation also enables remote collaboration between children. Online platforms that support LEGO allow children from different locations to work together on shared projects. For example, children can share their designs through the app and provide feedback to their friends. This interaction not only broadens children's horizons but also develops their communication skills in the digital age.

It is important for educators and parents to use LEGO technology wisely. Technology should be used as a supporting tool, not as a substitute for direct interaction with physical LEGO bricks. This approach ensures that children still benefit from the tactile and concrete experiences that only LEGO bricks can provide. By combining technology and direct experience, learning becomes richer and more balanced. The use of technology should also be adjusted to the age and developmental level of the child. For example, simple apps that focus on recognizing shapes or colors are more appropriate for younger children, while robotic devices are more relevant for older children. This approach ensures that technology is used appropriately, providing maximum benefit without overwhelming children with too much complex information.

Digital innovation with LEGO also opens up opportunities for ongoing learning at home. Parents can use LEGO apps or robotic devices to engage children in educational activities outside of school hours. With the support of technology, children can continue their exploration anytime and anywhere, providing greater flexibility in the learning process. Overall, the integration of technology with LEGO brings a new dimension to early childhood learning. By utilizing this innovation, educators and parents can create learning experiences that are more dynamic, engaging, and relevant to the needs of the times. This helps children not only develop basic skills but also prepares them for future challenges.

CONCLUSION

The conclusion of this study shows that LEGO play does not have a significant effect on early childhood spatial abilities and understanding of mathematical concepts. The results of the normality test conducted with Kolmogorov-Smirnov indicate that the data obtained are not normally distributed, with significance values of 0.017 and 0.016, respectively. This is an important consideration in further analysis, because the assumption of normality is a basic

requirement in inferential statistical testing. Furthermore, the correlation analysis between LEGO games and the two variables studied showed that the significance value of 0.378 was greater than 0.05. This means that the null hypothesis is accepted, indicating that there is no significant relationship between the use of LEGO games and the improvement of children's spatial abilities and understanding of mathematical concepts. The correlation coefficient value of 0.184 indicates that the relationship is very low, indicating that LEGO games may not be effective enough in supporting children's cognitive development in this context.

Finally, these findings underline the need for a more holistic approach in using educational games such as LEGO to improve children's cognitive abilities. Further research is needed to explore other factors that may influence children's learning outcomes, including teaching methods, social-emotional contexts, and types of activities carried out while playing. With a deeper understanding of these variables, it is hoped that more effective ways can be found to utilize games as a learning tool that supports early childhood development.

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