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Smart Tree Media Innovation for Developing Early Childhood Cognitive Skills

Muji Masiah[1], Fauzi[2]
[1,2]UIN Saifuddin Zuhri Purwokerto, Indonesia

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ABSTRACT

The Early years of childhood represent a critical phase for cognitive development, requiring appropriate stimulation through meaningful and engaging learning experiences. The use of concrete and play-oriented learning media is considered essential in helping children grasp abstract numerical concepts. This study seeks to explore the implementation of smart tree learning media and examine it is contribution to enhancing cognitive abilities in early childhood. A qualitative descriptive case study approach was used in this research. The study took place at Masyithoh Adiraja Kindergarten and involved 22 children aged 5-6 years. Data were gathered through classroom observations, semi-structured interviews, and documentation, and were analyzed using an interactive qualitative analysis framework. The results reveal that the active participation of smart tree media facilities supports the development of foundational cognitive skills, including number sequencing, quantity recognition, one-to-one correspondence, and basic arithmetic operations. Its interactive and tangible characteristics enable children to engage in exploratory, meaningful learning. These findings suggest that integrating play-based and manipulative media can serve as an effective pedagogical strategy in early childhood education settings.

Corresponding Author:

Muji Masiah, Fauzi
State Islamic University Prof. K.H. Saifuddin Zuhri Purwokerto
Email: muji123masiah@gmail.com

1. INTRODUCTION

Cognitive development in early childhood is a key foundation in shaping future thinking, understanding, and problem-solving skills. At an early age, especially between 0 and 6 years, brain development is very rapid, making this period the golden age. Cognitive is a person's ability to understand knowledge and apply it. Cognitive can also be interpreted as encompassing reasoning, creativity, abilities, and memory. A combination of children's maturity and environmental influences. However, children's characteristics differ, so their development is different [1]. Cognitive ability is the ability to think more complexly, including reasoning and problem-solving skills. This ability makes it very easy for children

to master broader general knowledge, so that they can continue to function reasonably in interaction with society and the environment.

The development of cognitive skills is a top priority for shaping early childhood thinking capacity and ensuring optimal readiness for the next stage of learning. During this period, early childhood development is crucial because it is the foundation for a child's ability to think, understand, remember, and solve the problems they face [2]. At this stage, children begin to develop symbolic thinking, memory, attention, and the ability to understand the relationship between the past and its aftermath. Cognitive abilities that develop optimally will contribute to academic preparation and learning success in further education. On the other hand, insufficient stimulation at this stage will hinder the child's intellectual development. A study shows that early educational interventions have a long-term impact on cognitive and non-cognitive abilities [3]. Cognitive development is closely related to problem-solving skills, creativity, and decision-making from an early age [4]. Seeing this, the right learning strategy is needed to optimize early childhood cognitive development.

Cognitive development can be achieved through activities such as counting, grouping, recognizing shapes, and distinguishing objects [5]. However, several aspects affect children's development, and children's cognitive abilities also undergo stage-by-stage development [6]. According to Piaget, there are four cognitive stages with their own characteristics: sensorimotor (ages 0-2 years), preoperational (ages 2-7 years), concrete operational (ages 7-12 years), and formal operational (ages 12-18 years). The focus of this study is on the development of children aged 4 to 6 years, specifically at the preoperative stag*e*. Piaget states that children aged 2 to 7 years are in the pre-operational stage, where the stage of symbolic thinking begins to appear, in which children begin to use words, pictures, and pretend games (symbols) to represent objects or events in the real world. However, their way of thinking still tends to be egocentric (difficult to see from the point of view of others), unsystematic, and dominated by intuition rather than logic, and then develops into a concrete operational stage, where they are only able to understand new concepts through the manipulation of real objects and direct experience. At this stage, children also begin to present the world using words, pictures, or shadows. They begin to form a stable concept and reason [7].

According to Piaget, effective learning must facilitate assimilation and accommodation. Therefore, the learning approach must be experiential and game-based, allowing the child to interact directly with the object environment. Through games allow children can develop the competencies and skills they need in a fun way [8]. Piaget said that from the age of toddlers, a person has a certain ability to deal with objects around them. This ability is still very simple, namely in the form of a motor sensor capability. Play-based learning is considered most suitable for the characteristics of early childhood because it provides a rich, engaging learning experience. Through play activities, children can explore the environment, actively build knowledge, and develop critical and creative thinking skills. This approach aligns with constructivist theory, which emphasizes that learning occurs through direct interaction with the environment. Research shows that play-based learning can significantly improve children's attention, memory, and problem-solving skills [9]. The

use of concrete learning media is an important factor in helping children understand abstract concepts such as numbers and simple operations. Concrete media allow children to manipulate objects directly, thereby strengthening conceptual understanding. Other research confirms that game-based learning increases children's active engagement and learning motivation [10]. The integration of learning to play and concrete media is an effective strategy in developing early childhood cognitive abilities.

Various studies have examined the use of visual and manipulative media to improve early childhood cognitive abilities, including games and concrete props. Number Tree Media is one of the innovations designed to help children understand numeracy through attractive, interactive visual representations. Research shows that game-based and manipulative media are effective in improving the ability to recognize numbers, count, and understand the concept of quantity. Research by Hibana shows that game-based learning can improve memory, attention, and problem-solving skills in early childhood [11]. In addition, Sitorus's research confirms that play-based learning contributes to overall improvements in cognitive abilities [12]. Another study found that game-based media can increase children's creativity and logical thinking skills [13]. However, most research still focuses on basic aspects such as simple numeracy and has not examined cognitive development in more complex ways. Therefore, it is necessary to innovate media that can integrate various aspects of cognitive development more comprehensively.

In understanding their world, children actively use schemes, assimilation, accommodation, organization, and balance [14]. At this stage, early childhood also begins to move from the abstract to the concrete. Although various studies have shown that play-based media can improve early childhood cognitive development, there are still some gaps that need further study. Most previous research has focused on improving basic numeracy skills. Research examining the development of complex cognitive skills, such as logical reasoning and problem-solving, remains very limited. The integration of concrete manipulative media with the approach to play within a single systematic learning design has not been widely found. Recent research emphasizes the importance of an integrated approach to early childhood learning to promote optimal cognitive development [15].

The researcher is interested in conducting a study titled "Smart Tree Media Initiation in Developing More Complex Early Childhood Cognitive Skills" at Masyithoh Adiraja Kindergarten. This research aims to develop and analyze the use of "Smart Tree" media as a learning innovation to improve early childhood cognitive skills. This media is designed to integrate play activities with concrete, interactive tools. This research is expected to make a theoretical and practical contribution to the development of innovative learning strategies in early childhood education. Media innovations visualized in the form of trees, named "Smart Trees" or similar, have strong potential as a key tool for optimizing the development of early childhood cognitive skills. With this learning media innovation, it can invite children to engage in fun activities.

2. METHODS

This study uses a descriptive, qualitative case study approach to gain an in-depth understanding of the implementation of smart tree media innovations in the development of

early childhood cognitive skills [16], [17]. The research was conducted in group B (Khadijah) at Masyitoh Adiraja Kindergarten, Adipala District, Cilacap Regency, with participants aged 5-6 years [18] [19]. Children in the age of 5-6 years have different developmental characteristics in the pre-operational stage, where they begin to be able to think symbolically, recognize simple concepts, and show improved cognitive abilities through play and exploration activities [20], [21]In addition to children, classroom teachers are also involved as supporting informants to obtain data related to the implementation of learning media in daily life [22].

Data collection was carried out using 3 techniques, namely participatory observation, in-depth interviews, and documentation [23]. Participatory observation is carried out by having the researcher directly involve themselves in learning activities to observe children's interactions with smart tree media, recording cognitive behaviors such as the ability to group, remember, and solve simple problems [24]. In-depth interviews were conducted in a semi-structured manner with children and teachers, using simple language appropriate to children aged 5-6 years. Interviews include learning experiences, understanding of learning media, and responses to activities carried out [20]. Documentation is carried out through the collection of photos of learning activities, field notes, and children's work during the use of smart tree media, thereby strengthening observation and interview data [23].

Data analysis was carried out using the Miles and Huberman analysis model, which included data reduction, data presentation, and conclusion drawing [24]. Process Coding is carried out by identifying data from observations, interviews, and documentation into units of meaning, then coding them according to the theme [25]. Data categorization is carried out by grouping codes into major themes such as cognitive development, child interaction, and the effectiveness of smart tree learning media, thereby forming a pattern of research findings [20]. Data triangulation is carried out through source triangulation, methodological triangulation, and temporal triangulation to ensure the validity of the data and the consistency of the research findings [23].

3. RESULTS AND DISCUSSION

Based on research data that has been found in the field through observations, interviews, and documentation at Masyithoh Adiraja Kindergarten, Adipala District, Cilacap Regency, it can be conveyed regarding Smart Tree Media Innovation in Early Childhood Cognitive Skill Development at Masyithoh Adiraja Kindergarten, Adipala District, Cilacap Regency as follows:

3.1. Smart Tree Innovation Form

a. Smart Tree as a Manipulative Media Tool for Konket. (1) Interactive Board: This smart tree media is made in the form of a board with pictures of trees with attractive colors and shapes, which can be placed on a table or on the wall, so that children can be directly interactive during learning activities. (2) Concrete Material Integration: This medium uses natural objects or natural materials used directly for calculation. This media can introduce the concept of abstract numbers with children's concrete physical experiences. This is especially important in the pre-operative stage. (3) Removable components:

number cards, counting operation symbols, and classification objects are made removable (manipulative), for children's fine motor activity and exploration. The study found that children could perform counting activities more systematically through direct interaction with Smart Tree media. Children not only count verbally, but also make one-on-one correspondence between objects and number symbols. This can be seen in the child's ability to correctly count objects and relate them to the appropriate numerical symbols. These findings show that concrete manipulative media can strengthen understanding of number concepts through hands-on experience. In line with Nugroho's research, which states that the use of concrete media can improve children's early numeracy skills through exploratory and interactive activities [17].

b. Logical Thinking and Classification. (1) The development of numbers and quantities: connecting the symbol of numbers with the quantity of real objects. (2) Classification and Sorting: The smart tree can encourage children to group objects by color, shape, or texture, which can train visual classification and differentiation skills. (3) Simple causality: the smart tree includes simple elements to develop problem-solving or causal skills, such as children entering the number of fruits that correspond to the number and the result of simple summation, and it can also train basic logical reasoning. Using Smart Tree media, children show improvement in recognizing, naming, and sorting the numbers 1-10. Tree-shaped visual media with movable number components help children understand number symbols more concretely. This ability develops because the child not only sees the number symbol, but also associates it with the number of real objects. Research in the Journal of Early Childhood Education confirms that integrating visual and manipulative elements into learning media is effective in improving recognition of numerical symbols in early childhood [20].

c. Stimulation of Various Senses. (1) Tactile stimulation: the use of objects that have diverse textures that can increase children's sensory discrimination. (2) Active learning: these smart trees can encourage children to interact physically. Children can move, paste, and count with existing tools and materials. This can make the learning process more child-centered and play-based.

3.2. Steps to Implement Learning Through Smart Tree Media Innovation

a. Introduction to Smart Tree Media Teachers creatively introduce smart tree media through interactive visual and auditory approaches, using fruit media, leaves, number cards, clips, buttons, and other concrete tools. A teacher must have the skills and ability to create engaging and varied learning experiences so that children do not feel bored. For this reason, learning activities are integrated with fun play, so that children can be enthusiastic and focused when learning and playing with *smart tree* media. In this case, teachers also use smart tree strategies, made with interesting tools and materials, so that children are more interested in using them. Teachers also use a variety of fruits so that children can get to know them through hands-on, more fun, concrete experiences. Concrete media is everything used in learning activities to stimulate children's thoughts,

feelings, and attention and interest, so that there is a learning process between children and their teachers. Thus, the learning process becomes more lively, contextual, and meaningful for them. Here is an introductory image of smart tree media, presented as visual symbols.

Figure 1. Introduction *to Smart Tree* Media

This image shows children engaged in learning and play using smart tree media, in accordance with the agreed-upon rules of the game set by the teacher and the child. Such as children taking turns in an orderly manner, giving opportunities to their friends, tidying up the props used, and teachers gradually accompanying children in activities according to their development. This strategy also strengthens children's interactive activities, enabling them to collaborate effectively. With concrete media, children can think symbolically. This smart tree media innovation can develop cognitive skills, as it helps children recognize number sequences, number concepts, one-to-one correspondence, and the concept of summation in a simple way. Thus, learning activities using smart tree media can develop cognitive skills, as children can solve problems.

b. Integration of smart tree media innovation with play activities. The observation results show that teachers integrate media with concrete objects in fun early childhood play activities through scaffolding. Teachers strive to guide children towards a higher level of responsible behavior and social interaction based on the social skills they possess. Children are given guidance gradually, based on their developmental level. Children are invited to touch existing media and concrete objects, count fruits, relate the number of fruits to numbers, recognize textures, and group fruits by color, shape, size, and texture. Based on the interview results, the teacher stated that this smart tree media innovation can introduce children to the sequence of numbers and number concepts in a fun way, as playing will help them understand more easily. Furthermore, playing is an activity that can stimulate children's creativity and thinking, without making them feel forced to do so. This shows that the learning process is not only receptive but also active and meaningful, because children are directly involved in the activities. The documentation

also shows various forms of activities carried out in learning. One of the documents shows the activities of children who are cooperative, enthusiastic, and enjoy playing with the smart tree media. In addition, it can also be seen that children petrify each other when they find it difficult.

Figure 2. Children are interactive, collaborative, and helpful

The documentation shows the child's active involvement in understanding the concept of numbers and number symbols. Children can also solve problems independently.

c. Reflection and Interactive Q&A: After the learning activity is completed, the teacher provides an opportunity for reflection through open-ended questions and answers appropriate to the child's developmental stage. Reflection is carried out in a simple, relaxed, and dialogical atmosphere, where the teacher gives lighter questions, such as, how many oranges do you count?, mentioning the order of numbers 1-10. Afterward, children were given the opportunity to share their play experiences, what made them happiest after playing with the smart tree media, the difficulties they faced, and how they overcame those challenges. Like the teacher just now, I really like to play. I can know how many oranges and how many salak there are. I can also relate the number of fruits to the appropriate amount, and people tell me, "A friend helps me," so I can know how many guavas there are. This simple expression can reflect an early metacognitive ability, which is a child's awareness of his or her own thought processes. Children begin to be able to solve problems and recognize mistakes, both practically and collaboratively. In the context of early childhood learning, this kind of activity is very important because it gradually trains reflective skills, decision-making, and evaluation.
These findings suggest that children begin to solve simple problems, such as determining how many objects correspond to a given number or performing simple addition. This process involves logical thinking, analysis, and decision-making activities. Media *Smart Tree* provides concrete, real-world situations so that children can solve problems through object manipulation. This aligns with research on *Golden Age Journal: A Scientific Journal of Early Childhood Growth and Development*, which states that game-based learning can improve problem-solving skills through hands-on experience and active exploration [11].

3.3. The impact of the use of smart tree media innovations on developing cognitive abilities

a. Development of Counting and Number Concepts: Smart Tree Media Innovations are Effective Media. Smart Tree Media Innovations are effective media for the development of counting and number concepts. This visual-manipulative media serves to bridge the abstract understanding of numbers into the realm of concrete experience, in line with children's learning characteristics. Through the use of smart tree media, children gradually learn to recognize, pronounce, and sort number symbols in a fun way through games. In addition, children can match the number of objects to existing numbers, stimulating the ability to calculate and the concept of number value. This smart tree media can also practice simple calculation operations such as addition and subtraction. The game media are made in real form so that children can experience colors, shapes, sizes, rough and smooth, heavy and light, and so on. So that children can play by exploring their surroundings to achieve the same thing at the stage of cognitive growth and development. Through interactive, collaborative games, so that children can develop their cognitive abilities. The teacher stated in the interview: "They can sort the number symbols and sort the number of fruits or media available. Is this teacher correct in the order of numbers 1-10? In this case, the child begins to recognize the concept of numbers.

Figure 3. Getting to Know the Concept of Numbers

b. Better Reasoning and Problem Solving Through the use of smart tree media, abstract concepts can be transformed into concrete, structured challenges, thereby improving reasoning and problem-solving. When children are faced with the task of matching the number of fruits to the corresponding number, they will naturally think logically. This process requires a reasoning step, from analyzing visual information to formulating solutions through physical manipulation. For this reason, through interaction with the media, smart trees can serve as problem-solving and decision-making exercises that ultimately lead to answers, thereby developing cognitive skills. The teacher stated in the observation, "They can take a number card that corresponds to the number of fruits. This fruit has 7 numbers, which one is it? This shows that the child has begun to solve problems independently, as children's problem-solving skills develop through continuous interactions between physical and psychological domains that need to be

stimulated through various activities in the learning environment around children (Lestariningrum & Wijaya, 2020).

Figure 4. Improving Ranking and Solving Problems

Smart Tree media effectively improves cognitive development because it integrates concrete learning, play, and active interaction in a single activity. This medium allows children to build knowledge through direct experience, in accordance with the constructivist theory, which emphasizes that knowledge is built through interaction with the environment. Concrete media helps children in the preoperational stage to understand abstract concepts through real experience. The interactive nature of media increases children's motivation and involvement in learning. Children become more active, enthusiastic, and focused, making the process of internalizing concepts more effective. The results of this study align with previous studies that emphasize concrete media in early numeracy learning. Research by Nugroho shows that interactive media can significantly improve numeracy skills and number recognition.

4. CONCLUSION

Based on the study's results, it can be concluded that the use of Smart Tree media makes a significant contribution to the development of early childhood cognitive skills, particularly numeracy, number recognition, problem-solving, and collaboration. This media has been proven to help children connect abstract concepts of numbers with concrete experiences through manipulative and interactive activities, making the learning process more meaningful and easier to understand. Children's active involvement in Smart Tree-based play activities also encourages a gradual increase in learning motivation, social interaction, and logical thinking skills. This research provides important implications for early childhood education teachers, namely the need to integrate concrete and manipulative learning media in teaching and learning activities. Teachers are advised to design play-based learning that leverages innovative media, such as Smart Tree, to create an interactive, fun, and student-centered learning environment. The use of this media can be an effective strategy for developing children's early numeracy and social skills through collaborative classroom activities. Subsequent research is suggested to test the effectiveness of Smart Tree

media using a broader research design, such as a quantitative approach or an experiment with a larger sample size to achieve stronger generalizability of results.

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