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Balancing Challenges and Opportunities: Enhancing Early Childhood Cognitive Skills Through Digital Tools

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Abstract
This study investigates the role of digital tools, particularly educational videos, in enhancing early childhood cognitive skills at Pertiwi Indralaya Kindergarten. Using a qualitative descriptive approach based on the Miles and Huberman framework, data were collected through classroom observations, interviews, and documentation involving 20 children aged 4–5. Findings reveal that 55% of students exhibited "Very Well Developed" cognitive skills, while 45% were "Developing as Expected," with no children in lower categories. Key cognitive areas improved included problem-solving, memory retention, and logical reasoning, supported by a balanced integration of digital and traditional learning methods. Challenges such as maintaining focus and avoiding screen dependency underscore the need for structured guidance. The study concludes that combining digital and conventional strategies can foster cognitive development, highlighting the importance of teacher facilitation and responsible technology use in early childhood education.

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INTRODUCTION

Early childhood cognitive development faces unique challenges and opportunities in the digital era, mainly in how children process and interact with digital information. As one of the key areas of human psychology, the cognitive domain includes mental behaviors related to understanding, consideration, information processing, problem-solving, intentionality, and belief. While cognitive ability can be interpreted as the general ability to understand something (Loka et al., 2022), its development in early childhood has taken on new dimensions with the prevalence of digital technology.

The crucial development phase in a person's life starts early, with children actively developing various aspects of themselves, including cognitive skills fundamental to learning and thinking (Limardi et al., 2019). Cognitive ability is a process of thinking, namely the ability of an individual to connect, assess, and consider an event or incident (Humaida & Suyadi, 2021). Cognitive is a process that occurs internally in the central nervous system when humans think. This cognitive ability develops gradually, in line with physical development and the nerves in the central nervous system (Basyir et al., 2022). Thus, it can be concluded that cognitive is the ability to think that involves knowledge that focuses on reasoning and problem-solving, connecting, assessing, and considering an event or incident that is rational or involves reason (Anggita et al., 2022).

The digital era is characterized by the presence of technology that can increase the speed and magnitude of knowledge circulation in the economy and society (Lesmana et al., 2023). In the Indonesian educational context, particularly in early childhood education, this digital transformation has created opportunities and challenges that must be carefully examined.

Recent studies show that Indonesian children face specific challenges in the digital era, particularly in maintaining concentration when using technology (Yulizar et al., 2022). While children show increasing engagement with digital devices such as tablets and smartphones, a significant research gap exists in understanding how these tools can be effectively integrated into early childhood education without compromising cognitive development. Furthermore, studies indicate that excessive exposure to digital information affects children's focus and learning concentration (Jiang, 2023), but there is limited research on developing effective intervention strategies specific to the Indonesian context.

On the other hand, the digital era also brings opportunities to improve the cognitive skills of early childhood. Bobbi De Porter and Mike Hernacki in Muthmainnah stated that 10% of information is absorbed from reading activities, 20% from listening activities, 30% from viewing activities, 50% from viewing and listening activities, 70% from pronunciations that are said, and 90% from pronunciations and actions that are taken (Herawati, 2019). From these findings, it can be concluded that learning in early childhood will take place effectively if assisted by audio-visuals, where children will absorb information by seeing and hearing (Herawati, 2019). The use of audio-visual media is one example of the use of technology in early childhood education.

Various educational applications and online games can effectively build children's thinking skills, solve problems, and stimulate their imagination (Mulyadi et al., 2022). With the right approach, technology can help enrich

children's learning experiences (Pramono et al., 2021). In addition, the digital era also allows children to access various information and knowledge more quickly and easily (Winata et al., 2021). With the help of technology, children can learn about various topics that interest them and develop their cognitive skills through innovative and engaging learning methods (Sahaya et al., 2023). In this context, it is important for parents, educators, and early childhood education practitioners to understand the challenges and opportunities to provide appropriate assistance for developing children's cognitive skills (Lindriany et al., 2023).

This study aims to identify and analyze the challenges and opportunities in enhancing cognitive skills for early childhood in the digital era. It focuses on how digital educational tools, particularly educational videos and projector-based learning, can support cognitive development in Indonesian kindergarten settings. This focus is particularly relevant as young children today are digital natives who must develop cognitive skills while navigating traditional and digital learning environments (Loka & Diana, 2022).

While previous studies have explored the role of digital media in general education, limited research exists on its specific impact on early childhood cognitive development in Indonesia. This study addresses this gap by examining how digital learning tools, particularly educational videos, can effectively integrate into early childhood education. It investigates how digital tools influence cognitive engagement and development in Indonesian kindergarten settings. By exploring challenges such as screen dependency and opportunities for enhanced learning experiences, this research provides actionable insights for optimizing early childhood education in the digital era.

METHOD

This study employs a qualitative descriptive case study design to investigate the implementation of digital learning tools in early childhood cognitive development. The research was conducted over a three-month period from August to October 2024 at Pertiwi Indralaya Kindergarten, located at Lintas Timur Street KM. 36, Indralaya Mulya Village, Indralaya District, Ogan Ilir Regency, South Sumatra Province, Indonesia. The study participants included 20 students aged 4-5 years in Class A, selected through purposive sampling based on their regular attendance and participation in digital learning activities.

Data collection involved multiple techniques, including direct observation, in-depth interviews, and documentation. Systematic classroom observations were conducted twice a week during the three months, with each session lasting 2 hours during core learning activities. Observations were documented using detailed field notes, observation checklists, and video recordings with parental consent. In-depth interviews were conducted with the school principal (60-minute duration) and two classroom teachers (45 minutes each), focusing on school policies, implementation strategies, and experiences with digital learning. Additional documentation included lesson plans, learning outcomes, assessment records, and photographic evidence of learning activities.

Data analysis followed the Miles and Huberman approach, implementing three concurrent flows of activity: data reduction, data display,

and conclusion drawing/verification. The data reduction phase involved selecting and organizing field notes and interview transcripts, while data display focused on creating organized information through thematic matrices. The conclusion-drawing phase identified patterns and explanations from the analyzed data. To ensure trustworthiness, the study employed triangulation of data sources and member checking with interviewed teachers.

RESULT

After conducting research, the researcher found several findings in the learning process that will be described in several parts, including the introduction, the core, and the closing.

1) The Preliminary Activities

The daily teaching and learning activities at Pertiwi Indralaya Kindergarten start at 08.00 Western Indonesia time. Before the study hours begin, the teachers greet the children first, and the children shake hands with their teachers. Next, the teacher guides the children to line up in front of their respective classes. In this marching activity, the teacher invites the children to sing together, count, recognize colors in English, and recognize the names of the months based on their order of 12 months. After that, the children shake hands with the teacher and enter the class one by one in an orderly manner.

After the children sit neatly in class, the activity continues with preliminary activities. The preliminary activity begins with the teacher guiding the children to read the study prayer and say greetings together. After that, the teacher takes attendance of students present on that day.

2) The Core Activities

The core activity is filled with the teacher providing material to the children. The material on that day is about introducing counting to children. In this case, the teacher does not provide material monotonously but uses a picture of an apple to teach the concept of counting. For example, on the right, the teacher draws two apples, then on the left, the teacher draws four apples, and then together, they count and add up all the apples on the board. In addition to counting, children also learn to write numbers, draw apples, and color apples to increase their creativity.

Based on the results of interviews with class teachers, it is known that teachers can do various things to improve children's cognitive abilities in the digital era, such as using interactive educational games and applications, implementing project-based learning techniques to stimulate creativity, integrating technology in learning to attract children's interest, and providing access to digital resources that support their cognitive development. In addition, the role of teachers in improving children's cognitive abilities in the digital era is also significant. They can use technology creatively as an interactive and enjoyable learning tool.

The process of improving children's cognitive skills using digital technology assistance at Pertiwi Indralaya Kindergarten is with the help of a projector. In teaching and learning activities every two weeks, children watched videos related to cognitive issues, such as videos of praying together, singing, telling stories, and dancing. Efforts to use this technology make it easier for children to remember because the child's brain senses knowledge through educational videos.

Digital media is also used in Pertiwi Indralaya Kindergarten. Gadgets are used to develop children's cognitive development. Activities carried out include playing digital educational games on gadgets. When introducing digital media to children, most children are enthusiastic and eager to learn.

The interviews report that teachers can design activities that hone cognitive abilities such as problem-solving, developing creativity, and improving thinking skills. They can also choose appropriate educational applications and software to expand children's knowledge and strengthen skills in various areas such as mathematics, language, and science. In addition, teachers can provide direct direction and guidance to children in using technology so that they can use it wisely and productively. Thus, kindergarten teachers act as facilitators and companions in the learning process that utilizes the positive potential of digital technology to improve children's cognitive abilities.

The principal added that the digital era provides excellent educational opportunities and can be used to develop children's cognitive abilities. Innovative educational technology, such as interactive learning applications and game-based learning, can improve children's cognitive skills so that learning activities can occur in a pleasant atmosphere.

After the core activities are finished, the children take a break. During this break, the children have lunch together. Nevertheless, before that, they were guided outside to wash their hands in turns. After washing their hands, they read the prayer together and eat lunch. Furthermore, the activity is continued by playing in the classroom or outside the classroom.

3) The Closing

After playing, the next activity is the closing. Children were asked about their feelings during the learning activities that day in this activity. The teacher also briefly reviewed the material presented previously and conveyed the learning plan carried out the next day. After everything is finished, the children are asked to tidy up their belongings to get ready to go home. The teacher guided the children in reading the prayer so they could go home together. Afterward, the children came forward one by one in an orderly manner to shake hands with the teacher and go home. After ensuring that all children had gone home, the teacher assessed the children's work that day appropriately and responsibly.

In addition to the results of observation, the researcher then describes the results of interviews with school principals regarding the challenges in improving the cognitive skills of early childhood in the digital era as follows:

> “One of the challenges in improving children's cognitive abilities in the digital era like today is the increase in children's exposure to technology, which can interfere with their focus and attention. In addition, exposure to this technology also poses a risk of addiction to social media and online games, which can interfere with the development of children's cognitive abilities. It is also important to teach children about using technology healthily and responsibly and to facilitate quality free time outside the screen to holistically develop children's social, emotional, and cognitive skills.”

In line with the principal, a teacher said the positive effects of using technology in the classroom are problematic. One is the difficulty of getting children to focus longer during teaching and learning activities. The ease with which children are distracted by things outside the context of the conversation makes teachers have to be innovative and utilize digital tools wisely and under control.

Teachers conduct assessments with observation measurement instruments to determine children's cognitive development after digital media-based learning practices are implemented. The results are shown in the table as follows:

Table 1. Children's Cognitive Skills of Pertiwi Indralaya Kindergarten

Name	The Cognitive Skills Categories			
	BB	MB	BSH	BSB
Aisyah Ayudia Inara			√	
Aleesa Angel Lesta				√
Arsy Addara			√	
Athallah Oktariyanti				√
Devita Sofiah Nasari				√
Dian Al Mahri			√	
Dikky Wahyudi				√
Fiona Inara Azkadina			√	
Khayra Alesha				√
M. Fahmi Al Muqoddas				√
M. Fahri Al Falah				√
M. Khairan Rafassya				√
M. Marcel Dwi Pradipta			√	
M Ghoza Mahendra				√
M. Ghozi Mahendra			√	
M. Risky Al Habib			√	
Kheyran Zatara				√
Neila Sadina Hamida			√	
Nashwatul Leilani			√	
Putri Aziha Azrina				√

Source:
Observation result at TK Pertiwi Indralaya.

Information:
BB: Not Yet Developed
MB: Starting to Develop
BSH: Developing As Expected
BSB: Developing Very Well

The assessment of children's cognitive skills at Pertiwi Indralaya Kindergarten is conducted systematically by observing several key developmental aspects. These aspects include number concept recognition (counting and numerical operations), pattern recognition and sorting abilities, problem-solving capabilities, memory retention, and logical thinking skills. The assessment also considers children's ability to understand cause-and-effect relationships and spatial awareness and classify objects based on size,

shape, and color. Teachers evaluate these cognitive aspects through traditional activities and digital learning experiences, using a standardized assessment framework that aligns with national early childhood education standards.

In assessing cognitive development, teachers observe children's performance across four main categories (BB, MB, BSH, BSB) based on their ability to:

1. Demonstrate understanding of basic mathematical concepts, including counting, number recognition, and simple addition
2. Show logical thinking through problem-solving activities and puzzle completion
3. Display memory skills through recall of songs, stories, and educational video content
4. Exhibit classification abilities by sorting objects according to various attributes
5. Show understanding of spatial concepts and relationships
6. Demonstrate ability to follow multi-step instructions
7. Express curiosity and engage in exploratory learning
8. Apply knowledge gained from digital educational content in practical activities

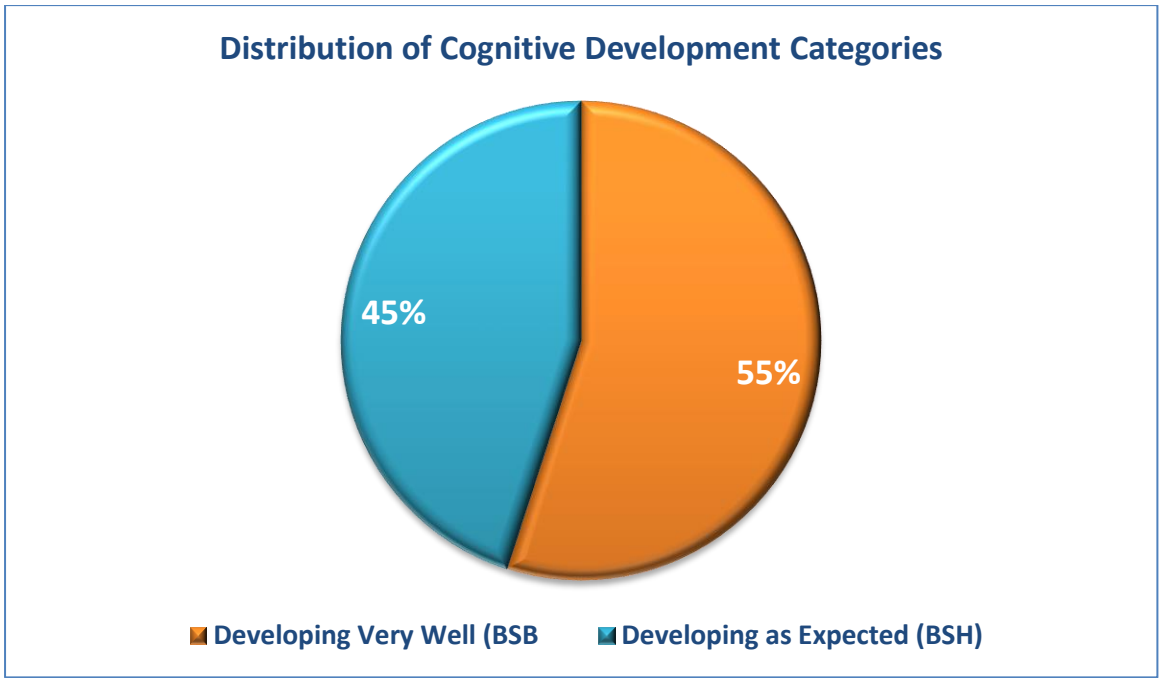

Chart 1. Distribution of Cognitive Development Categories

Based on the assessment result shows that 55% of children in this kindergarten get the cognitive development category Developing Very Well (BSB). That suggests these children have exceeded the expected developmental milestones and demonstrate advanced cognitive abilities. Then, 45% of children are classified as Developing As Expected (BSH). It indicates they are meeting the standard developmental benchmarks appropriate for their age.

The assessment results shown in the table reflect the comprehensive evaluation of children's cognitive abilities across multiple domains. Children categorized as BSB (Developing Very Well) consistently demonstrate advanced

capabilities in number recognition, problem-solving, and logical thinking tasks. They can apply knowledge gained from traditional and digital learning experiences, often exceeding expected developmental milestones for their age group. These children readily engage with educational technology while performing well in conventional learning activities.

Children in the BSH (Developing As Expected) category show steady progress in cognitive development, meeting age-appropriate benchmarks in pattern recognition, basic mathematical concepts, and memory tasks. They demonstrate good comprehension of digital learning content and can effectively transfer this knowledge to practical applications, though they may occasionally require guidance in more complex tasks.

The distribution between the BSH (45%) and BSB (55%) categories indicates the effectiveness of the kindergarten's integrated approach to cognitive development, combining traditional teaching methods with digital learning tools. This balanced approach has successfully supported children's cognitive growth while preventing over-reliance on digital media, as evidenced by the absence of children in the BB (Not Yet Developed) and MB (Starting to Develop) categories.

Overall, these results suggest that most children (100%) either meet or surpass cognitive development expectations, reflecting effective educational practices and supportive learning environments in kindergarten.

DISCUSSION

The interview with the principal and teachers highlights a balanced view of the challenges and opportunities in enhancing the cognitive skills of early childhood learners in the digital era. Each of these aspects is discussed in the following sections:

1) Challenges

The data highlights educators' challenges in fostering cognitive development in early childhood during the digital era. One critical finding is that children prefer video content over conventional reading activities. To address this, TK Pertiwi Indralaya has developed an integrated learning approach that combines digital media use with conventional activities such as reading, painting, storytelling, and playing. This strategy aligns with (Nurjanah & Mukarromah, 2021) findings, emphasizing the importance of balancing digital learning and early childhood developmental characteristics.

Another significant challenge in enhancing children's cognitive abilities in the digital era is increased exposure to technology. This constant interaction with digital devices can interfere with children's focus and attention, making it harder for them to engage deeply in learning activities (Barr & Kirkorian, 2023; Karkashadze et al., 2021).

The ever-present stimuli from screens may hinder children from engaging in tasks requiring sustained mental effort. Some studies suggest that contact with a mobile phone screen can impact children's mental abilities. An example is a study conducted by Suggate et al. in 2021. He said that screen media use during preschool, particularly active engagement with media, is linked to poorer mental imagery skills two years later (Suggate & Martzog, 2020, 2022). The other source stated that increased screen exposure is linked to reduced functional connectivity between neural networks involved in fundamental attention skills and cognitive control (Meri et al., 2023).

Furthermore, the prevalence of social media and online games introduces the risk of addiction, which can hinder the healthy development of cognitive skills. As stated by Kuss et al., internet addictions, such as gaming and social media, are linked to mental health issues and occur at high rates (Kuss et al., 2021).

Constant interaction with digital devices can disrupt children's ability to concentrate and maintain focus, a phenomenon often called "digital distraction". Those distractions may lead to reduced participation in activities that foster critical thinking and problem-solving, potentially stalling overall cognitive growth (Kostić & Ranđelović, 2022).

2) Opportunities

Despite several challenges, the digital era offers remarkable opportunities for advancing early childhood education. Integrating educational technologies, such as interactive learning applications and game-based learning platforms, creates dynamic and enjoyable learning environments (George, 2019; Hwang & Chen, 2022; Mohebi, 2021). These tools are particularly effective in engaging children while strengthening their cognitive skills.

The findings of this study reinforce the use of technology as a medium to attract children's interest and provide access to digital resources that complement traditional teaching methods, creating a more dynamic and stimulating learning environment. A study even recommends emphasizing digital technology in early childhood education, care curricula, and teacher education programs (Undheim, 2022).

Additionally, the digital era provides a platform to teach children responsible technology use, fostering a balance between screen time and offline activities (Sikarwar et al., 2023). Parents can also access various resources to learn about the digital world and guide their children in succeeding in this era of digital technology (Heitner, 2016). Educators and parents can ensure that technology effectively supplements traditional learning by promoting digital literacy and setting boundaries.

Furthermore, facilitating quality activities away from screens, such as outdoor play and creative pursuits, supports the holistic development of children's social, emotional, and cognitive abilities (Charan et al., 2024; Sugiyama et al., 2023). Even today, there are several models of interactive outdoor games that can be an alternative for teachers to continue using technology but in a safer way. For example, Exergames and Active Video Games, Intelligent Playgrounds, and Technology Supported Outdoor Games are believed to have educational benefits for children (Wijffelaars & Markopoulos, 2024).

3) Integration of digital tools to improve children's cognitive abilities

The teacher's interview reveals how integrating digital technology can effectively support children's cognitive development, particularly at Pertiwi Indralaya Kindergarten. Teachers actively incorporate digital tools such as interactive educational games, applications, and project-based learning activities to enhance children's engagement and creativity.

Teachers are facilitators and guides, creatively leveraging technology to design interactive and meaningful learning experiences. They emphasize activities that foster problem-solving, creativity, and critical thinking skills while using digital applications tailored for specific subjects like mathematics,

language, and science (Nikolopoulou, 2020). By carefully selecting appropriate educational software (Dogan et al., 2021), teachers expand children's knowledge and strengthen their foundational skills across various areas.

This research showed that the practical implementation of technology in teaching and learning involves using technology to display online videos. These videos cover engaging topics, including prayers, songs, storytelling, and dance, which appeal to children's cognitive and sensory development (Goode & Vasinda, 2021). Integrating visual and auditory stimuli helps children process information more effectively and enhances memory retention (Hirabayashi et al., 2020). The results align with the Dual Coding Theory, demonstrating how combining auditory and visual stimuli in educational videos enhances cognitive processing and retention (Mir et al., 2023).

Cognitive skills assessment involves a structured evaluation of developmental milestones through systematic observation. Key areas assessed include mathematical concepts, problem-solving, memory retention, logical thinking, spatial awareness, and classification skills. Teachers employ both traditional activities and digital learning tools to gauge children's understanding of cause-and-effect relationships, ability to follow multi-step instructions, and exploratory learning engagement.

The results indicated that the balanced use of traditional methods and digital tools has effectively supported holistic cognitive development (Lindeman et al., 2021) while ensuring that children remain engaged and adaptable learners. By balancing entertainment with educational value, educators help children use technology as a resource for learning rather than a distraction.

The practical implications of these findings indicate that the successful integration of digital technology in early childhood learning depends on balanced and structured implementation while maintaining important aspects of conventional learning that support holistic cognitive development. The data visualization above clearly shows the positive impact of this balanced approach, with all children achieving at least the expected development level. It suggests that digital learning tools can effectively support cognitive development when properly implemented without compromising traditional learning methods.

CONCLUSION

The findings of this study emphasize the transformative potential of integrating digital tools into early childhood education while maintaining a balanced approach with conventional teaching methods. By leveraging educational videos and interactive digital applications, cognitive skills such as problem-solving, memory retention, and logical thinking were effectively enhanced among students at Pertiwi Indralaya Kindergarten. Notably, the absence of children in the lower developmental categories (BB and MB) underscores the effectiveness of this integrated pedagogical strategy, with 55% of children categorized as "Developing Very Well" (BSB) and 45% as "Developing As Expected" (BSH). When applied thoughtfully, digital tools can significantly contribute to exceeding age-appropriate cognitive development benchmarks.

However, the study also highlights challenges, including managing children's focus and mitigating risks of overexposure to technology. Addressing these challenges requires structured guidance, responsible technology use, and the incorporation of screen-free, socially enriching activities. These findings reinforce the importance of teacher facilitation and parental involvement in ensuring that digital media is a complement rather than a substitute for traditional learning experiences. Future research should explore long-term impacts and scalable models to optimize digital and conventional learning approaches in diverse educational contexts. By adopting a balanced, evidence-based framework, educators can maximize the cognitive benefits of digital learning while fostering holistic child development.

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