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The impact of using AI-based applications on early childhood cognitive development

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Abstract

This research aims to explore the impact of artificial intelligence (AI)-based applications on the cognitive development of early childhood through a qualitative approach. With the increasing use of technology in children's education, it is essential to understand how AI applications affect cognitive aspects such as problem-solving, creativity, and social skills. Data were collected through in-depth interviews with 20 parents and 10 educators, as well as direct observations of children's interactions with these applications. The analysis results indicate that AI-based applications can enhance children's learning interest, accelerate their understanding of basic concepts, and encourage creative exploration. However, there are also concerns regarding dependency on technology and negative impacts on social interactions, particularly as AI allows unrestricted access to the internet, which can lead to criminal implications. Parents reported that these applications often serve as effective tools to support learning, especially when accompanied by guidance. However, parents also need to provide adequate devices, which can incur significant internet costs. This research highlights the importance of balancing technology use with conventional learning experiences and emphasizes the need for guidance for parents and educators in selecting appropriate applications.

Keywords

AI-based applications, Cognitive development, Early childhood education

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Introduction

Early childhood is children who are in the age range of 0 to 6 years, a very crucial period in their development. At this stage, children experience rapid growth in various aspects, including physical, social, emotional, and cognitive. Rapid growth and significant development at this early age will later form the basis for their abilities in the future. Early childhood cognitive development refers to children's ability to think, understand, and solve problems, which are very important to form the basis for future learning (Warmansyah, J., et al. 2023).

Two important figures in the theory of cognitive development are Jean Piaget and Lev Vygotsky. Piaget suggested that children go through four stages of cognitive development, where they interact with the environment to build knowledge (Agustyaningrum, A., & Pradanti, R. 2023). Meanwhile, Vygotsky emphasized the importance of social interaction in cognitive development, where children learn through experiences with adults and peers (Khoiruzzadi, M., & Prasetya, A. 2023).

A stimulating environment, such as interaction with parents, playing with peers, and active exploration, greatly influences children's cognitive development. Parental affection and attention also play an important role in supporting children's cognitive growth (Naldi, A. 2023). At this early age, children begin to develop critical and creative thinking skills. They learn to solve simple problems and make decisions based on their experiences. Structured and unstructured play activities can improve children's abilities.

So that early childhood education (PAUD) plays an important role in supporting children's cognitive development. Through quality PAUD programs, children get fun and educational learning experiences, which can improve their academic and social abilities.

Early childhood education (PAUD) aims to provide the right stimulation to support this development, so that children can grow into quality individuals and are ready to enter basic education. In addition, through PAUD, children get fun and educational learning experiences, which can improve their academic and social abilities in the future (Pohan, J. E. 2020).

In Indonesia, early childhood education is regulated in various policies, including Permendikbud No. 137 of 2014 concerning National PAUD Standards. This policy emphasizes the importance of quality education that is in accordance with the child's developmental stage, and provides guidance for PAUD organizers in designing an effective curriculum.

Referring to the Permendikbud above which states the importance of quality education, teachers must have creative and innovative abilities in educating in accordance with the child's developmental stage to help especially the child's cognitive development.

Along with the progress of the era, the development of information and communication technology has brought significant changes in various aspects of life, including education. One of the striking innovations is the use of artificial intelligence (AI)-based applications in the learning process. In this digital era, early childhood is increasingly exposed to technology, which changes the way they learn and interact with their surroundings. AI applications offer a variety of interactive features designed to support learning, from educational games to adaptive learning aids.

In Indonesia, especially in Ponorogo, the use of AI-based applications in early childhood education institutions, such as BA Aisyiyah, is becoming increasingly popular. AI-based applications can adjust teaching materials according to the child's speed and learning style, which has the potential to accelerate their cognitive development.

AI applications often use gamification and interesting multimedia content, which can increase children's involvement in a fun and non-boring learning process, so that this application becomes an attraction for children's interest in using learning. Although many studies have shown the benefits of technology in education, there are still concerns about its long-term impacts, especially related to children's social and emotional development.

Here are some AI applications that can help the cognitive development of early childhood: (1) interactive learning applications such as Khan Academy Kids and ABCmouse, (2) AI-based educational games such as Osmo and Toca Boca, (3) virtual assistants for learning such as Google Assistant and Amazon Alexa, (4) adaptive learning platforms such as DreamBox Learning, (5) language learning applications such as Duolingo, (6) educational animations and videos such as YouTube Kids

The use of these applications not only helps children learn, but also supports their cognitive development in a fun and engaging way. It is important for parents and educators to choose applications that suit the needs and interests of children so that the learning process becomes more effective.

The qualitative method was chosen in this study to dig deeper into the perspectives of parents, educators, and children regarding their experiences in using AI-based applications. Through in-depth interviews and observations, this study aims to understand how these applications affect the cognitive development of early childhood, as well as the challenges that may be faced in the learning process. The results of this study are expected to provide valuable insights for the development of better education policies, as well as recommendations for parents and educators in choosing and using the right applications to support children's learning.

By focusing on BA Aisyiyah Ponorogo, this study also seeks to provide a more specific picture of the local context, so that it can be a reference for other educational institutions in utilizing technology effectively. Along with the rapid development of technology, a deep understanding of the impact of using AI-based applications in early childhood education is very important to ensure that technology can be used as a tool that supports, not hinders, children's optimal development.

Previous relevant research discussing early childhood, technology, and children's cognition includes research entitled "The Effect of Technology-Based Learning on Early Childhood Cognition" which discusses its research on the impact of educational technology in general, without emphasizing the AI aspect (Aisyah, S. 2020). Research entitled "The Effectiveness of Interactive Learning Applications in Improving Children's Cognitive Skills" which discusses its research on the focus of examining how much interactive applications can improve cognitive skills, but does not specifically highlight AI (Santoso, B. 2019).

Research entitled "The Impact of Using AI-Based Educational Games on Children's Cognitive Development" which discusses its research on the focus of using AI in the

context of educational games, is relevant to the focus of AI, but with a narrower scope (Fernanda, M. 2021). Research entitled "The Role of AI in Improving Early Childhood Learning: A Review" which discusses its research on Providing a review of the role of AI in early childhood education, which can provide a broader context but is lacking in terms of empirical research (Rizal, A. 2022).

In general, based on all the studies above, they have similarities in focusing on early childhood education and the influence of technology or applications on cognitive development. However, the differences lie in the specifications of AI use, the types of applications studied, and the methodological approaches used. So, researchers are interested in further research with the title "The Impact of Using AI-Based Applications on Early Childhood Cognitive Development."

Method

This study adopted a qualitative approach conducted at BA Aisyiyah Ponorogo. The data collected consisted of two types, namely primary and secondary data, through observation, interview, and documentation methods. Primary data includes information from several main sources: (1) the principal, (2) group A teachers, and (3) group B teachers, (4) parents. Meanwhile, secondary data was obtained from various relevant literature, books, and journals. During the data collection process, documentation and participatory observation were carried out to obtain a deeper picture. In this qualitative study, data analysis was carried out through several stages, including reduction, presentation, and verification or drawing conclusions. The validity of the data was tested through several criteria, such as internal validity (credibility), external validity (transferability), reliability (dependability), and objectivity (confirmability). With this approach, the study aims to produce accurate and reliable findings (Figure 1).

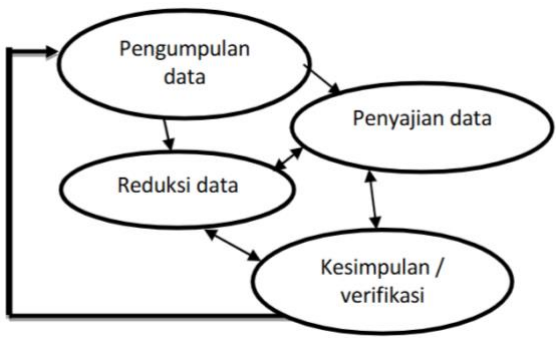

Figure 1. Miles and Huberman Interactive Model Data Analysis (Sugiyono, 2019)

Result and Discussion

Implementation of AI Applications to Develop Early Childhood Cognitive Skills

Artificial intelligence (AI)-based applications have been increasingly applied in early childhood education (PAUD), especially to support children's cognitive development. Through various applications specifically designed for children, this technology provides a fun and interactive way of learning. However, the application of this AI technology

requires special understanding and attention from teachers and parents in order to have a positive impact on children's development. In this context, observations and interviews with teachers and parents of BA Aisyiyah are important sources for understanding how AI-based applications are used and perceived by children, as well as their impact on their cognitive development. At BA Aisyiyah, the use of AI applications to develop early childhood cognitive skills has been effectively implemented by teachers at school and parents at home. The applications selected are specifically designed for children, offering an interactive and fun learning experience.

At school, teachers integrate these applications into the curriculum in creative ways. For example, during a letter recognition lesson, children are invited to play with an application that presents educational games. Group activities are also held, where children can collaborate, discuss, and share experiences after using the application. Teachers actively monitor children's progress, providing constructive feedback to support their development.

Meanwhile, at home, parents play an important role in accompanying children when using the application. They help children understand the content and set regular usage times, so that the balance between learning and other activities is maintained. After the application session, parents discuss with their children about the material learned, stimulating critical thinking and strengthening their understanding.

Observations and interviews show that collaboration between teachers and parents greatly influences the effectiveness of application use. Teachers report an increase in interest in learning among children, while parents feel that children are more enthusiastic about learning at home. With this synergy, BA Aisyiyah has succeeded in creating a learning environment that supports the overall cognitive development of early childhood. Among them:

1. Implementation of AI Applications in Early Childhood Learning

Based on the results of observations and interviews with teachers and parents, the implementation of AI-based applications in early childhood focuses on several cognitive aspects, such as:

a. Teaching Numbers and Letters: Many teachers and parents report that applications such as Khan Academy Kids and ABCmouse Endless Alphabet or Montessori 123 have helped children learn to recognize numbers and letters in an interesting way. With the help of AI, these applications can adjust the level of difficulty according to the child's ability, making the learning experience more personal and effective.

b. Language Learning: Applications such as Duolingo for Kids and Lingokids use an AI-based approach to teach children foreign languages in a fun and interactive way. AI can adjust exercises based on the child's progress, allowing children to learn vocabulary and language structures through play.

c. Educational Games: AI-based educational applications, such as Osmo or Toca Boca, are widely used to teach basic skills such as hand-eye coordination, creativity, and problem solving. Teachers and parents observed that these apps can stimulate children's creativity and introduce them to various concepts through interactive games.

d. Educational Animations and Videos: Apps like YouTube Kids help curate age-appropriate content, supporting a safe and fun learning process.

2. Teachers' Experiences in Using AI Apps in the Classroom

The teachers interviewed revealed that the use of AI-based apps in the learning process of preschool children provides a positive experience in terms of child engagement. Here are some insights gained from observations and interviews with teachers:

a. More Personalized Learning: According to teachers, AI-based apps allow them to provide a more personalized learning experience. AI can adjust the material according to the child's level of understanding, which makes the child feel valued and not burdened. For example, if a child is still struggling to recognize numbers, the app can provide more practice in that area before moving on to more difficult material.

b. Increased Child Engagement: Teachers also reported that children are more interested and engaged in learning when using AI apps. These apps, which are often packaged in the form of games, make children more motivated to learn. With attractive visuals and gamification elements, children are more likely to learn without feeling forced.

c. Flexibility of Time and Location: Many teachers acknowledge that AI-based applications can be used anytime and anywhere, allowing children to continue learning outside of class hours. This application provides an opportunity for children to continue independent practice at home with parental supervision.

3. Parents' Experiences in Using AI Apps for Their Children

The parents interviewed also provided important perspectives on the use of AI apps to support their children's cognitive development. Some of the findings were:

a. Ease of Monitoring Child Development: Parents found it easier to monitor their children's development because AI-based apps often provide reports or analysis of their children's progress. For example, parents can see how well their children are mastering certain skills, such as recognizing letters or numbers, and identify areas that need improvement.

b. Importance of Parental Supervision: Although AI apps offer an engaging learning experience, parents emphasized the importance of supervision. Some parents felt that while these apps are useful, children still need adult guidance to ensure that

they are not just focused on the screen, but are also learning how to interact with others, play physically, and learn through real-world experiences.

c. Improved Language and Cognitive Skills: Parents reported that their children were more interested in speaking and sharing new words after using AI-based language apps. They also felt that these apps helped introduce children to new concepts in a fun way, improving critical thinking and problem-solving skills.

Positive Impact of Using AI Applications in Early Childhood Cognitive Development

Based on the results of observations and interviews with teachers and parents of children at BA Aisyiyah, there are various positive impacts of using AI-based applications in developing and improving early childhood cognitive development. Here are some of the main points revealed in the study:

1. Personalized Learning

AI-based applications are able to adjust learning content according to the needs and ability levels of each child. This allows children to learn in the most effective way for them, thereby accelerating the understanding of basic concepts. According to John McCarthy, artificial intelligence or AI is an effort to model the human thought process and design machines to imitate human behavior (Robandy, I. 2019).

2. Increasing Learning Motivation

Teachers and parents reported that this application is often interesting and interactive, so it can increase children's motivation to learn. The gamification elements and fun multimedia content make children more enthusiastic in participating in the learning process. AI in education also has a positive impact on teachers because it can increase work efficiency. Teachers no longer need to bother and spend a lot of time doing administrative tasks because they can automate these tasks (Norvig, P. 2004).

3. Development of Critical and Creative Skills

The use of AI applications can stimulate the development of children's critical and creative thinking skills. Through the challenges and games offered, children are invited to solve problems and think innovatively, which is very important in their developmental stage.

4. Adaptive Cognitive Development

AI can adjust learning materials based on children's responses and abilities. This technology enables a more effective learning experience, helping children to learn basic concepts such as numbers, letters, shapes, and colors in a more interactive way. With this adaptation, children can learn at a pace that suits their abilities, without feeling burdened by material that is too difficult or bored with material that is too easy.

5. Fun and Interactive Learning

AI-based applications are often accompanied by gamification elements that combine game elements in learning. This makes children more interested and actively involved in learning. For example, AI-based educational robots such as Cozmo or Pibo use games to teach basic cognitive skills through direct interaction, which makes children feel happier and more motivated to learn.

6. Improved Language Skills

AI-based applications can also help in developing children's language skills, both in the form of listening, speaking, and writing. Applications such as Google Assistant or Amazon Alexa can help children interact with devices using voice commands, which trains their communication skills. Customized language learning and conversation-based learning can stimulate the development of language skills in children.

7. Access to Diverse Learning Resources

AI applications provide children with access to a variety of learning resources. This helps them to explore new topics and expand their knowledge beyond the formal curriculum, creating a richer learning experience. Artificial Intelligence can facilitate access for students who want to find various interactive learning resources (Budi Aryasa, Komang, 2022).

8. Facilitate Development Monitoring

With AI-based applications, teachers and parents can easily monitor their children's cognitive development. The data generated by the application provides useful feedback to evaluate the child's progress and identify areas for improvement.

9. Encourage Interaction and Collaboration

Some AI applications are designed to support interaction between children, either through joint play or collaborative activities. This helps children learn to work together and communicate well, which are important social skills.

From the results of observations and interviews at BA Aisyiyah, it is clear that the use of AI-based applications in early childhood education provides many significant benefits for their cognitive development. Although there are challenges that need to be faced, these positive impacts show the great potential of technology in supporting more effective and enjoyable learning for children. Therefore, it is important for educators and parents to use these applications wisely and in a targeted manner.

Negative Impacts of Crime

A development in the field of technology is something that cannot be avoided in the development of human science (Agustian & Salsabila, 2021). Since ancient times, it has been a basic human nature to always innovate and create discoveries that make human life easier (Maksum & Fitria, 2021). The presence of a much-talked-about discovery is the discovery of artificial intelligence (AI) technology, which indicates that technological

progress continues to bring changes to many aspects of hu-man life (Sukarniti, 2020). but not all technological developments bring benefits. The development of this technology also brings a challenge, where the emergence of a digital inequality that is a serious problem, which is characterized by some people not having access and the ability to use technology access optimally (Ainun et al., 2022), so that various crimes that intersect with technology are very common in social life, one of which is:

1. Exposure to Inappropriate Content: There are concerns about the possibility of children being exposed to inappropriate or dangerous content through AI applications. Without close supervision, children can easily access material that is not appropriate for their age, which can affect their cognitive and emotional development.
2. Hacking and Data Security: Teachers and parents also mention the risk of personal data security. Many applications collect user data, and if not properly protect-ed, this information can be misused by irresponsible parties. This poses a risk to children's privacy and can lead to criminal acts.
3. Misuse of Technology: In some cases, AI applications can be used for bad purposes, such as fraud or manipulation. For example, children can be targets of online fraud or even cyberbullying, which can have a negative impact on their mental health and well-being.

From the results of interviews with teachers and parents at BA Aisyiyah, it is clear that although AI-based applications offer many benefits in the cognitive development of early childhood, there are also a number of negative impacts that need to be considered. It is important for parents and educators to provide proper supervision and guide children in using this technology so that negative impacts can be minimized. One of the preventive efforts that can be made is to provide education and literacy to the community about AI technology and how easy it is to use the technology as a tool that can have positive and negative impacts; by providing education and literacy to the community, it will increase public awareness of the dangers of AI-based fraud. Educational activities can be carried out by providing information or tips on how to identify and avoid AI-based fraud, which of course also utilizes various media, such as social media, by spreading education online, for example via Facebook, Youtube, or Instagram or can provide education directly by holding a seminar or counseling to provide information about AI-based technology and fraud. Eradicating fraud based on AI technology cannot be completed if it is not done in a comprehensive manner involving various aspects, for example, policy aspects, cross-sector cooperation, starting from the community and government sectors and also the technology aspect itself. In relation to the use of technology aspects in efforts to prevent fraud based on AI technology, there are several prevention efforts that can be made, one of which is using a fraud detection algorithm (Budiman, 2022).

A Balanced Approach in Using AI Applications to Improve and Develop Children's Cognitive Aspects

Based on the results of observations and interviews with teachers and parents of children at BA Aisyiyah, a balanced approach in using AI-based applications is very important to maximize their benefits in early childhood cognitive development. Here are some suggested principles and strategies:

1. Combination of Digital Activities and Direct Interaction

One approach expressed is the importance of combining the use of applications with direct interaction. Teachers emphasized that although AI applications can provide an interesting learning experience, face-to-face interaction with teachers and peers is still needed to develop children's social and emotional skills (Kurniawan, A. B., & Soeskandhi, H. 2022).

2. Parental Supervision and Guidance

Parents play an important role in supervising the use of AI applications. Discussions between parents and children regarding the content being studied can strengthen understanding and help children explore new ideas. This guidance also ensures that children are not exposed to inappropriate content (Putri, A. N., & Hasan, M. A. K. 2023).

3. Adaptation of Learning Content

The applications used must be able to be adapted to the needs and abilities of each child. Teachers at BA Aisyiyah suggest choosing applications that provide customization options, so that children can learn in the way that suits them best. This also helps avoid frustration when children face challenges that are too difficult.

4. Limited Time Use

Both teachers and parents agree that application use should be limited to a certain time. This aims to prevent dependence on technology and ensure that children remain engaged in other activities, such as playing outside, art, and reading books.

5. Regular Evaluation and Feedback

It is important to conduct regular evaluations of children's progress. AI applications often provide data on children's development, but teachers and parents need to discuss the results and provide constructive feedback. This helps children understand their strengths and areas that need improvement.

6. Holistic Approach

A balanced approach focuses not only on cognitive aspects, but also on the child's emotional, social, and physical development. Activities that encourage creativity, such as arts and crafts, and physical activity, should remain an integral part of children's learning experiences, along with the use of technology (Abdullah, H. 2024).

By adopting a balanced approach to the use of AI-based applications, both teachers and parents at BA Aisyiyah can ensure that children not only benefit from technology, but also continue to develop holistically. This approach ensures that children can learn in a fun and effective way, without neglecting the importance of social interaction and diverse learning experiences.

While AI-based applications offer many benefits, they should be used as an aid in children's education, not as a substitute for human interaction or direct learning experiences. Parents and educators should ensure moderate and balanced use of technology, and monitor how and when children interact with digital devices.

AI-based applications offer a lot of potential to support early childhood cognitive development. With the ability to personalize learning and provide interactive experiences, these applications can enhance children's language skills, logic, and creativity. However, the use of this technology must be done wisely, paying attention to the balance between digital learning experiences and real social interactions. With the right approach, AI can be a very useful tool in supporting children's cognitive development, helping them grow into intelligent, creative, and social individuals.

Conclusion

The application of AI-based applications to support early childhood cognitive development has been proven to have a positive impact, both in terms of personalizing learning, increasing child engagement, and helping children learn basic concepts in a fun way. However, the application of this technology must be done carefully, with sufficient supervision from parents and teachers, and ensuring a balance between digital experiences and real-world interactions. AI technology, if used properly, can be a very effective tool in improving early childhood cognitive development, but it still requires proper guidance and regulation so that its benefits can be optimal.

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