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Development of Interactive Educational Games to Stimulate Early Childhood Cognitive Abilities

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Abstract: This study aims to develop an interactive educational game based on Android to stimulate the cognitive abilities of children aged 4–5 years at PAUD Melati. The research employed a Research and Development (R&D) method using the ADDIE development model, which consists of the stages of analysis, design, development, implementation, and evaluation. The educational game was developed using the Construct 2 application with an environmental theme and was designed to train children's cognitive abilities, such as identifying problems, finding solutions, and solving simple problems. The research subjects were children aged 4–5 years at PAUD Melati. Data were collected through observation, questionnaires, and documentation, and analyzed using descriptive qualitative and quantitative techniques. The results showed that the developed interactive educational game was feasible to be used as a learning medium. The limited trial results indicated that children were enthusiastic, actively involved, and able to complete the games well, indicating increased interest and engagement in learning activities. Therefore, the Android-based interactive educational game can be used as an innovative learning medium to stimulate early childhood cognitive development.

Keywords: Interactive Educational Game, Cognitive Ability, Early Childhood, Construct 2.

Introduction

Early childhood is in the golden age, which is a crucial period in human development characterized by rapid brain growth and development (Atiasih et al., 2023; Novitasari, 2018). During this period, children are highly sensitive to various forms of stimulation provided by their surrounding environment (Oktaviani et al., 2022). Early Childhood Education (PAUD) plays a strategic role in providing appropriate stimulation to optimize all aspects of children's development (Astuti et al., 2024; Rakhmawati, 2019), particularly cognitive development, which is related to the ability to think, understand concepts, remember, and solve problems (Nainggolan & Daeli, 2021).

Cognitive development in early childhood cannot be separated from the cognitive development theories proposed by Jean Piaget and Lev Vygotsky. According to Piaget, early childhood is in the preoperational stage, in which children begin to think symbolically but still require concrete experiences to understand concepts (Babakr et al., 2019; Purnamasari, 2024). Meanwhile, Vygotsky emphasized that children's cognitive development is strongly influenced by social interaction and assistance from adults or peers through the concept of the Zone of Proximal Development (ZPD)

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(Vygotsky dalam (Gehlot, 2021)). This indicates that early childhood learning should be designed to be active, interactive, and aligned with children's developmental characteristics (Dina & Purnamasari, 2023).

One learning approach that aligns with early childhood developmental characteristics is learning through play (Hayati & Putro, 2021). Play is the world of children and serves as the primary means for children to learn naturally (Iskandar, 2021; Karim & Wifroh, 2024). Through play activities, children can develop cognitive abilities such as symbolic thinking, concept recognition, and simple problem-solving skills (R. W. Astuti et al., 2024; Ilyas, 2020; Rosyadi, 2020). Research indicates that play-based learning provides enjoyable and meaningful learning experiences that can enhance early childhood cognitive development (Dewi, 2022; Tulung & Wahyuningsih, 2025).

Along with the development of digital technology, technology-based learning media have increasingly been utilized in early childhood education (Subekti et al., 2024; Syarif & Wibowo, n.d.; Yusuf & Darmasnyah, 2025). Digital learning media are considered capable of providing more engaging learning experiences through the combination of text, images, animation, sound, and video (Widyawati, 2019; Yeni & Yusnita, 2025; Yusuf & Darmasnyah, 2025). Previous studies have shown that the use of digital and interactive learning media can improve children's attention, motivation, and memory in understanding learning materials (Kuntari, 2023; Nasution et al., 2024).

One rapidly developing form of digital learning media is interactive educational games. Educational games are designed not only as entertainment but also as learning media that contain educational elements. Educational games can train children's logical thinking, concentration, and problem-solving skills through enjoyable activities (Imawati et al., 2022; Putra et al., 2023). esearch has shown that the development of interactive learning media, including educational games based on PowerPoint and multimedia, is feasible and effective in stimulating early childhood cognitive abilities (Dina & Purnamasari, 2023).

In addition, educational games allow children to be actively involved in the learning process through the concept of learning by doing, where children learn while performing and exploring (Hidayati & Budiarti, 2022). Educational games also provide opportunities for children to repeat learning materials without feeling bored, thereby helping to strengthen conceptual understanding and improve memory (Mulyatun et al., 2021; Setiawan et al., 2019).

Although various studies have demonstrated the benefits of interactive educational games in early childhood learning, the development of educational games that are truly tailored to the characteristics and needs of children's cognitive development still needs to be continuously pursued. Therefore, research on the development of interactive educational games that are systematically designed to stimulate early childhood cognitive abilities is necessary. This development is expected to serve as an innovative, effective, and enjoyable alternative learning medium to support the optimization of early childhood cognitive development.

Method

This study employed a Research and Development (R&D) method using the ADDIE development model, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation. This method was selected because the study aimed to develop a product in the form of an interactive educational game used to stimulate early childhood cognitive abilities.

The research subjects were children aged 4–5 years at PAUD Melati. The study was conducted during the ongoing semester of the academic year. The research object was an interactive educational game developed using the Construct 2 application.

The analysis stage was conducted to identify learning needs and the cognitive developmental characteristics of children aged 4–5 years. The design stage included designing the game concept, learning objectives, gameplay flow, and visual appearance. The development stage involved developing the interactive educational game using Construct 2 and conducting validation by media experts and material experts. The implementation stage was carried out through a limited trial of the game with children aged 4–5 years at PAUD Melati. The evaluation stage aimed to assess the feasibility and effectiveness of the game and to make revisions based on the evaluation results.

Data collection techniques included observation, questionnaires, and documentation. The data were analyzed using descriptive qualitative and quantitative techniques. Quantitative data were obtained from the results of product feasibility assessments, while qualitative data were used as the basis for refining the interactive educational game**.**

Result and Discussion

This study produced an Android-based educational game application for early childhood. The research steps were as follows. In the first stage, a needs analysis was conducted through interviews with several teachers and parents, which revealed the need for technology-based media that could increase children's interest in learning.

In the second stage, the researcher designed the learning media by collecting various resources. The developed theme was "Environment." The researcher collected images from various sources, including Google, Canva, and self-designed materials, which were integrated into a single game. The stages of designing the educational game media included: (1) designing background elements that functioned as characters in the educational game; (2) creating the media layout displayed in the educational game with environmental themes and three game sections, namely *The Thirsty Flower*, *The Lost Chick*, and *The Broken Toy Car*; and (3) designing background visuals to support the game's appearance. Image objects and backgrounds were obtained from Google, Canva, and self-designed materials. At the development stage, the production process began with collecting content materials such as images, audio, and simple animations.

The third stage involved developing the educational game by designing solutions based on children's needs analysis, namely an Android-based educational game to stimulate children's cognitive abilities and problem-solving skills. At this stage, the educational game media were developed based on the analysis results. The discussion and results show that the educational game with an environmental theme was able to improve children's cognitive development by enabling them to identify problems, find solutions, and solve problems.

Figure 1. Game "The Thirsty Flower"

Figure 1 shows the *The Thirsty Flower* game page. In this game, children are asked to think about what is happening to the flower and which object can help make the flower fresh again.

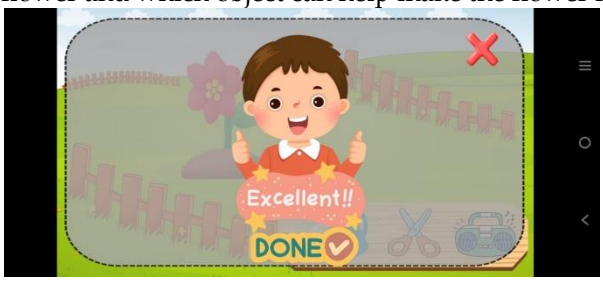

Figure 2. Reward Display

Figure 2 shows the reward provided when children successfully complete the game.

Figure 3. The Lost Chick

Figure 3 shows the *The Lost Chick* game page, which displays a chick that is sad because it is separated from its mother by a maze. Children are asked to think about how to help the chick meet its mother. Arrow buttons (up, down, left, and right) are provided to move the chick toward its mother outside the maze.

Figure 4. The Lost Chick Completion

Figure 4 shows the moment when the chick successfully reunites with its mother and they appear happy and hug each other.

Figure 5. *The Broken Toy Car* Game

Figure 5 shows the *The Broken Toy Car* game page, where one wheel of the toy car is missing. A toolbox containing several tools is displayed. Children are asked to identify the problem and determine how to solve it by choosing the appropriate tool from the toolbox to repair the toy car.

Figure 6. The Display When the Child Successfully Selects the Right Tool

Figure 6 shows the moment when the child successfully selects the correct tool to properly attach the wheel to the damaged toy car. The car then produces an engine sound, starts moving, and emits exhaust smoke.

Figure 7. Reward Page

Figure 7 shows the reward page displayed after children complete the game.

Next is the implementation stage, in which a trial was conducted with a 4–5-year-old child identified by the initials RFY. In this trial, RFY was able to complete all the games quite well. In *The Thirsty Flower* game, RFY first observed the wilted flower and noticed the available objects, namely a watering can, scissors, and a radio. RFY immediately chose the watering can and directed it toward the wilted flower, after which the flower became fresh again.

Figure 8. Subject 1 Trial Documentation

In *The Lost Chick* game, RFY initially observed the image and did not immediately realize that there were buttons to move the chick. At first, RFY attempted to drag the chick directly. After guidance from the teacher, RFY understood that the arrow buttons were used to move the chick toward its mother. RFY then used the buttons to guide the chick successfully.

Figure 9. Subject 2 Trial Documentation

In *The Broken Toy Car* game, RFY observed the toy car to identify the problem. Shortly afterward, a toolbox containing a car wheel, a hammer, and glue appeared. RFY was asked to choose the appropriate tool to repair the toy car. RFY immediately selected the car wheel and placed it correctly.

Subsequently, the car engine sound played, exhaust smoke appeared, and the car began to move forward.

Figure 10. Trial Implementation Documentation

Based on the research results and trials, Android-based games offer many advantages, such as usability at school, at home, and outdoors, as well as the ability to present materials that attract children's attention. The game provides benefits such as combinations of letters, colors, unique animations, and educational game types that are tailored to children's abilities. In addition, the use of Android-based games can assist teachers in delivering understanding and knowledge during the learning process for children aged 4–5 years.

The results indicate that the interactive educational game developed using Construct 2 is feasible as a learning medium to stimulate the cognitive abilities of children aged 4–5 years. These findings are consistent with Piaget's theory, which states that early childhood is in the preoperational stage and requires learning media that are concrete and visual.

Furthermore, the use of interactive educational games also supports Vygotsky's theory, which emphasizes the importance of stimulation and interaction in children's cognitive development. Games provide opportunities for children to learn actively and repeatedly, thereby strengthening conceptual understanding (Humaida & Suyadi, 2021).

This study's findings are in line with previous research stating that interactive learning media, including technology-based media, are effective in increasing engagement and cognitive abilities in early childhood. Therefore, interactive educational games can serve as an innovative alternative learning medium that supports early childhood learning processes (Dina & Purnamasari, 2023).

Conclusion

Based on the research results and discussion, it can be concluded that the interactive educational game developed using the Construct 2 application is feasible as a learning medium to stimulate the cognitive abilities of children aged 4–5 years at PAUD Melati. The educational game was designed according to early childhood developmental characteristics and cognitive development indicators, enabling the creation of a pleasant and meaningful learning environment.

The limited trial results indicate that the interactive educational game increased children's interest and engagement in the learning process. Therefore, interactive educational games can be used as an innovative alternative learning medium to support the optimization of early childhood cognitive development.

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