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Designing an Android-Based Educational Game for Fruit Recognition in Seruni Pertiwi Preschool

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Abstract

The objective of this research is to design and develop an Android-based educational game for fruit recognition in Seruni Pertiwi Preschool. The educational game application consists of a main menu, fruit menu, and tree menu. The fruit menu includes various fruit options such as bananas, papayas, apples, grapes, oranges, pineapples, watermelons, durians, rambutans, and strawberries. The research methodology employed in this thesis includes data and information collection, system design, software requirement analysis, interface design, coding, testing, and implementation. The Unity 3D engine is utilized for designing the educational game application. Based on the conducted testing, the following conclusions can be drawn: the developed educational game is free from errors based on the black-box testing results. The research findings indicate that the average validation score from user feedback, ranging from user 1 to user 10, is 4.6, which indicates a high level of agreement with the system assessment, falling under the category of "strongly agree".

Keywords: Android-based educational game; fruit recognition; Seruni Pertiwi; preschool; Unity 3D.

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Introduction

Technology in this era has rapidly advanced, especially in the field of smartphones (Kasmi et al., 2022). Smartphones are highly sophisticated mobile phones that function similarly to computers, running operating systems software that provides default connections and basic features for application developers to incorporate advanced capabilities, such as internet browsing and e-book reading (Baig et al., 2015).

The rapid development of technology has transformed people's habits in seeking information (Ashour, 2020; Awaliah et al., 2022). Sometimes, it becomes challenging to find accurate and reliable information. As a result, limited access to alternative sources, such as newspapers, audiovisual media, and electronic media, prompts individuals to rely heavily on the Internet, which offers extensive information access (Muttaqin et al., 2023).

One factor contributing to declining learning outcomes is the lack of implementation of new teaching methods (Leal Filho et al., 2019). According to (Sarker et al., 2019), one of the reasons for poor teaching quality is that teachers and students do not effectively utilize different teaching methods. Although teachers, as educators, rarely employ Android devices, they acknowledge that such learning strategies can significantly enhance students' skills in various subjects (Obada et al., 2023). Android, as a wireless-enabled operating system, can be utilized effectively through smartphones (Aman & Mustika, 2019; Iskandar et al., 2022).

The rapid advancement of technology has a significant impact on the learning process in the field of education, including the development of learning materials and the delivery of content during teaching and learning (Simarmata, Raja, et al., 2022; Simarmata, Romindo, et al., 2022). In early childhood education (PAUD), children are more inclined towards play rather than traditional studying, which is why PAUD is often referred to as "learning through play" or "play-based learning." Presently, children show greater interest in smartphone games compared to real-world games. They are attracted to the appealing characteristics, colors, communication features, and enjoyable shapes and fonts offered by smartphone games (Anderson, 2022; Torpegaard et al., 2022).

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Seruni Pertiwi Preschool, located in Bua District, Luwu Regency, employs traditional teaching methods using objects and picture books as learning tools. Unfortunately, this approach fails to capture students' interest, and teachers rely heavily on memorization and singing as teaching techniques. As a result, students who are not fond of singing are less engaged in learning fruit recognition materials. However, students are already familiar with Android devices, as they often use them at home for both learning activities and entertainment. Incorporating educational games can be an effective method to stimulate students' interest in learning. Educational games provide easily comprehensible knowledge through a play-based learning approach, offering a fresh perspective on education (Iskandar, 2022; Samuelsson, 2023).

Therefore, an educational game application will be developed to facilitate fruit recognition. The game will utilize puzzle-solving elements to assist students in understanding different fruit shapes. This game application can be accessed conveniently on smartphones anytime and anywhere, providing an accessible platform for engaging in learning activities.

Several relevant studies have been conducted in the field of educational games and technology integration in learning. (Bergant & Tomc, 2022) developed an augmented reality application for learning about farm animals on the Android platform using Unity. The purpose of this study was to cultivate students' interest in learning and facilitate the delivery of educational content by combining education with augmented reality technology. (Cooke et al., 2020) implemented the Game Design Document (GDD) method in designing interactive educational games to engage students. The study demonstrated that using the GDD method made it easier for children to learn, understand, and master the English language. The target users of the game application were children guided by teachers. Fithri (2017) conducted an analysis and design of an educational game to serve as a learning motivation for early childhood (Stiller & Schworm, 2019). The findings of the research indicated that the game was effective in acquiring more knowledge and transforming monotonous learning patterns.

Based on the insights gained from these studies, it can be concluded that designing an educational game for fruit recognition using puzzle games on the Android platform holds great potential. The proposed research aims to develop an engaging and interactive educational game application that assists children in learning and identifying various types of fruits.

Method

In this study, the research and development (R&D) method was employed. R&D is a series of processes or procedures used to develop new products or improve and explain existing products (Hervas-Oliver et al., 2021). It is important to note that the products in question are not necessarily physical objects or hardware, but can also include software programs for data processing, libraries, laboratories, educational forms, and so on. The R&D method is considered effective in enhancing practices. Therefore, in this research, the researcher chose to utilize the R&D method to improve the existing practices.

This research utilized two types of data, primary data was obtained through direct observation and interviews with the preschool teacher. Including the fact that the current teaching system relies on manual methods, utilizing 2D drawings. It was also discovered that the students face challenges in comprehending drawings and visualizations presented through educational game applications. In addition to primary data, secondary data was collected through an extensive literature review. Various sources such as books, journals, reports, and scientific articles on fruit recognition learning media were examined. These secondary sources provided valuable information to support the research findings.

System Analysis

System analysis can be defined as breaking down a complete information system into its components. It involves identifying and assessing problems, opportunities, constraints, and expected requirements to propose improvements.

From the issues identified in Seruni Pertiwi Preschool, through data collection and observation processes, conclusions can be drawn regarding the existing teaching methods. The current system provides an overview of how the learning process is conducted in Seruni Pertiwi Preschool. The analysis of the existing system can be seen in the following diagram:

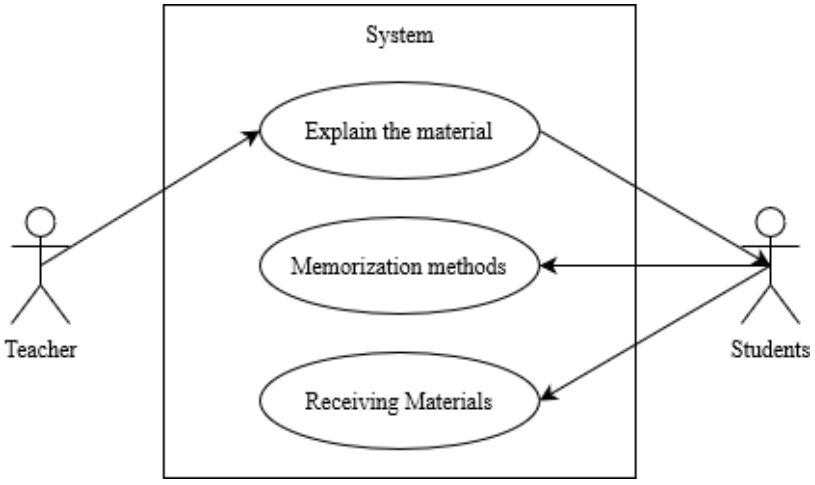


Figure 1. Current System Analysis

Based on the above diagram, the teacher explains the subject matter to the students manually, while the students use rote memorization as a method to receive the material. The students receive the material directly from the teacher.

Based on the analysis of the current system, the author provides a solution in the form of a system that can generate interest for both students and teachers. Determining whether the educational system is suitable for children's development is no longer difficult. The proposed system provides an overview of the system that will be created by the author.

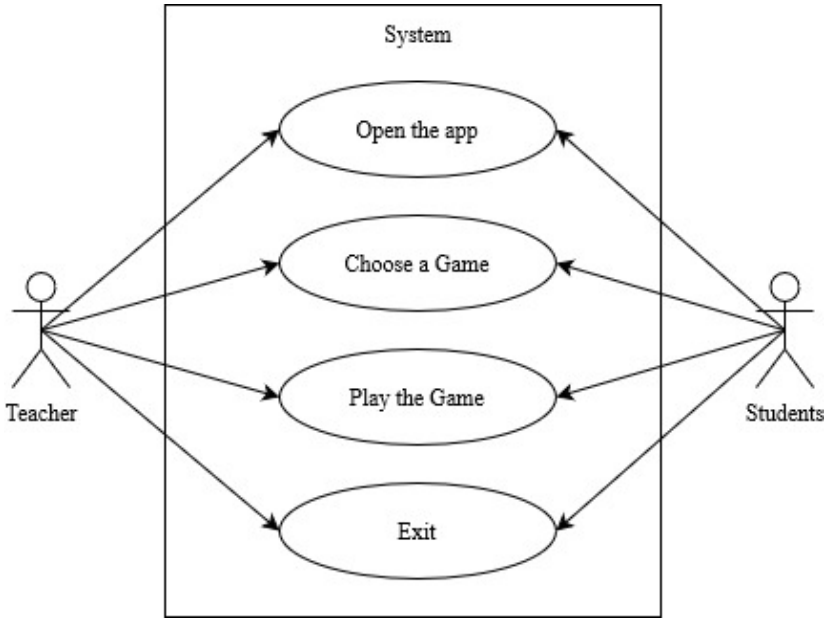


Figure 2. Proposed System Analysis

Based on the above diagram, the teacher opens the application, and both the teacher and students access the fruit selection page. The students choose a fruit to be assembled into a puzzle. The students can then start playing the puzzle game. After finishing the game, the teacher and students can exit the application.

System Requirements Analysis

The functional requirements of the Android-based educational game application to be developed include the following: (a) the user should be able to open the main form, (b) the main form should feature a start button to initiate the game, (c) upon pressing the start button, a form should appear displaying a selection of fruit names, and (d) the game should be playable once initiated.

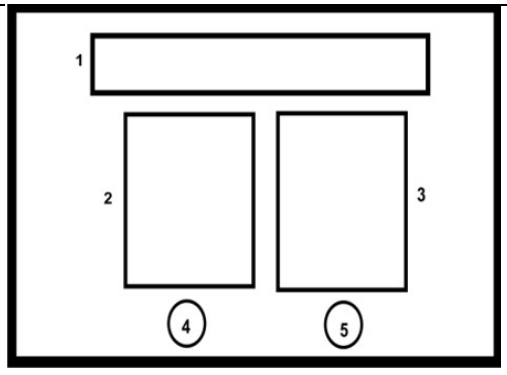
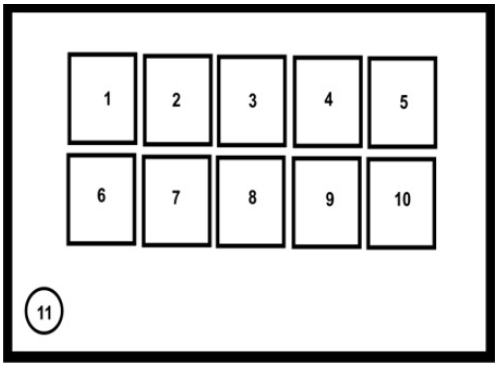
The non-functional requirements for the Android-based educational game application for fruit recognition are divided into software and hardware requirements. Regarding software, the application relies on the Windows Home 10 64-bit operating system and utilizes Unity 3D, Balsamiq Mockups, and CorelDraw X5 as supporting software. As for hardware, the development process necessitates an IdeaPad 3 laptop with an AMD 3020e processor with Radeon Graphics Ghz, 4 GB of RAM, and an Android smartphone with a minimum Android version of 4.0.

System Design

System Analysis can be defined as breaking down a complete information system into components to define and evaluate problems, new opportunities, failures, and expected needs. This allows us to propose improvements. System Design is generally intended to provide users with a general overview of the system they are designing. Below is an Android-based educational game application for fruit recognition using puzzle gameplay.

Storyboarding is a visual tool that aids in the design and development of user interfaces (Homaeian et al., 2021). It involves creating a series of illustrations or sketches that depict the various screens, interactions, and flow of the application. Storyboarding helps to visualize the user experience, identify potential issues or improvements, and gather feedback from users. Here is the storyboard design for this study.

Table 1. Storyboard Design of the Fruit Puzzle Game.

No.	Image	Description
1		Home Game Puzzle 1. Game title display 2. Fruit image 3. Fruit tree image 4. Audio button 5. Exit button
2		Fruit Image Menu Screen 1. Banana image 2. Papaya image 3. Apple image 4. Grape image 5. Orange image 6. Pineapple image 7. Watermelon image 8. Durian image 9. Rambutan image 10. Strawberry image 11. Home button

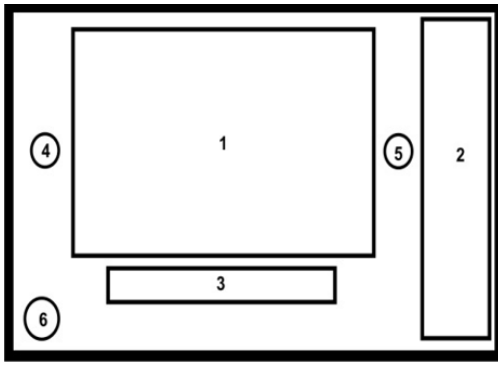
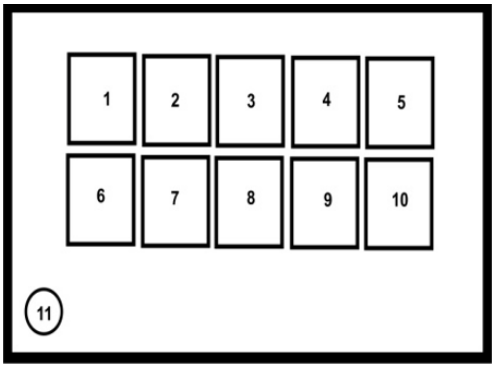
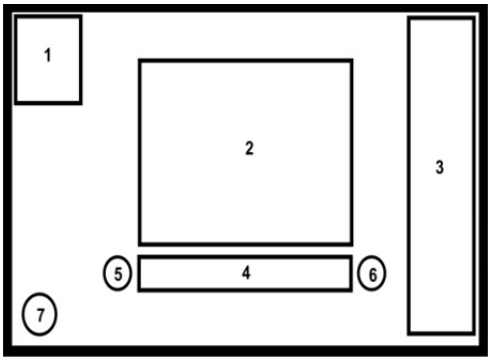
3		Banana Fruit Puzzle 1. Banana fruit image 2. Banana puzzle piece images 3. Fruit name display 4. Back button 5. Next button 6. Home button
4		Fruit Tree Image Menu Screen 1. Apple Fruit Tree 2. Papaya Fruit Tree 3. Mango Fruit Tree 4. Durian Fruit Tree 5. Coconut Tree 6. Dragon Fruit Tree 7. Mangosteen Fruit Tree 8. Strawberry Tree 9. Banana Fruit Tree 10. Pomegranate Tree 11. Home button
5		Apple Fruit Tree Game 1. Puzzle completion image 2. Apple tree image 3. Apple fruit image 4. Apple Name 5. Back Button 6. Next Button 7. Home Button

Table 1 provides a comprehensive overview of the storyboard design for the Fruit Puzzle Game, displaying multiple screens and their respective elements. Storyboarding enables researchers to visualize and plan the various screens and interactions in the game. The highlighted screens include the Home Game Puzzle, Fruit Image Menu Screen, Banana Fruit Puzzle, Fruit Tree Image Menu Screen, and Apple Fruit Tree Game.

Results and Discussion

Result

Designing a system is essential in determining the program's structure, including data input procedures and information or report display. In the following section, we discuss the implementation of software, hardware, and the user interface.

During this stage, the designed interface is implemented using Balsamiq Mockup software. Once the graphical design is finalized, the visual appearance and layout of the application are created within Unity 2D, based on the design. This process involves translating the storyboarded screens and elements into a functional user interface, ensuring accurate implementation.

At this stage, the designed interface is implemented using Balsamiq Mockup software. Once the graphical design is completed, the application's visual appearance and layout are created within Unity 2D, based on the design. This process involves translating the storyboarded screens and elements into a functional user interface, ensuring that the design specifications are accurately implemented.

(a) (b)

(c) (d)

(e)

Figure 3. Design implementation.

In Figure 3, the design implementation can be observed. (a), the Home Menu screen serves as the initial interface that appears when the application is launched. (b), the Fruit Page screen displays a menu consisting of various fruit options. (c), the Fruit Puzzle Page screen presents the game interface for solving fruit puzzles. (d), The Tree Page screen showcases a list of fruit trees. (e), the Fruit Tree Game Page screen represents the game interface for the fruit tree game. These screens collectively form the implemented design of the application, providing users with interactive and engaging experiences.

System Testing

During the testing phase of the designed system, the black box testing method was employed by the author. This method aims to verify the success of the program design. Subsequently, testing is required to ensure that the software operates as expected by the user. The results of the testing are as follows:

Blackbox Testing

The interface of the application consists of visual elements that depict the educational fruit puzzle game on the Android platform.

Table 2. Blackbox Testing

Test Feature	Expected Outcome	Actual Result	Result
Home Menu Screen	Displaying the Home Menu Screen	Successful	Passed
Fruit Page Screen	Displaying the Fruit Page Screen	Successful	Passed
Fruit Puzzle Page Screen	Displaying the Fruit Puzzle Page Screen	Successful	Passed
Fruit Tree Page Screen	Displaying the Fruit Tree Page Screen	Successful	Passed
Fruit Tree Game Page Screen	Displaying the Fruit Tree Game Page Screen	Successful	Passed

Based on the conducted black box testing as shown in Table 2, which involved testing the main menu, fruit menu, fruit puzzle game, tree menu, and tree fruit game of the educational fruit recognition game application, it can be concluded that the testing of these application menus has been successful. The results of the testing indicate that the application has performed well and is deemed suitable for use based on the obtained test results.

User Testing

Expert media evaluators played a role in assessing the system's suitability. The application was tested by users, specifically parents and teachers of kindergarten students. User validation testing was conducted to determine the suitability of the educational game.

Total scores can be seen in the calculations below:

$$Expert\ Validation\ Score\ 1\ and\ 2 = \frac{Total\ Score}{Total\ Aspects} \quad (1)$$

$$Final\ User\ Validation\ Score = \frac{Validator\ 1\ Score + Validator\ 2\ Score + n..}{Total\ Validators} \quad (2)$$

Total Validators = 10
Total Questions = 17
User Score 1 = 82
User Score 2 = 80
User Score 3 = 81
User Score 4 = 77
User Score 5 = 78
User Score 6 = 78
User Score 7 = 80
User Score 8 = 81
User Score 9 = 76
User Score 10 = 79
User Score 1 = 82/17 = 4.8
User Score 2 = 80/17 = 4.7
User Score 3 = 81/17 = 4.7
User Score 4 = 77/17 = 4.5
User Score 5 = 78/17 = 4.5
User Score 6 = 78/17 = 4.5

User Score 7 = 80/17 = 4.7
User Score 8 = 81/17 = 4.7
User Score 9 = 76/17 = 4.4
User Score 10 = 79/17 = 4.6
Final User Validation Score = (4.8 + 4.7 + 4.7 + 4.5 + 4.5 + 4.5 + 4.7 + 4.7 + 4.4 + 4.6)/10 = 4.6

The Likert scale index percentage is as follows: 5 = Strongly Agree, 4-4.9 = Agree, 3-3.9 = Neutral, 2-2.9 = Disagree, 1-1.9 = Strongly Disagree. The measurement of information needs is based on the SERVQUAL model, which includes several items designed to measure user expectations and perceptions. In this assessment of the educational fruit introduction and puzzle game application, there are 17 questions. These aspects are described in various variables, and user expectations and perceptions are placed in statements based on a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Based on the data provided, you can see that the average user validation score from user 1 to user 10 is 4.6, which falls under the category of "Strongly Agree" for system evaluation.

Discussion

The results of the study revealed that the educational game application developed for fruit recognition at Seruni Pertiwi Preschool performed exceptionally well in both the system testing and user testing phases. During the system testing, various menus of the application, including the main menu, fruit menu, fruit puzzle game, tree menu, and tree fruit game, were rigorously tested. The findings showed that all these menus functioned effectively, indicating the success of the application's design and implementation.

In the user testing phase, experts in media evaluation, parents, and kindergarten teachers participated in evaluating the educational game application. This testing aimed to assess the applicant's suitability and effectiveness while gathering feedback from the target users. The results of the user validation testing demonstrated a high level of agreement among the users, with an average validation score of 4.6 on the Likert scale, indicating "Strongly Agree." This positive response indicates that the educational game application was well-received by the users and considered effective in facilitating fruit recognition and learning.

The results indicate that the application effectively engaged children in play-based learning activities and enhanced their fruit recognition skills. The visually appealing user interface, interactive features, and game-like elements of the application contributed to its effectiveness in providing an engaging and accessible platform for learning.

The results of this research align with previous studies that have emphasized the effectiveness of educational games in enhancing learning outcomes in early childhood education. Several studies have investigated the impact of educational games on children's cognitive development and learning abilities. For example, (Dore et al., 2019) conducted a similar study where they developed an interactive game to teach children about animal habitats. The findings from their research indicated that the game significantly improved children's knowledge retention and comprehension compared to traditional teaching methods.

Furthermore, a study by (Yu et al., 2021) explored the effects of educational games on preschoolers' language skills. The researchers developed a game-based application that focused on vocabulary building and language development. The results revealed a significant improvement in the children's language abilities after engaging with the educational game, indicating the potential of such interventions in supporting early language development.

Another relevant study conducted by Thompson et al. (2020) investigated the impact of educational games on mathematical skills among preschoolers. The researchers developed a game-based intervention that targeted number recognition and basic arithmetic concepts. The findings demonstrated that the educational game significantly enhanced children's mathematical abilities and improved their overall engagement and motivation in learning mathematical concepts.

In line with these previous studies, the current research underscores the positive effects of educational games in early childhood education. The incorporation of puzzle-solving elements in the fruit recognition game not only helped children understand different fruit shapes but also contributed to the development of their cognitive abilities, problem-solving skills, and critical thinking. These findings collectively emphasize the potential of educational games as effective tools for enhancing learning outcomes in early childhood education.

Conclusions and Suggestions

Conclusions

The results indicate that children who engaged with the game showed significant improvements in fruit recognition, cognitive abilities, problem-solving skills, and critical thinking. These findings align with previous studies that have emphasized the positive impact of educational games on children's learning and development. The study contributes to the growing body of research on game-based learning in early childhood education and provides valuable insights for educators, and parents. The puzzle-solving elements in the fruit recognition game specifically contribute to children's cognitive growth and problem-solving abilities.

Suggestions

Based on the findings of this research, several recommendations can be made for educators, parents, and curriculum designers:

1. Educators and curriculum designers should consider incorporating educational games into early childhood education curricula.
2. When designing educational games, it is important to strike a balance between playfulness and learning objectives.
3. Given the increasing prevalence of technology in children's lives, integrating educational games into digital platforms can be beneficial.
4. To effectively utilize educational games in the classroom, educators may benefit from professional development and training on game-based learning approaches.
5. Parents can play an active role in supporting their child's learning through educational games.

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