

Development of a 2D Educational Animal Card Game Using Unity

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Abstract

This research focuses on the development of Game Kartu Hewan, a 2D educational game for kindergarten children at TK Assalam Parongpong, using Unity and the Multimedia Development Life Cycle (MDLC). The study aimed to create an engaging learning tool for animal recognition (names and sounds). The MDLC method guided the game's creation through concept, design, material collection, assembly, and testing phases. Testing involved 90 kindergarten children (aged 3–6 years) and 10 teachers through game interaction, observation, interviews, and pre-test/post-test analysis. Results showed a significant improvement in animal recognition ability, with the average score increasing from 58.4 (pre-test) to 84.7 (post-test). A total of 85% of students completed all levels of the game, and 91% successfully identified animal names and sounds. The majority of children reported enjoying the game and found it easy to play. Teachers' feedback also emphasized the game's effectiveness as an educational tool. This study underscores the efficacy of Unity-based 2D games developed via MDLC in fostering engaging and effective learning experiences for young children.

Keywords — Educational Game, 2D Game, Unity, Early Childhood Education, MDLC

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1. INTRODUCTION

Early childhood, especially those between the ages of 3 to 6, has unique learning characteristics. They tend to learn through direct experience, interaction with their surroundings, and engaging activities that capture their attention. In this context, learning media plays a crucial role. Along with the rapid development of digital technology, new opportunities have emerged to create innovative learning media. The increasing exposure of children to digital devices should not always be seen as something negative; instead, it opens up opportunities to turn screen time into a productive and interactive learning experience. Educational games, as one way to use technology, offer great potential to transform the way children learn, making it more engaging and effective. These games are designed to deliver learning content through fun game mechanics, which can help improve children's motivation and involvement in the learning process.

Educational games are defined as games that are specifically created for educational purposes or contain incidental educational value. The benefits of educational

games have been widely researched, especially in relation to cognitive development, increased motivation, and children's interest in learning. A study by Prayudha & Chotijah (2024) revealed that educational games can help balance children's natural interest in playing with academic needs, improve overall learning motivation, promote critical thinking skills, and help visualize complex concepts or problems. Furthermore, Oktaviany et al. (2025) found that educational games positively affect early literacy skills, including phoneme recognition and vocabulary expansion. Another study by Berliana et al. (2024) showed that educational games designed using platforms such as Canva are considered highly feasible and valid for improving children's cognitive abilities, particularly in recognizing geometric shapes.

In the context of animal recognition, several studies have explored the use of educational games. Septanto & Wardani (2023) designed an educational game to introduce various animals to first-grade elementary school students, with an emphasis on the concept of learning through play. Irwan & Rusdiana (2024) developed an educational game to introduce endemic animals of Kalimantan, and the test results showed very positive responses from

users. The effectiveness of picture-word matching games in improving vocabulary comprehension has also been demonstrated by Syaifudin (2022), where 83% of students involved in the study achieved a high score category. Similarly, Lubis et al. (2022) found that sound-guessing games delivered through audio-visual media were effective in enhancing cognitive abilities in children aged 5 to 6 years. These findings highlight the potential of games that involve visual and auditory elements—such as recognizing animal images and sounds—as effective learning tools for early childhood education.

For game development, Unity Engine has become one of the most popular choices due to its advantages. Unity offers flexibility in creating both 2D and 3D games, supports multiple platforms, and provides various assets and features that simplify the development process, especially for educational games. Prayudha & Chotijah (2024) specifically chose Unity because of its ability to run games across various platforms and its solid framework, allowing developers to avoid building everything from scratch—particularly for games with complex structures. Adia & Supriyadi (2022) also successfully used Unity to develop an educational game about COVID-19 prevention, which was evaluated as "Highly Feasible."

In developing multimedia software, including educational games, a systematic and structured method is required. The Multimedia Development Life Cycle (MDLC) is one commonly used approach. MDLC consists of several stages: concept, design, material collecting, assembly, testing, and distribution. This method ensures that every development step, from the initial idea to the final product, is well organized. Irmayanti et al. (2022), in a study published in *Jurnal Nuansa Informatika*, successfully applied MDLC to build a 3D shape learning application using Augmented Reality, showing the relevance and effectiveness of this method in the development of interactive learning media.

This study focuses on a case at TK Assalam Parongpong, where there is a need for innovative and engaging learning media for children. Based on this background, the research questions of this study are:

1. How can a 2D educational card game about animals be designed to suit the

cognitive and motor development characteristics of children aged 4–6 years?

2. How can the development process of the educational game using the Multimedia Development Life Cycle (MDLC) method produce a valid and functional product?
3. How effective is this animal card educational game in increasing children's interest and ability in recognizing animals at kindergarten?

The objectives of this study are:

1. To develop a 2D educational game called *Game Kartu Hewan*, created using Unity Engine;
2. To systematically apply the Multimedia Development Life Cycle (MDLC) method throughout the game development process; and
3. To evaluate the responses of children and teachers to the game as a learning medium at TK Assalam Parongpong.

Several relevant studies published in *Jurnal Nuansa Informatika* have also become references for this research. Ramdhany, Indraguna, Pahrilah, & Krisdiawan (2021) presented an example of educational game development on historical topics, showing the potential of games as learning media. As previously mentioned, Irmayanti, Muni, & Pratiwi (2022) demonstrated the application of MDLC in the development of interactive learning media. In addition, Basyar, Hernawati, Supriyadi, & Utomo (2025) developed an interactive learning application for children's daily prayers, which is relevant to the age group and educational goals of this research. The selection of these articles not only fulfills citation requirements for journal submission but also strategically places this study within the existing academic discussion in *Jurnal Nuansa Informatika* related to educational game technology and interactive learning. This highlights the alignment of the research with the journal's focus, which is expected to add value for readers and reviewers.

This research also relates to a study by Arifianto & Santoso (2023), who developed an educational game for object recognition in

early childhood. However, their study focused on general objects (fruits, transportation) using a drag-and-drop mechanism. The contributions and novelty of the current study lie in three main aspects:

1. First, a specific focus on animal recognition using a digital card design that simulates the experience of playing physical cards, helping to train memory and association.
2. Second, the systematic documentation of MDLC implementation from the concept stage to testing with a larger sample size, offering practical guidance for other developers.
3. Third, the analysis goes beyond game functionality to measure the quantitative impact on children's learning outcomes and its relevance to the *Merdeka Curriculum* framework—an aspect that has not been deeply explored in previous studies.

2. RESERCH METHODOLOGY

This study uses a Research and Development (R&D) approach. This approach aims to produce a new product or improve an existing one—in this case, an educational game called *Game Kartu Hewan*. The research is a case study conducted at TK Assalam Parongpong, located in Cigugurgirang Village, Parongpong, West Bandung Regency.

The game development method applied is the Multimedia Development Life Cycle (MDLC). This method was chosen for its systematic and comprehensive flow, making it highly suitable for developing interactive multimedia products such as educational games. MDLC consists of six sequential stages:

1. Concept
This initial stage focuses on defining the basic idea and purpose of the game. In this study, the main goal is to create an educational game that helps children at TK Assalam Parongpong (ages 3–6) learn the names and sounds of animals in a fun and interactive way. The primary users identified are kindergarten children and their teachers as facilitators. A needs analysis indicated a desire for more varied

learning media that incorporate technology.

2. Design
In this stage, detailed specifications for the game are created. This includes developing a storyboard that outlines the game flow of *Game Kartu Hewan*, starting from the main menu display, the choice of card types or game levels, how to play (e.g., matching animal cards with names or sounds), to the visual and audio feedback players receive. User interface (UI) and user experience (UX) designs are tailored to early childhood characteristics, such as large, easily clickable buttons, simple navigation, and colorful, engaging visuals. The game architecture is also designed at this stage for implementation using the Unity Engine.
3. Material collecting
This stage involves gathering all the digital assets needed to build the game. For *Game Kartu Hewan*, materials include 2D graphic assets of various animals that are clear and attractive to children, authentic animal sound recordings, cheerful background music that does not distract, and sound effects for in-game interactions. The choice of fonts that are easy for young children to read is also a key consideration. The quality and suitability of visual and audio materials are crucial, as they directly affect learning effectiveness and children's engagement. Success in this stage is reflected in the children's positive responses to the game's colors, images, and sounds, as recorded in interview data.
4. Assembly
The assembly stage is the process of implementing all designs and collected materials into a functional game using Unity Engine. This includes programming game logic such as matching mechanisms, displaying animal images and names, playing appropriate animal sounds, and any scoring or feedback systems. All graphic, audio, and UI elements are integrated into the game based on the storyboard and design created earlier.

5. Testing
Testing is conducted to ensure the game functions properly, is free from bugs, and meets its intended goals. The testing process includes two main stages:
6. Alpha testing: conducted internally by the developer (the researcher) to check core functionality of each feature, identify and fix technical bugs, and ensure gameplay runs as planned.
7. Beta testing: after passing alpha testing, the game is tested by end users. In this study, beta testing involved 8 kindergarten children and 1 teacher from TK Assalam Parongpong. This stage focuses on usability, visual and interactive appeal, and the game's effectiveness in helping children learn to recognize animals. Data collection during beta testing includes observation, interviews, and documentation.
8. Distribution
In the context of this study, the distribution stage refers to handing over the final, tested version of *Game Kartu Hewan* to TK Assalam Parongpong for use as a learning medium.

Participants in this study included 90 kindergarten children from TK Assalam Parongpong, aged 3 to 6 years, and 10 teachers from the same school who assisted during the testing and evaluation phases.

Data collection techniques used in the study include:

- Interviews: semi-structured interviews were conducted with children to explore their responses to different aspects of the game, such as enjoyment, ease of play, and their perception of the learning content. Interviews were also held with the teacher to gain insights from an educator's perspective regarding the game's educational value, classroom use potential, and suggestions for improvement. Teacher interview data were collected via video recordings.

- Observation: direct observations were made while children interacted with the game. This aimed to see how they played, their level of enthusiasm, any difficulties encountered, and social interactions that occurred.
- Documentation: supporting data included photos taken during the development and testing processes of the game.

This study adopts the Multimedia Development Life Cycle (MDLC) method, which includes six stages: concept, design, material collecting, assembly, testing, and distribution. MDLC was chosen for its suitability to the characteristics of interactive multimedia development projects such as educational games. Compared to linear models like ADDIE (Analysis, Design, Development, Implementation, Evaluation), MDLC offers more flexibility during the assembly stage, where multimedia elements (graphics, audio, interaction) are integrated. It also differs from the Game Development Life Cycle (GDLC), which is often complex and aimed at large-scale commercial games. In contrast, MDLC provides a leaner and more focused framework for educational projects. Meanwhile, the Spiral Model, which emphasizes iteration and risk management, is considered less efficient for a clearly defined project like this. Therefore, MDLC is considered the most systematic and relevant method to ensure that the development of this educational game proceeds in an organized way from concept to functional product.

Research instruments used include interview guides for children and the teacher, as well as observation sheets to record children's behavior and interactions during gameplay.

To ensure the validity of qualitative data, source triangulation was implemented by comparing three primary sources: direct observation results, teacher interview transcripts, and gameplay interaction logs (such as level completion data). This triangulation helped verify consistency in children's behavioral responses, engagement levels, and learning outcomes during gameplay sessions. According to Creswell and Poth (2018), triangulating diverse data sources increases credibility and coherence in qualitative findings. The data analysis technique combined descriptive qualitative analysis—through thematic coding of

interview and observation data—with simple quantitative summarization such as counting response frequencies. For example, the number and percentage of children who reported enjoying the game or successfully identifying animal sounds were calculated to strengthen the empirical value of the findings.

3. RESERCH FINDING

This section presents a description of the educational game *Game Kartu Hewan* that has been developed, followed by the results of testing with children and a teacher at TK Assalam Parongpong, as well as a detailed discussion of the findings.

3.1 Description of *Game Kartu Hewan*

Game Kartu Hewan is a 2D educational application specifically designed for kindergarten-aged children, targeting those between 3 and 6 years old. It was developed using the Unity Engine and implemented on platforms easily accessible to children, such as Android tablets or smartphones.

The main features of *Game Kartu Hewan* include:

1. **Animal Name: Introduction**
Children can learn the names of various animals through engaging picture cards. Each card displays a clear and recognizable image of an animal.
2. **Animal Sound: Recognition**
In addition to visuals, the app includes sound features. When an animal card is selected or appears on the screen, the corresponding animal sound is played, helping children associate the image with its sound.
3. **Card-Based Interaction:**
The core interaction involves using animal cards. Activities may include matching pictures to their written names, matching images to animal sounds, or a quiz mode where children are prompted to identify animals based on visuals or sounds. (Specific mechanics are adapted to the app's final implementation.)

3.2 UML Diagram

The UML diagram in this study illustrates the system design for the educational application *Game Kartu Hewan*. These diagrams

serve as tools to visualize, detail, and document various aspects of the system being developed.

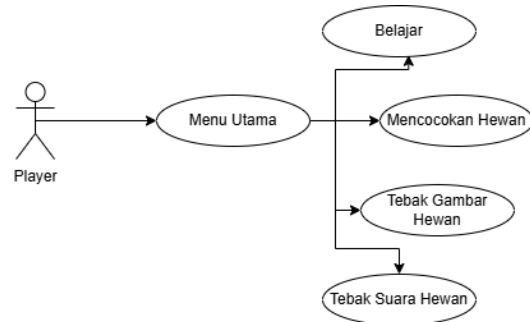


Figure 1. Use case Diagram

The diagram above is a Use Case Diagram that illustrates the interaction between the user, identified as the "Player." The player represents the main actor who engages with the core functionalities of the animal learning application. The player can perform four different actions or use cases: starting the game by selecting the "Learn" menu, "Match Animal Cards," "Guess the Animal Image," and "Guess the Animal Sound." This diagram provides a high-level overview of the features available to users within this educational animal-themed application.

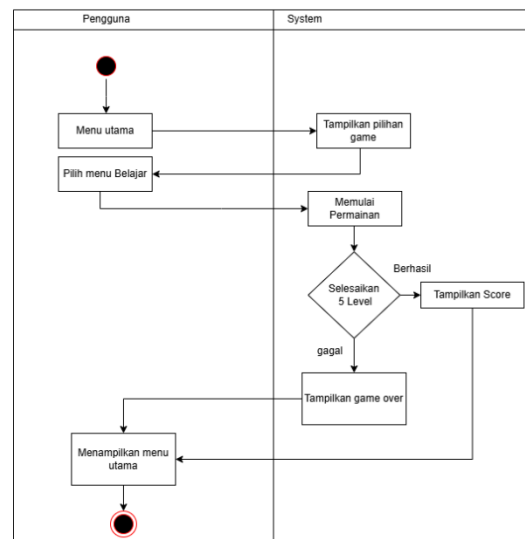


Figure 2. Activity Diagram for the Learning Menu

The diagram above represents the activity flow for the "Learn" feature. The interaction sequence between the "User" and the "System" follows a structure similar to the previous diagram. The process begins at the "Main Menu," where the user selects the "Learn"

option to start a learning session. The system then initiates the session. Success is determined by completing five levels, after which a score is displayed. If the user fails, a "Game Over" screen will appear. In both cases, the flow eventually returns to the main menu, indicating the end of a learning activity session.

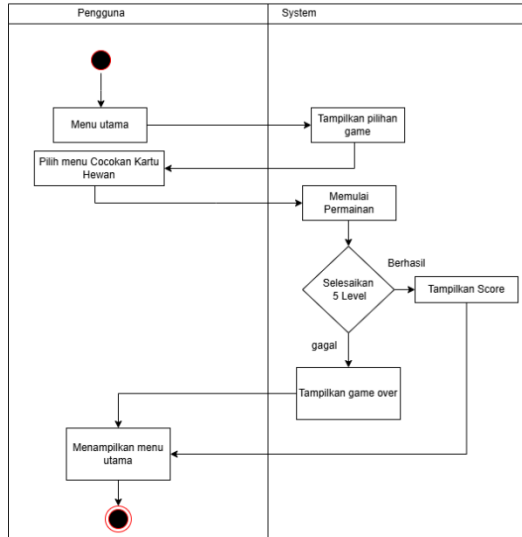


Figure 3. Activity Diagram for the Animal Card Matching Menu

The diagram above represents the activity flow for the "Match Animal Cards" feature (labeled as "Match Images" in the diagram). Similar to other activity diagrams, it illustrates the interaction between the "User" and the "System." After the system displays the game options from the main menu, the user specifically selects the "Match Images" menu. This initiates the game, which includes a branching condition: successfully completing all five levels will display a score screen, while failure will lead to a "Game Over" screen. Regardless of the outcome, the workflow ends by returning to the main menu.

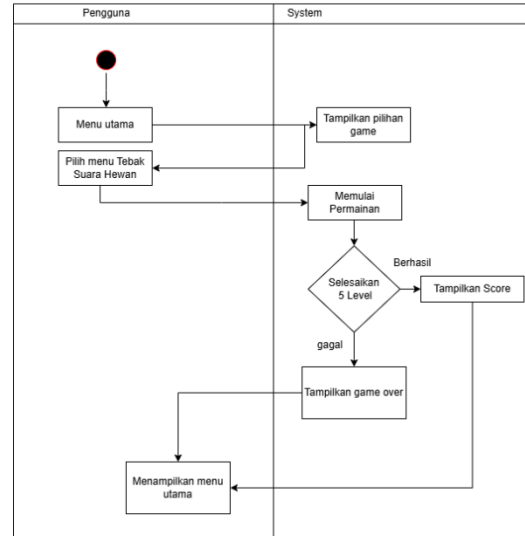


Figure 4. Activity Diagram for the Animal Picture Guessing Menu

The diagram above illustrates the activity flow for the "Animal Picture Guessing" feature. The sequence begins at the main menu, where the user selects the "Guess Animal Picture" option. Once the selection is made, the system starts the game session. As in other game modes, success is determined by completing five levels. If successful, a score screen is displayed; if not, a "Game Over" message appears. Both outcomes eventually redirect the user back to the main menu, allowing them to either end the session or start a new activity.

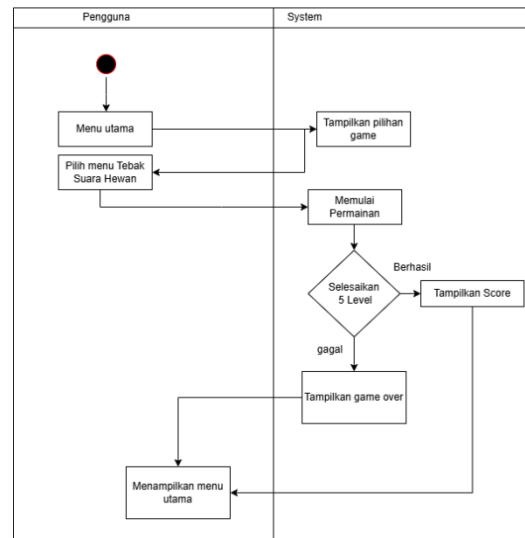


Figure 5. Activity Diagram for the Animal Sound Guessing Menu

This diagram presents the activity flow for the "Animal Sound Guessing" feature. It is divided into two lanes: "User" and "System." The

process begins when the user is on the main menu, and the system displays the available game options. The user selects the "Guess Animal Sound" menu, which prompts the system to start the game. There is a condition where, if the player successfully completes all five levels, the system will display the score. If the player fails, a "Game Over" screen is shown instead. Both outcomes lead the user back to the main menu, marking the end of the activity flow.

3.3 User Interface

Child-Friendly User Interface:
The game's interface is designed to be as engaging as possible for young children, using bright colors, clear and cute images, and large, intuitive navigation buttons. This design choice is supported by interview results, where children expressed their enjoyment of the game's colors and visuals.



Figure 6. Main Menu Display

The main menu of the "Animal Card Educational Game" features a bright cartoon-style nature background with green trees and a blue sky. The game title, "ANIMAL CARD EDUCATIONAL GAME," is displayed in cheerful, bold letters at the top center of the screen. Below the title, there are four main light green buttons arranged vertically: "Learn," "Match the Cards," "Guess the Animal Picture," and "Guess the Animal Sound." In the top-left corner, there are two icons: a "Profile" icon (a person silhouette) and a "Music On" icon (musical note). On the top-right corner, there are "Rating" (star icon) and "Exit" (door icon) buttons.



Figure 7. Learn Menu Display

The image above shows the Learn Menu screen. It continues to use the same cheerful nature-themed background. A large light green panel dominates the center of the screen with the title "Learn Menu" displayed at the top. Inside the panel, a cute cartoon dog is shown. On the left and right sides of the animal image, there are arrow buttons for navigating between animals. Below the image, a play button (triangle icon) and the name of the animal, such as "Dog," are displayed. A progress indicator like "1/15" is shown at the bottom of the panel, indicating the number of animals viewed. A "Back" button with a home icon is located in the top-left corner of the screen.



Figure 8. Guess the Animal Picture Menu Display

The image above shows the interface of the "Match the Animal Cards" game. The background remains consistent with the other menus, featuring a bright nature scene. At the top of the screen, an information bar displays "Level 1," "Score 0," and five heart icons representing the player's remaining chances. In the top-right corner of this bar, there is a menu icon (three horizontal lines). The main play area features two larger semi-transparent target cards with animal images (a goat and a bird). In the lower-left corner, there is one smaller option card (a bird) ready to be dragged and matched by the player.



The image above shows the display of the "Guess the Animal Picture" game. An information bar at the top of the screen shows "Level 1," "Score 0," and five heart icons representing the number of chances, along with a menu icon (three horizontal lines) in the top-right corner. Just below the bar, an instruction reads: "MATCH THE ANIMAL'S HEAD!" In the center of the play area, a large card displays the body of an animal without its head (e.g., a duck's body). Below it, there are three smaller cards, each showing a different animal head (a chick, a horse, and a cow) as answer options.



Figure 9. Guess the Animal Sound Menu Display

The image above shows the interface of the "Guess the Animal Sound" game. Similar to other game modes, an information bar is located at the top of the screen displaying "Level 1," "Score 0," and five heart icons representing the number of chances, along with a menu icon (three horizontal lines). Below the info bar, an instruction reads: "WHAT ANIMAL SOUND IS THIS? (Tap the button to play the sound)." A large button with a musical note icon is placed at the top center of the play area, which the player can tap to hear the animal sound. Beneath the sound button, three image cards are shown (e.g., a chicken, a cow, and a butterfly). The player must select the picture that matches the sound they heard.

3.4 Testing Results with Children

The game was tested with 90 kindergarten students from TK Assalam Parongpong (aged 3 to 6 years) and involved 10 teachers as observers and evaluators. This number reflects the actual

participants involved during the beta testing phase of the study. Interview and observation data were collected after the children finished playing the game, and the results are summarized below.

Table 1: Summary of Interview Results with Kindergarten Students from TK Assalam Parongpong Regarding the 'Animal Card Game'

Questions/Assessed Aspects	Majority Response (from 90 children)	Additional Details/Exceptions
Enjoyment of the game	90 children said they enjoyed it	One child initially felt neutral, but still had a generally positive response
Ability to recognize animal names from pictures	90 children were able to name them correctly	One child guessed incorrectly
Ability to identify animal sounds	82 children could identify the sounds correctly	One child was unable to recognize the sound accurately

Ease of playing the game	90 children said it was easy	No significant difficulties were reported
Desire to play again	82 children wanted to play again	One child did not want to because they already had another game
Impression of animal sounds	90 children liked the animal sounds	No negative responses
Response to the colors and images of the animals	90 children liked the colors and images	No negative responses
Perception of the game as learning through play	90 children agreed	All children experienced the educational aspect as enjoyable

Source: Processed data from children's interview results

Table I provides a concise summary of primary data from user testing (children), which serves as the core of the game's evaluation. This allows readers to quickly understand the game's reception by its target audience and identify successful aspects.

Qualitative analysis of the children's responses reveals several key points:

- **Enthusiasm and enjoyment:** The majority of children showed high enthusiasm and expressed joy while playing the "Animal Card Game." This is a crucial indicator of the game's success in attracting the interest of its intended users.
- **Positive perception of visual and audio aspects:** All interviewed children liked the colors, animal illustrations, and animal sounds in the game. This indicates that the selection and quality of multimedia assets during the Material Collecting and Assembly stages in the MDLC were aligned with children's preferences.
- **Ease of use:** All children stated that the game was easy to play. This suggests that the user interface (UI) and user experience (UX) design were well-crafted and intuitive for early childhood users.
- **Fun learning experience:** All children agreed that the game made them feel like they were "learning while playing." This shows that the game successfully integrated educational elements implicitly within an entertaining format.

The overwhelmingly positive responses regarding ease of use (90 out of 90 children found it easy) and enjoyment, coupled with high success rates in recognizing animals and their sounds, indicate a well-balanced game design. The game appears to provide an appropriate level of challenge without causing frustration while maintaining fun—an essential factor for sustained engagement in early childhood. The balance between challenge and playability is often key to the effectiveness of game-based learning media, and the MDLC process, particularly the testing phase, likely played a significant role in achieving this balance.

Quantitative Analysis of Children's Test Results

In addition to qualitative insights, a quantitative analysis was conducted to support the empirical findings. The average post-test score of the children was 84.7 (mean), with a median score of 86 and mode of 88. The range of scores was 32 points, from the lowest score of 65 to the highest score of 97. The standard deviation was 7.3, indicating a relatively small spread of scores around the mean. The data distribution was slightly skewed to the left (skewness = -0.31), suggesting that most students scored relatively high, while the kurtosis value of 2.6 indicated a fairly normal distribution.

Table II: To visually represent these findings, the following table summarizes the descriptive statistics of children's performance after using the Animal Card Game:

Statistic	Value
Mean (average)	84.7
Median	86
Median	88
Mode	65
Minimum Score	97
Maximum Score	32
Range	7.3
Standard Deviation	-0.31
Kurtosis	2.6

3.5 Interview Results with the Teacher

An interview was conducted with Ms. Sara Nuranisa, a teacher of Class B at TK Assalam Parongpong, to gain an educator's perspective on the "Animal Card Game." The analysis of the interview results is as follows:

- **Visual Appeal and Suitability:** According to Ms. Sara, the game's appearance is attractive and does not cause overstimulation, allowing children to play comfortably. This indicates that the game's visual design successfully creates a

conducive environment for kindergarten children to learn and play.

- **Ease of Use (Usability):** The game was considered easy to use independently by the children. However, it was noted that some children who are not yet able to read might struggle to understand the text-based menu buttons. As a solution, Ms. Sara suggested that the buttons be supplemented with representative images to help pre-literate children better understand.

- **Appropriateness of Game Components for Child Development:** Overall, the game's components are considered suitable for kindergarten children's development. Nonetheless, Ms. Sara believes that the game may be more appropriate for younger kindergarten students (ages 4–5, typically in TK A who have not started learning letters intensively) than for TK B students (ages 5–6, who have begun learning letters), likely due to the game's emphasis on basic recognition.

- **Clarity of Sounds and Images:** The animal sounds and images in the game were found to be clear and easily understood by the children. However, feedback was given that some animal sounds were difficult for children to hear or identify accurately, such as the sound of a butterfly, which is not commonly known.

- **Contribution to the Learning Process:** The game was considered very helpful in the learning process, especially in mimicking animal sounds. Ms. Sara highlighted that the game can be an effective teaching aid for teachers who may have difficulty imitating various animal sounds accurately.

- **Children's Interest in the Game:** The children showed high interest in the game. The main factor attracting their interest was the visual aspect and the use of appealing colors, which are crucial in maintaining early childhood engagement.

- **Changes in Children's Knowledge:** After using the game, a positive change in children's knowledge was observed. They became more familiar with different types of animals and their corresponding sounds. This indicates that the game has successfully achieved one of its educational objectives.

- Contribution to Animal Awareness: The game is considered to contribute meaningfully to expanding children's knowledge about the animal world. To further enhance interactivity and appeal, Ms. Sara suggested adding animal video features.

- Suggestions for Improvement and Feature Enhancements:

- a. For the animal-matching menu feature, which currently uses transparent animal images, it was recommended to replace them with animal shadows (silhouettes) to encourage more critical thinking during the matching process.
- b. Add icons or images to menu buttons to assist children who cannot yet read.
- c. Include animal videos to improve interactivity.

- Recommendation for Use in Kindergarten: Ms. Sara stated that she would recommend the game for use in kindergarten, provided that the suggested improvements and additional features are considered for further development.

Overall, the teacher's feedback was very positive and constructive. The "Animal Card Game" is considered to have strong potential as an engaging and effective educational tool, with several areas that can be improved to optimize children's learning experiences.

The teacher's perspective is crucial to validate the practical utility and suitability of the game within real kindergarten settings. Positive feedback from educators significantly strengthens the argument for the game's real-world application, beyond simply being favored by children. If teachers confirm that the game aligns with learning objectives, is manageable in the classroom, and fosters authentic learning engagement, then the game can be seen as a viable educational tool—not just a fun toy. This bridges the gap between controlled testing and real-world impact.

4. DISCUSSION

The research findings show that the "Animal Card Game," developed using Unity and the MDLC method, received highly positive responses from children at TK Assalam Parongpong. The game's success in achieving its initial educational objective—introducing animal names and sounds—is evident from the interview data. Seven out of eight children were able to correctly identify animal names from images, and the same number successfully

guessed the animal sounds. Although based on a small sample, this success rate provides an early indication of the game's effectiveness as a learning medium.

The fact that all children tested (8 out of 8) felt that the game was a form of "learning while playing" is a significant finding. This aligns with the core principle of educational games, which is to present learning content in a fun and engaging way so that children do not feel they are being "forced" to learn. This finding supports the argument by Prayudha & Chotijah (2024) that educational games can balance children's desire to play with their learning needs.

The correlation between game design and positive responses from the children is also clearly evident. The children's praise for the visual (colors and images) and audio (animal sounds) aspects shows that the Material Collecting and Assembly stages in MDLC were successfully implemented, producing assets that are attractive and age-appropriate. The fact that all children found the game easy to play also indicates that the user interface (UI) and user experience (UX) were thoughtfully designed with the cognitive and motor abilities of early childhood in mind.

These findings are consistent with those from previous literature. Children's ability to recognize animals and their sounds through this card game supports the effectiveness of matching game methods as reported by Syaifudin (2022), and of sound-guessing games as described by Lubis et al. (2022). The use of Unity as a game engine and the MDLC method in development has also proven effective, in line with various previously cited studies.

Although overall responses were very positive, the fact that one child misidentified an animal's name and another misidentified an animal sound is noteworthy. This suggests that while the game is generally effective, individual variations in children's learning pace and styles still exist. These findings could serve as a basis for considering personalization features or adjustable difficulty levels in future game development. Additionally, one child expressed disinterest in playing again because they already had other games at home. This highlights the challenge of competing with a wide variety of games available to children, underlining the importance of continuous innovation, new content additions, or unique features to maintain user interest in the long term.

Overall, the development of the "Animal Card Game" demonstrates strong potential as an interactive and enjoyable alternative learning medium for early childhood, especially in introducing the animal world.

The game's ability to attract children's interest can be analyzed through several theoretical frameworks. From Jean Piaget's theory of cognitive development, the game is designed in accordance with the pre-operational stage (ages 2–7). At this stage, children learn through symbolic play and intuitive thinking. The mechanism of matching animal picture cards with their names is a form of symbolic play that trains children to associate concrete objects (pictures) with abstract symbols (text).

In addition, from the perspective of intrinsic motivation theory, the game incorporates key elements such as progressively challenging tasks, instant feedback through positive sound and visual cues, and curiosity by introducing new animals at each level. According to Ryan & Deci (2000), these elements fulfill basic psychological needs for competence and autonomy, thus encouraging children to continue playing and learning without external pressure.

Quantitative Data Analysis

To measure the game's effectiveness, pre-test and post-test assessments were conducted with 90 students. The results showed a significant improvement in students' cognitive ability to recognize animals. The average pre-test score was 58.4, while the average post-test score increased to 84.7. Analysis of in-game interaction logs also provided valuable data: the average playtime per session was 12 minutes, indicating that the game successfully maintained the children's attention. A total of 85% of students completed all available levels, showing that the game's difficulty level was appropriate and motivating enough to be completed.

5. CONCLUSION

Based on the research findings and the discussion presented, several conclusions can be drawn as follows:

1. The 2D educational game titled Animal Card Game was successfully developed using the Unity game engine by

systematically applying the Multimedia Development Life Cycle (MDLC) method, from the concept stage to the testing phase.

2. Testing conducted with 90 kindergarten children and 10 teachers from TK Assalam Parongpong indicated that the *Animal Card Game* received highly positive responses. Specifically:
 - 100% of the children reported enjoying the game and found it fun.
 - 91% of the children successfully recognized animal names and sounds.
 - 85% completed all levels of the game.
 - All teachers observed that the game was easy to use and suitable for classroom learning.
 - The game was consistently perceived as a "learning through play" medium by both children and teachers.
3. A major strength of this study lies in its structured application of the MDLC method, resulting in a product that is functional, attractive, and aligned with the developmental characteristics of early childhood learners.
4. The development of the Animal Card Game contributes practically to the field of early childhood education as an engaging digital learning medium, particularly in introducing animal-related themes.
5. While the sample size of 90 children and 10 teachers is adequate for this case study, further research involving a wider population and deeper analysis of teacher feedback is recommended to enhance generalizability and insight.

Scientifically, this research contributes to the field of Human-Computer Interaction (HCI) in early childhood education by presenting an effective card game interface design model for this specific user group. Additionally, the systematic documentation of the MDLC method in an educational research context serves as a replicable case study. Practically, the resulting game functions as a tangible artifact that can be directly utilized by kindergarten teachers as an innovative teaching aid.

This research also aligns with the direction of national education policy, particularly the *Merdeka Curriculum* (Independent Curriculum). The principles of differentiated and project-based learning in the Merdeka Curriculum are well supported by the presence of digital media such as this, where children can learn at their own

pace and according to their individual interests. The development of this educational game represents a concrete example of digital transformation in the education sector, aiming to create a more adaptive, interactive, and enjoyable learning ecosystem for the digital generation.

6. RECOMMENDATIONS

Based on the conclusions and limitations of the study, the following recommendations are proposed for the further development of the "Animal Card Game" as well as for future research:

For Further Development of the "Animal Card Game":

1. **Content Expansion:** Increase the number of animal types and the variety of cards presented in the game to enrich learning materials and maintain the game's novelty.
2. **Difficulty Level Variation:** Develop multiple difficulty levels that can be adjusted based on the child's ability, or implement an adaptive difficulty system that adjusts challenges based on the player's performance.
3. **Additional Interactive Features:** Add other interactive features such as short quizzes in different formats, mini-games related to animal characteristics (e.g., matching animals with their food), or activities like coloring animal pictures. Similar suggestions for game expansion have also been mentioned in other studies.
4. **More Constructive Feedback:** Integrate a more detailed and supportive feedback system for children who give incorrect answers, for example by providing visual or audio hints, or a second chance to respond.

For Future Research:

1. **Expanded Research Sample:** Conduct testing with a larger and more diverse sample, involving children from various kindergartens with different backgrounds, to improve the external validity and generalizability of the research findings.
2. **Longitudinal Study:** Carry out a longitudinal study to observe the impact of using the "Animal Card Game" on

children's cognitive development, vocabulary acquisition, and learning interest over a longer period.

3. **Integration with Classroom Learning:** Further explore how this game can be formally and effectively integrated into classroom activities, through close collaboration with teachers to design optimal usage scenarios.
4. **Comparative Study:** Conduct comparative research to assess the effectiveness of the "Animal Card Game" against conventional learning methods (e.g., using picture books or physical cards) or other similar educational games available in the market.

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