

DEVELOPMENT AND EVALUATION OF A DIGITAL HYGIENE LEARNING GAME FOR KINDERGARTEN CHILDREN



Conduct by:

Name : Khun Muhammad Dalle Jasmin

Student ID : 22523264

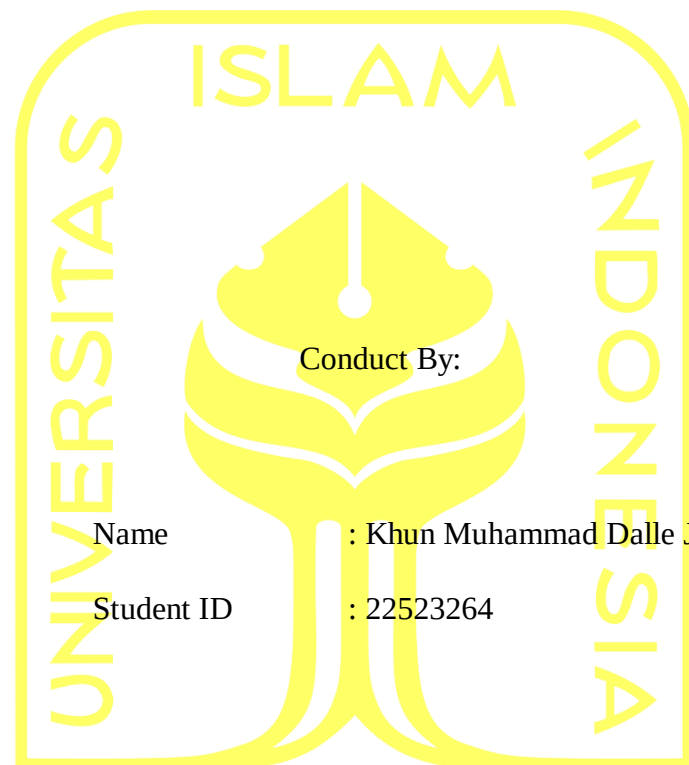
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SUPERVISOR ENDORSEMENT PAGE

**DEVELOPMENT AND EVALUATION OF A DIGITAL
HYGIENE LEARNING GAME FOR
KINDERGARTEN CHILDREN**

THESIS



Name : Khun Muhammad Dalle Jasmin

Student ID : 22523264



Yogyakarta, May 25th, 2026

Advisor,

(Chanifah Indah Ratnasari, S.Kom., M.Kom.)

EXAMINER ENDORSEMENT PAGE

DEVELOPMENT AND EVALUATION OF A DIGITAL HYGIENE LEARNING GAME FOR KINDERGARTEN CHILDREN

THESIS

Has been defended in front of the examiners as one of the requirements to obtain a Bachelor of Informatics degree from the Undergraduate Program in Informatics at the Faculty of Industrial Technology, Universitas Islam Indonesia

Yogyakarta, May 25th, 2026

Chair

Chanifah Indah Ratnasari, S.Kom., M.Kom.

Examiner 1

Ahmad Luthfi, Dr., S.Kom., M.Kom.

Examiner 2

Dr. Nur Wijayaning Rahayu, S.Kom., M.Cs.

Acknowledged by,

Head of Undergraduate Program in Informatics

Faculty of Industrial Technology

Universitas Islam Indonesia



(Ir. Dhomas Hatta Fudholi, S.T., M.Eng., Ph.D.)

AUTHENTICITY STATEMENT

The undersigned:

Name : Khun Muhammad Dalle Jasmin
Student ID : 22523264

Final project with title:

DEVELOPMENT AND EVALUATION OF A DIGITAL HYGIENE LEARNING GAME FOR KINDERGARTEN CHILDREN

Stating that all components and contents in this final project are my own work. If in the future it is proven that some parts of this work are not my own work, the final project submitted as my own work is ready to be withdrawn and ready to bear any risks and consequences.

Thus this statement letter is made, hopefully it can be used properly.

Yogyakarta, April 23rd, 2026



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(Khun Muhammad Dalle Jasmin)

DEDICATION

Alhamdulillah, with deepest gratitude, I dedicate this final project to Allah Swt. for His endless blessings and guidance throughout my research journey. I am profoundly grateful to my parents for their unwavering support, prayers, and belief in my potential, which motivated me to achieve this milestone. My sincere thanks go to my academic advisor, Chanifah Indah Ratnasari, S.Kom., M.Kom., for her patient mentorship and invaluable insights during the development of this thesis. I also extend my appreciation to the teachers and students of *TK Sultan Agung* for their enthusiastic participation.

MOTTO

“What begins with doubt can end with discovery, when effort is guided by sincerity and trust in the process.”

FOREWORD

Alhamdulillah, praise and gratitude be to Allah Swt. for His abundant grace, mercy, and guidance, which allowed the author to complete this final project report titled "Development and Evaluation of a Digital Hygiene Learning Game for Kindergarten Children." This report is submitted as a requirement to obtain a Bachelor's degree from the Undergraduate Program in Informatics, Faculty of Industrial Technology, Universitas Islam Indonesia.

The completion of this research was made possible through the support, guidance, and prayers of many parties. Therefore, the author would like to express sincere gratitude and appreciation to:

1. Allah Swt., for the endless blessings and strength provided throughout every stage of this journey.
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9. My friends and fellow Informatics students, for their support and companionship throughout this academic process.

The author realizes that this report is far from perfect. Therefore, any constructive criticism and suggestions for future improvement are highly appreciated. Hopefully, this research contributes meaningfully to the field of early childhood education and health.

Yogyakarta, May 25th, 2026

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(Khun Muhammad Dalle Jasmin)

ABSTRACT

Improving clean and healthy living habits in early childhood is critical as many young children require structured support to practice daily hygiene routines consistently. Preventable health problems related to poor hygiene behavior, such as diarrheal diseases and infections, remain a significant concern among children under five. This study aimed to develop and evaluate a digital learning game, "Hygiene Hero: Clean Up Buddies," for kindergarten children aged four to six years.

The research employed a design and development approach using the Prototyping Model as the software development model, which allowed for iterative refinement through three main phases: Listen to Customer, Build/Revise Prototype, and Customer Test Drives Prototype. The game content was explicitly grounded in authentic daily routines practiced in kindergarten settings, such as washing hands, brushing teeth, sorting waste, and cleaning classroom spaces. Evaluation was conducted through a one-group pre-test–post-test design to examine the game's effect on children's knowledge, and a usability assessment using an adapted System Usability Scale (SUS).

The findings showed a statistically significant improvement in children's hygiene knowledge ($Z = -2.262$, $p = 0.024$), with the mean score increasing from 81.05 to 89.47. Furthermore, the game achieved high usability with an average SUS score of 88.42, placing it in the "Excellent" to "Best Imaginable" category. This indicated that the interface was appropriate and well-accepted by young learners. This study contributes to early childhood education by demonstrating that digital games designed around authentic classroom hygiene routines and refined through iterative feedback can serve as effective complementary media to reinforce healthy habit formation.

Keywords: Digital Educational Game, Early Childhood Hygiene, Interactive Learning Media, Prototyping, Usability.

GLOSSARY

APK	Short for Android Package Kit, the file format used by the Android operating system for the distribution and installation of mobile apps.
Canva	A graphic design tool used in the initial phase of this research to create raw visualizations and early concepts of the game.
Drag and Drop	Game interaction method where players actively move a visual object from one starting position to a specific target area.
Figma	Collaborative interface design tool used to create low-fidelity and high-fidelity prototypes for visualizing game layout and flow.
High-Fidelity	Version of a prototype that closely resembles the final product in terms of visuals and interaction.
Low-Fidelity	Simplified version of a design, often used in early prototyping to test basic flow and navigation without complex visuals.
Prototyping Model	Iterative software development method that involves repeating cycles of listening to users, building/revising designs, and user testing to refine requirements.
System Usability Scale	A ten-item standardized questionnaire used to evaluate the perceived usability of a system, with a final score ranging from 0 to 100.
Unity	A widely recognized game development engine used to implement two-dimensional or three-dimensional interactive digital applications.
Waterfall	A linear software development model where each phase must be completed before the next one begins.
Wilcoxon Signed-Rank Test	Non-parametric statistical method used to evaluate differences between pre-test and post-test scores when data do not meet normal distribution assumptions.

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CHAPTER I

INTRODUCTION

1.1 Background

Preventable health problems related to poor hygiene practices remain a significant concern among young children. Empirical evidence consistently shows that inadequate hygiene behavior is associated with increased risk of infectious diseases. A cross-sectional study in Myanmar reported that children under five living in households with limited hygiene practices had a significantly higher prevalence of diarrheal disease compared to those with adequate hygiene facilities (Soe et al., 2024). Similarly, research in Indonesia found that handwashing with soap (HWS) was statistically associated with diarrhea incidence among toddlers and was identified as a significant determinant of diarrheal cases in the study area (Safaryna et al., 2024). In addition, poor personal hygiene behaviors such as inadequate handwashing and nail cleanliness have been linked to Soil-Transmitted Helminth (STH) infections among school-aged children (Afandi et al., 2025). These findings suggest that hygiene behavior plays an important role as a determinant of children's health outcomes rather than merely functioning as a daily routine.

In early childhood education, clean and healthy living behaviors must be formed at an early age to establish sustainable habits. Studies in Indonesian early childhood settings indicate that children's awareness and consistency in practicing hygiene routines still require structured reinforcement and educational support (Kasmiati, 2023; Windarta, 2021). Preliminary classroom observations conducted in this study indicate that preschool children often forget to wash their hands before eating, do not brush their teeth properly, and tend to neglect environmental cleanliness unless repeatedly reminded by teachers. These realities highlight the urgency of designing hygiene education strategies that go beyond verbal instruction and promote active habit formation.

Children aged 4–6 years are typically in the preoperational stage of cognitive development, which is characterized by symbolic thinking and learning through concrete experiences according to Piagetian developmental theory (Khotimah & Agustini, 2023). From a psychosocial perspective, this age range corresponds to Erikson's stage of initiative versus guilt, during which children begin developing autonomy, responsibility, and early self-regulation skills (Berk, 2013). Therefore, hygiene education at this developmental stage must

be delivered through interactive, experience-based learning approaches that align with children's cognitive and psychosocial characteristics.

Game-based learning has been widely recognized as an effective pedagogical strategy in early childhood education. Interactive learning media and educational games have been shown to enhance engagement, motivation, and active participation among young learners (Candra & Rahayu, 2021; Putri & Fadlilah, 2023). A meta-analysis by Alotaibi (2024) reported that game-based learning in early childhood education produces moderate to large effects on cognitive outcomes and learner engagement when aligned with learning objectives. Furthermore, de Freitas (2018) emphasizes that educational games are effective learning tools when systematically designed and pedagogically grounded.

In the field of health education, digital and game-based interventions have also demonstrated positive outcomes. Randomized and quasi-experimental studies indicate that interactive digital games significantly improve children's oral hygiene knowledge and practices compared to traditional teaching media (Azarys et al., 2024; Kumar K et al., 2022). In Indonesia, hygiene-themed educational games and digital applications have been developed to support children's personal hygiene learning (Amalia et al., 2020; Latif et al., 2023; Nurcholis et al., 2017). These studies confirm the potential of digital media to facilitate hygiene education.

1.2 Problem Statement and Research Question

The development of this digital hygiene learning game is driven by the following research gaps and practical challenges:

- a. Several existing digital hygiene learning products tend to present general health content without explicitly grounding the material in authentic daily hygiene routines practiced in kindergarten settings.
- b. Prior studies have implemented structured software development methodologies, including Unified Modeling Language (UML)-based design and Software Development Life Cycle (SDLC)-based multimedia or game development (Latif et al., 2023; Nurcholis et al., 2017). Although these studies involved users or stakeholders during requirement gathering or testing, they did not clearly emphasize repeated teacher and child prototype refinement combined with learning outcome measurement and standardized usability evaluation.

- c. Standardized usability evaluation is not consistently reported for hygiene-focused digital games in early childhood education, making it difficult to ensure applications are developmentally appropriate and intuitive for young learners.

Based on these gaps, the research question is broken down into the following components:

- a. How can a hygiene-focused digital learning game be designed through an iterative prototyping process that actively involves both teachers and children?
- b. How can the game be developed so that it is grounded in authentic kindergarten routines and remains pedagogically meaningful and developmentally appropriate?
- c. How can the practical usability of the game be evaluated using a recognized measurement instrument?

1.3 Scope of Work

This research focused on:

- a. Android-based game;
- b. Unity engine implementation;
- c. Designed for kindergarten children aged 4–6 years;
- d. The game covers six kindergarten routines: bathing, toothbrushing, tidying toys, classroom cleaning, waste sorting, and handwashing before eating.
- e. The evaluation emphasizes a pre-test and post-test knowledge assessment, an adapted System Usability Scale (SUS), and qualitative validation through teacher and child feedback.

1.4 Research Objective

The objectives of this research are:

- a. To design a hygiene-focused digital learning game authentic to real kindergarten routines.
- b. To develop the game through an iterative process with teacher and child involvement.
- c. To evaluate its learning outcomes and usability using a recognized instrument.
- d. To ensure the game is educationally meaningful and suitable for young learners.

1.5 Research Contribution

This research is expected to contribute by establishing a framework for integrating hygiene education into digital learning environments for early childhood. It showcases an

iterative, collaborative design approach, produces a developmentally appropriate and user-friendly game, and provides empirical evidence on its educational effectiveness and usability.

1.6 General Research Methodology

This study employed a design and development research approach using a Prototyping Model as the software development model. The general research methodology consisted of the following stages:

- a. Listen to Customer: Gather needs via observation/interviews.
- b. Build/Revise Prototype: Create low-fidelity to high-fidelity versions, refining based on input.
- c. Customer Test Drives Prototype: Real-world trials yield actionable feedback for the next build.

The final evaluation combined a one-group pre-test and post-test design to measure children's hygiene knowledge, an adapted SUS questionnaire to evaluate usability, and qualitative feedback to interpret the testing results.

1.7 Report Structure

The structure of this thesis consists of several chapters in this final assignment, including:

- a. Chapter I introduction, which contains the background, problem formulation, problem limitations, research objectives, research contribution, research methodology, and research systematics.
- b. Chapter II literature review, contains theories and similar studies relevant to hygiene education, educational games, development methodologies, and evaluation methods.
- c. Chapter III methodology, explains the research approach, development procedure, testing instruments, and data analysis procedure.
- d. Chapter IV result and discussion, presents the development results, prototype testing results, game testing results, and interpretation of the findings.
- e. Chapter V conclusion and suggestion, contains the conclusions, limitations, and recommendations for future research.

CHAPTER II

LITERATURE REVIEW

2.1 Hygiene and Cleanliness

Cleanliness and hygiene are related, but they do not refer to the same concept. Cleanliness refers to the visible condition of being clean and orderly, such as clean surroundings, clean learning materials, and properly organized classroom objects. Hygiene has a broader health-oriented meaning because it refers to practices that help prevent disease transmission and support healthy living habits. In early childhood education, hygiene learning may include personal hygiene, environmental cleanliness, and sanitation, such as washing hands, brushing teeth, bathing, keeping clothes clean, maintaining clean surroundings, using toilets properly, and managing waste (Haryani, 2024; Pradhan et al., 2020).

This distinction is important for understanding hygiene learning content for children. Hygiene education does not only teach children to recognize clean or dirty objects, but also helps them understand simple health related routines, self care, independence, and responsibility. Personal hygiene can be introduced through body care, oral care, and hand hygiene, while environmental cleanliness can be introduced through activities related to keeping learning spaces, shared objects, and surroundings clean. These routines are relevant because regular hygiene practices, including handwashing and toothbrushing, are associated with children's development and daily health behavior formation (Petermann-Rocha et al., 2023).

2.2 Education Game

Game-based learning refers to the use of game elements, interaction, goals, feedback, and challenges to support the learning process. In this context, an educational game is not only designed for entertainment, but also to help learners understand specific learning material through structured activities. For early childhood education, digital educational games can support learning because children are often more engaged when the material is presented through pictures, animation, sound, movement, and simple interaction.

Educational games have been shown to support students' learning outcomes, engagement, and motivation across several educational levels. Recent research indicates that game-based learning (GBL) can improve understanding of complex ideas and support the practical application of knowledge (Mikrouli et al., 2024). The use of game-based learning

media, such as educational games, can reduce learning monotony and increase children's interest in learning (Candra & Rahayu, 2021). Children are also more responsive to interactive multimedia because it increases their engagement in the learning process (Putri & Fadlilah, 2023).

2.3 Early Childhood Hygiene Education

Early childhood hygiene education is important because clean and healthy habits need to be introduced from an early age. Children aged 4–6 years are in an important stage of cognitive, motor, and independence development, so this period is suitable for building basic self-care habits (Khotimah & Agustini, 2023; Wulandari, 2019). Hygiene education at this age does not only teach children to know what is clean or dirty, but also helps them practice daily routines that support personal health, environmental cleanliness, and independence.

In kindergarten, relevant hygiene routines include washing hands before eating, brushing teeth, bathing, using soap and shampoo, drying the body with a towel, tidying toys after playing, throwing trash into the correct bin, and cleaning simple classroom objects such as dusty tables. These routines are familiar to children and can be connected directly to their daily activities at school or at home.

However, hygiene learning for early childhood also has challenges. Children may have limited reading ability, short attention spans, and difficulty understanding abstract explanations. Therefore, hygiene education should be delivered through concrete examples, visual media, repetition, direct practice, and teacher or adult guidance so that children can understand and apply the habits more effectively.

2.4 Characteristics of Kindergarten Children as Learners

Kindergarten children aged four to six years are still developing their cognitive, language, motor, and social abilities. At this stage, children tend to understand learning material more easily when it is connected to concrete objects, familiar daily routines, and direct experiences. Therefore, learning activities for this age group should be simple, visual, and developmentally appropriate, especially when introducing practical topics such as hygiene behavior (Berk, 2013; Khotimah & Agustini, 2023).

Children in this age group also learn better through concrete, visual, and interactive experiences, such as pictures, animation, sound, movement, and simple hands-on tasks. However, they still need guidance from teachers or adults to understand instructions, use

learning media correctly, and connect the activity with real-life behavior. Therefore, a digital learning game for kindergarten children should provide clear visuals, simple navigation, audio support, interactive activities, and opportunities for teacher or adult assistance when needed (Putri & Fadlilah, 2023).

2.5 Digital Game-Based Hygiene Learning

Interactive game-based approach is suitable for hygiene education because hygiene routines are practical behaviors that are easier to understand through concrete actions rather than verbal explanation alone. Activities such as dragging trash into the correct bin, tapping a toothbrush, choosing hygiene tools, or following handwashing steps can help children connect the learning content with real daily routines. Therefore, digital educational games can be used to introduce and reinforce hygiene knowledge in a way that is visual, interactive, and appropriate for kindergarten children.

However, the educational value of a hygiene game depends on how closely the game content reflects the real behavior expected from children. A game that only provides general health information may be less meaningful if it is not connected to the actual routines practiced in the classroom. Therefore, the development of a hygiene learning game needs to combine pedagogical content, child-friendly interaction design, and evaluation methods that can measure both usability and learning outcomes.

2.6 Four-Dimensional Framework (4DF)

To strengthen the educational basis of the game design, this study refers to the Four-Dimensional Framework (4DF) as an educational context model for digital game-based learning. The framework explains that educational games should be considered through four connected dimensions: the learner, the pedagogic approach, the representation of learning content, and the context in which the game is used (de Freitas & Oliver, 2006). In this study, 4DF is used as a pedagogical lens rather than as a software development methodology. The game was still developed through prototyping, while the framework helped clarify whether the prototype was appropriate as a hygiene learning medium for kindergarten children.

In relation to the developed game, the learner dimension refers to children aged four to six years who need concrete visuals, short instructions, simple interaction, audio support, and teacher guidance. The pedagogy dimension is reflected in the use of repeated hygiene routines, direct actions, immediate feedback, and quiz tasks to reinforce children's understanding. The

representation dimension refers to the way hygiene routines are translated into two-dimensional objects, animation, narration, drag-and-drop interaction, tapping, and simple quiz activities. The context dimension refers to the use of the game at TK Sultan Agung, where hygiene learning is connected to classroom routines, teacher assistance, available testing time, and children's existing habits at school and home.

2.7 Unity

Unity is a widely used game engine for developing two-dimensional and three-dimensional games and interactive applications. Its flexibility, cross-platform support, asset management, animation tools, scripting features, and large development ecosystem make it suitable for educational game development. Unity also supports deployment to mobile devices such as smartphones and tablets, which is relevant to this study because the final product was developed as an Android-based game.

2.8 Related Hygiene Learning Media

The review of similar research was conducted to identify previous studies related to educational games, hygiene learning media, children's learning, development methods, and evaluation methods.

2.8.1 Literature Search Strategy

Previous studies have developed hygiene-related learning media and digital games for children. The literature search for this section was conducted using Google Scholar, ScienceDirect, IEEE Xplore, and ResearchGate. The English keywords included "educational game for hygiene children", "digital hygiene learning game", "personal hygiene educational game Android", "early childhood hygiene education game", "game-based learning early childhood hygiene", and "System Usability Scale educational game". Indonesian keywords included "*game edukasi kebersihan anak*", "*permainan personal hygiene anak usia dini*", "*media game PHBS anak*", and "*aplikasi game edukasi kebersihan diri berbasis Android*". The search was mainly limited to publications from 2016 to 2025 to obtain recent studies related to educational games, hygiene learning media, development methods, and evaluation methods.

2.8.2 Explanation and Analytical Synthesis of Previous Studies

Nurcholis et al. (2017) designed a 2D educational game titled “Garbalien Invasion” with the theme of environmental hygiene. The study used an SDLC-based approach supported by multimedia development and game design documentation. The study is relevant because it shows how hygiene-related content can be transformed into a game, but the evaluation was more focused on design and implementation rather than statistical measurement of learning outcomes.

Putra et al. (2016) developed “Let’s Clean Up”, a game for children’s hygiene learning. The game introduced hygiene-related activities through interactive media and was intended for elementary school children. This study supports the idea that hygiene can be introduced through game-based media, although the target users were older than kindergarten children and the study did not emphasize iterative teacher-child prototyping.

Amalia et al. (2020) examined the effectiveness of the Sehat-I game on personal hygiene in early childhood using a quasi-experimental nonrandomized pre-test–post-test control design. This study is important because it evaluated the effect of a game on hygiene-related outcomes, not only the design of the media. However, the study did not focus on Android game development or usability testing with SUS.

Lubis et al. (2022) designed the “*Ayo Bersih*” educational game for children using the SDLC Waterfall method and RPG Maker MV. The game aimed to encourage children to maintain cleanliness in daily life. The study is relevant to the hygiene theme, but its linear development method provides limited space for repeated refinement with very young users.

Latif et al. (2023) developed an Android-based personal hygiene educational game application for children. The study used Unity 3D and UML-based design and evaluated the application using Black Box testing. This study is closely related to the present research because it also uses Android and hygiene content. However, the evaluation emphasized application feasibility and functional testing rather than combining pre/post knowledge testing and SUS-based usability evaluation.

Azarys et al. (2024) compared a digital educational game with PowerPoint-based video for improving oral hygiene knowledge among children aged seven to eight years. The study used a quasi-experimental pre-test–post-test design and found that digital educational games produced a higher increase in knowledge than PowerPoint-based video. This study provides strong evidence for using digital games in hygiene education, although the context was oral hygiene for elementary school children rather than authentic kindergarten routines.

Alotaibi (2024) conducted a systematic review and meta-analysis on game-based learning in early childhood education. Although the study was not specifically about hygiene, it provides a broad theoretical foundation showing that game-based learning can support learning outcomes and engagement in early childhood education. This supports the selection of a digital game as the learning medium in the present research.

Table 2.1 Summary of Similar Research

Source	Focus/Topic	Target Users	Method/Platform	Evaluation Method	Main Finding and Relevance
Nurcholis et al. (2017)	2D environmental hygiene educational game	Children / general learners	SDLC-based multimedia development and Game Design Document	Design and implementation testing	Involves stakeholder input and beta testing, but does not report pre/post learning evaluation or SUS usability testing.
Putra et al. (2016)	“Let’s Clean Up” hygiene learning game	Elementary school children	Game design using Construct 2	User response / design evaluation	Relevant to hygiene learning through games, but target users are older than kindergarten children.
Amalia et al. (2020)	Sehat-I game for personal hygiene	Early childhood	Quasi-experimental intervention	Nonrandomized pre-test–post-test control design	Strong evaluation of effectiveness, but not focused on Android development or SUS usability.
Lubis et al. (2022)	Ayo Bersih educational game	Children aged 7-9 years	SDLC Waterfall and RPG Maker MV	Implementation evaluation	Relevant hygiene game, but development is linear and less iterative.
Latif et al. (2023)	Android-based personal hygiene educational game	Children / elementary students	Unity 3D and UML-based design	Black Box testing and feasibility assessment	Uses Android, Unity 3D, observation/interview-based data collection, and feasibility testing, but does not combine repeated teacher-child refinement with pre/post learning evaluation and SUS usability testing.
Azarys et al. (2024)	Digital educational game for oral hygiene knowledge	Children aged 7-8 years	Quasi-experimental pre-test–post-test	Paired t-test and independent t-test	Provides evidence that digital games can improve hygiene knowledge better than video media.
Alotaibi (2024)	Game-based learning in early	Early childhood learners	Systematic review and meta-analysis	Effect size synthesis	Supports game-based learning as an effective approach for

	childhood education				early childhood education.
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Table 2.2 Analytical Framework of Similar Research

Source	Hygiene Focus	Media Type	Development / Research Method	Target User	Pre/Post Statistical Test	User-Centered Iteration	SUS Usability Test
Nurcholis et al. (2017)	Environmental hygiene	Digital game	SDLC-based multimedia	Children	No	Limited	No
Putra et al. (2016)	General hygiene	Digital game.	Game design / Construct 2	Elementary children	No	Limited	No
Amalia et al. (2020)	Personal hygiene	Game intervention.	Quasi-experimental	Early childhood	Yes	No	No
Lubis et al. (2022)	Clean living habits	Digital RPG game	Waterfall / RPG Maker MV	Children aged 7-9	No	No	No
Latif et al. (2023)	Personal hygiene	Android game	Unity 3D / UML	Children	No	Limited	No
Azarys et al. (2024)	Oral hygiene knowledge	Digital game	Quasi-experimental	Children aged 7-8	Yes	No	No
Present Research	Daily kindergarten hygiene routines	Android game	Iterative prototyping	Kindergarten children aged 4-6	Yes	Yes	Yes

Based on the analytical framework, previous studies show that hygiene learning games have been developed for environmental hygiene, personal hygiene, and oral hygiene. However, most of them still focus on general hygiene content, older children, structured development methods, or functional testing. Only a few studies evaluate learning outcomes through pre-test and post-test designs, and standardized usability testing such as SUS is still rarely applied.

Therefore, the present research addresses this gap by developing an Android-based hygiene learning game that is grounded in authentic kindergarten routines, such as handwashing before eating, tidying toys, cleaning the classroom, and sorting waste. This study also combines teacher-child iterative prototyping, pre/post statistical testing, and SUS usability evaluation, so it contributes not only as a digital hygiene learning product but also as an evaluation-based development study for early childhood educational games.

2.9 Prototyping Model

The exact software development model used in this study was the Prototyping Model. In this report, SDLC is treated as the broader software development life cycle concept, while the

Prototyping Model is treated as the specific iterative model applied in the development process. The term prototype refers to the temporary game artifact produced in each iteration, while Prototyping Model refers to the iterative process that structures requirement gathering, prototype construction, user testing, and revision. Therefore, the term Prototyping Model is used to describe the development methodology, whereas prototype is used to describe the product artifact created during the process (Pressman & Maxim, 2019; Tanaga & Oetama, 2023). Key phases include:

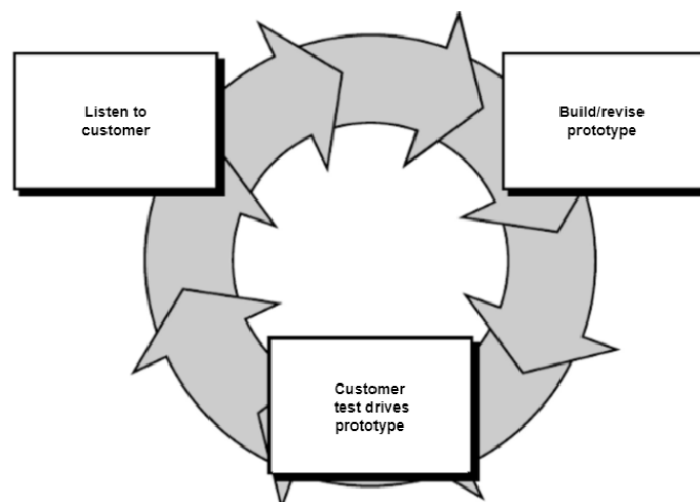


Figure 2.1 Prototyping Model Phases

- a. Listen to Customer is the phase for identifying user needs, learning context, design preferences, and functional requirements from stakeholders.
- b. Build/Revise Prototype is the phase for constructing a low-fidelity or high-fidelity prototype and revising it according to feedback.
- c. Customer Test Drives Prototype is the phase for testing the prototype with users to check usability, content suitability, and the need for further revision.

The Prototyping Model is relevant to this study because the requirements for a kindergarten learning game cannot be fully defined from literature or interviews alone. Teachers and children need to interact with early versions of the game before they can identify problems related to visual clarity, instruction, activity flow, audio, and content suitability. Through repeated refinement, the model supports teacher-child feedback and helps ensure that the game is understandable, usable, and developmentally appropriate before final testing.

2.9.1 Comparison of Game Development Methodologies

The comparison of development models in this study focuses on the fit between each model and the research context. Important considerations include the target users, the need for feedback cycles, the flexibility of requirements, and the evaluation needs of the educational game.

Table 2.3 Method Comparison

Method	Main Description	Strengths	Limitation	Suitability for This Research
GDLC	Game-specific development stages from concept to release.	Clear structure for game production; includes testing and release.	User feedback may still occur late if not combined with iterative testing.	Useful for organizing game production, but less focused on repeated teacher-child feedback.
Waterfall Model / Linear SDLC Approach	A linear SDLC model that moves from requirements to implementation and testing in sequence.	Predictable phases and strong documentation.	Less flexible when children or teachers request changes after testing.	Less suitable because kindergarten users require direct observation and revisions.
Prototyping Model / Iterative SDLC Approach	An iterative SDLC model that uses user input, prototype creation, testing, and revision.	Allows early visualization, direct feedback, and repeated refinement.	Requires time for multiple testing cycles and careful feedback management.	Most suitable because it supports teacher-child involvement and refinement of child-friendly design.

Based on the comparison in Table 2.3, the Prototyping Model was selected as the specific software development model used in this research. In this study, SDLC is understood as a broad software development life cycle concept that can include several models, such as Waterfall and Prototyping. Therefore, this research does not position Prototyping as separate from SDLC. Instead, it distinguishes the Prototyping Model as an iterative SDLC approach from the Waterfall Model as a more linear SDLC approach. The Prototyping Model was more suitable because the product targeted kindergarten children, whose needs could only be confirmed through direct interaction with early game versions. This model allowed teachers and children to evaluate early designs and allowed the researcher to revise the game based on actual feedback before final implementation and testing.

2.10 Evaluation Methods

Evaluation is an important stage in digital educational game research because the product must be assessed not only from its technical functionality, but also from its educational usefulness, usability, and suitability for target users. In this study context, evaluation methods can include learning outcome measurement through pre/post knowledge tests, usability measurement through the System Usability Scale, and qualitative validation through user feedback. Each method provides a different perspective: the pre/post-test measures knowledge change, SUS measures usability, and qualitative validation explains user experience and contextual findings.

Table 2.4 Summary of Evaluation Methods

Evaluation Aspect	Method	Purpose	Data Type	Use in This Study
Learning outcome	Pre/post knowledge test	Measures knowledge change before and after using the game.	Numerical test score	Used to evaluate children's hygiene knowledge improvement.
Instrument consistency	Cronbach's alpha	Measures whether test items are internally consistent.	Numerical reliability coefficient.	Used to check the reliability of the pre/post-test instrument.
Data assumption	Shapiro-Wilk test	Checks whether the score distribution is normal.	Significance value	Used to decide whether parametric or non-parametric analysis is appropriate.
Inferential analysis	Paired-samples t-test	Tests significant difference between two related scores when data are normal.	p-value	Mentioned as the parametric option if normality is fulfilled.
Inferential analysis	Wilcoxon signed-rank test	Tests significant difference between two related scores when data are not normal.	p-value / Z value	Used as the main test when the pre/post data are not normally distributed.
Usability	System Usability Scale	Measures perceived usability of the game.	SUS score 0–100	Used to evaluate whether the game is usable and acceptable.
Qualitative validation	Teacher interview and child feedback	Explains user experience and supports quantitative results.	Descriptive response	Used to interpret learning and usability findings.

2.10.1 Pre/Post Knowledge Testing

A pre/post knowledge test is used to measure the difference between participants' knowledge before and after an intervention. In a one-group pre-test–post-test design, the same participants answer a set of questions before using the learning media and then answer comparable questions after the intervention (Capili & Anastasi, 2024). The difference between the two scores is used as an indication of immediate learning change.

In this research, the pre-test and post-test are used to evaluate children's understanding of hygiene routines after playing the game. This design is appropriate because the research focuses on product development and initial evaluation rather than a full experimental comparison between different groups. However, the result should be interpreted as short-term knowledge improvement, not as definitive evidence of long-term behavior change. This limitation needs to be acknowledged because hygiene behavior requires repeated practice and observation over time.

2.10.2 Cronbach's Alpha

Before the learning outcome is interpreted, the consistency of the test instrument should be considered. Reliability analysis is used to examine whether the test items measure the intended construct consistently. One commonly used reliability measure is Cronbach's alpha, which estimates the internal consistency of a set of items (Cronbach, 1951; Tavakol & Dennick, 2011). A higher alpha value generally indicates stronger consistency among the items, although the interpretation should consider the number of items, the age of respondents, and the exploratory nature of the study.

Reliability analysis is not used to determine whether learning improvement occurs. Instead, it supports the credibility of the pre-test and post-test instrument. If the reliability result is acceptable, the score comparison can be interpreted with more confidence. If the reliability result is low, the findings should be discussed more cautiously because the score may be affected by inconsistency among the test items (Cronbach, 1951).

2.10.3 Shapiro-Wilk Test

The Shapiro-Wilk test is often recommended for small sample sizes because it has good statistical power compared with several alternative normality tests (Ghasemi & Zahediasl, 2012; Shapiro & Wilk, 1965). The significance level used in this study is 0.05. If the normality test produces a p-value greater than 0.05, the normality assumption is not rejected and a

parametric paired-samples t-test may be considered. If the p-value is less than or equal to 0.05, the data are treated as not normally distributed and a non-parametric alternative, such as the Wilcoxon signed-rank test, is more appropriate (Mishra et al., 2019; Wilcoxon, 1945).

2.10.4 Paired-Samples t-Test

The paired-samples t-test is a parametric method used to compare two related measurements from the same participants when the distribution of the paired differences is approximately normal (Hutson & Yu, 2023; Student, 1908). In a pre-test and post-test context, this test evaluates whether the mean difference between the post-test score and the pre-test score is statistically significant. The null hypothesis states that the mean difference is equal to zero, while the alternative hypothesis states that there is a difference between the two measurements.

The paired-samples t-test is appropriate when the data meet the normality assumption and when the scores can reasonably be treated as interval or continuous data. If the resulting p-value is less than 0.05, the null hypothesis is rejected, indicating that the difference between pre-test and post-test scores is statistically significant. However, if the normality assumption is not met, the paired-samples t-test should not be the main test because the result may not be appropriate for the data condition (Mishra et al., 2019).

2.10.5 Wilcoxon Signed-Rank Test

The Wilcoxon signed-rank test is a non-parametric method for comparing two related measurements when the data do not meet the normality assumption (Schober & Vetter, 2020; Wilcoxon, 1945). Instead of comparing the mean difference directly, this test ranks the absolute differences between paired observations and evaluates whether the positive and negative ranks show a systematic difference. Therefore, it is suitable for paired pre-test and post-test data that are not normally distributed or are based on a small sample.

In this context, the null hypothesis states that there is no significant difference between children's pre-test and post-test hygiene knowledge scores, while the alternative hypothesis states that there is a significant difference between the two scores. If the p-value is less than 0.05, the null hypothesis is rejected. This indicates that the score difference after using the game is statistically significant according to the selected paired comparison procedure (Schober & Vetter, 2020; Wilcoxon, 1945).

2.10.6 System Usability Scale (SUS)

The System Usability Scale (SUS) is a standardized questionnaire used to measure perceived usability after users interact with a system. SUS consists of ten statements rated on a five-point Likert scale, with alternating positive and negative items (Brooke, 1996). The instrument is widely used because it is short, easy to administer, and produces a single usability score ranging from 0 to 100.

The SUS score is calculated by converting each response into a contribution score. For positively worded odd-numbered items, the contribution score is obtained by subtracting 1 from the user's response. For negatively worded even-numbered items, the contribution score is obtained by subtracting the user's response from 5. The total contribution score is then multiplied by 2.5 to produce the final SUS score. A higher score indicates better perceived usability.

SUS scores can be interpreted using acceptability ranges and adjective ratings. Bangor et al. (2009) proposed adjective ratings such as poor, good, excellent, and best imaginable to help interpret individual SUS scores. In general, a score above the average usability benchmark indicates that the system is acceptable, while higher scores show stronger perceived usability. For young children, the SUS statements may be simplified and supported with visual response options such as facial icons. However, the scoring logic should remain consistent with the original SUS formula so that the result can still be interpreted using the SUS scale.

2.10.7 Qualitative Validation

Qualitative validation is used to complement numerical results by explaining how users experience the game during testing. In early childhood educational game evaluation, teacher feedback and children's informal responses are useful because they can reveal factors that are not fully captured by test scores or questionnaires, such as attention, reading ability, fatigue, clarity of instructions, visual attractiveness, and relevance to classroom routines. Therefore, qualitative validation helps interpret the learning and usability results more carefully.

2.11 Position of This Research

The literature review shows that previous hygiene-related educational games and learning media have supported children's hygiene education, but several gaps remain. First, many existing digital hygiene learning products still present general hygiene content and are not explicitly grounded in authentic kindergarten routines. Second, several studies use

structured development methods but do not consistently report repeated teacher-child prototype refinement combined with learning outcome measurement and standardized usability evaluation. Third, standardized usability evaluation is not consistently reported, making it difficult to judge whether the game is truly suitable for young learners.

This study is positioned as a development and evaluation study of an Android-based hygiene learning game for kindergarten children. The game is different from previous studies because it focuses on real daily hygiene routines practiced in kindergarten, is developed through iterative prototyping with teacher-child involvement, and is evaluated using a combination of learning outcome measurement, statistical analysis, SUS usability testing, and qualitative validation. Therefore, the contribution of this study is not only the development of a digital hygiene game, but also the integration of pedagogical relevance, user-centered development, and systematic evaluation for early childhood hygiene learning.

CHAPTER III METHODOLOGY

3.1 Research Design

This study employed a design and development research approach to develop and evaluate the digital learning game Hygiene Hero: Clean Up Buddies for kindergarten children. The exact software development model used to build the game prototype was the Prototyping Model, which is treated as the specific iterative SDLC approach applied in this research. This model was selected because it supports repeated cycles of user needs identification, prototype construction, user testing, and revision. This approach was appropriate because the target users were young children, whose interaction difficulties, visual preferences, and learning needs could be identified more accurately through direct observation and feedback.

The Four-Dimensional Framework was used to keep the design interpretation connected to the educational setting. During development and evaluation, the prototype was reviewed in relation to the target learners, the hygiene learning approach, the way the content was represented in the game, and the classroom context where the game was tested. This helped position the prototype not only as a software product, but also as a learning medium for kindergarten children.

In this study, the Four-Dimensional Framework (4DF) was used as the educational context model, while the Prototyping Model was used as the software development model. The 4DF guided the educational fit of the game through learner, pedagogy, representation, and context dimensions. Meanwhile, the Prototyping Model guided the technical process of building, testing, and refining the game prototype.

The evaluation component used a one-group pre-test and post-test structure to examine changes in children's hygiene knowledge before and after using the game. Usability was evaluated using an adapted System Usability Scale (SUS), while qualitative validation was obtained through teacher feedback and informal conversations with children. Therefore, the methodology combined development procedures, quantitative evaluation, and qualitative feedback to assess both the learning outcome and the practical usability of the game. The overall research methodology flow is shown in Figure 3.1 Research Methodology FlowchartFigure 3.1.

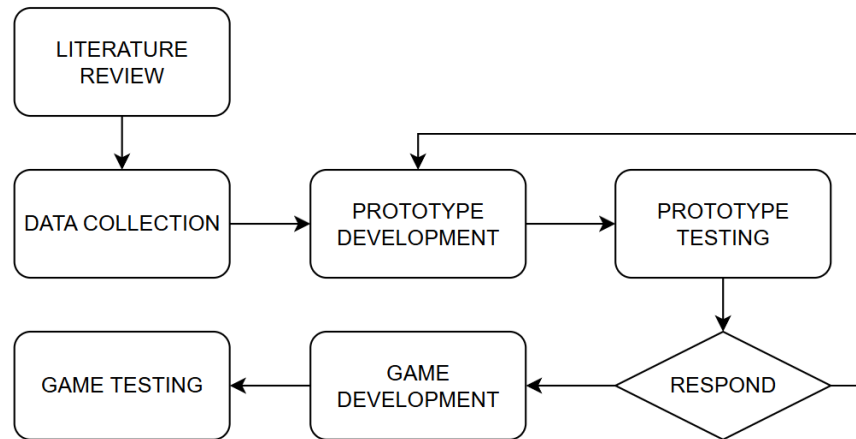


Figure 3.1 Research Methodology Flowchart

3.2 Research Setting and Participants

The research was conducted at TK Sultan Agung, a private kindergarten located in Sleman, Yogyakarta, Indonesia, during the 2025/2026 academic year. The school was selected because it was willing to participate in the study and because the hygiene routines practiced in the school were relevant to the learning content developed in the game. The research activities were carried out during regular classroom hours with assistance from the classroom teacher.

The participants in the game testing phase were 19 kindergarten children from the second-year class. The class consisted of eight boys and eleven girls aged between four and six years. The participants were selected using convenience sampling based on the school's willingness to participate and the principal's recommendation. The second-year class was considered suitable because most children were in the five-to-six-year-old range and were able to follow simple classroom instructions with teacher assistance.

Table 3.1 Participant Profile

Aspect	Description
Research site	TK Sultan Agung, Sleman, Yogyakarta, Indonesia
Academic year	2025/2026
Participant group	Second-year kindergarten class
Number of participants	19 children
Gender distribution	8 boys and 11 girls
Age distribution	1 child aged 4 years, 3 children aged 5 years, and 15 children aged 6 years
Sampling technique	Convenience sampling based on school willingness and principal recommendation
Testing condition	Conducted during regular classroom hours with the classroom teacher and researcher present

3.3 Prototyping Procedure

The game was developed using three main phases of the Prototyping Model: Listen to Customer, Build/Revise Prototype, and Customer Test Drives Prototype. These phases were used to ensure that the game design was not only technically functional but also aligned with kindergarten routines, teacher expectations, and children's learning characteristics.

3.3.1 Listen to Customer Phase

The Listen to Customer phase was conducted to identify the learning needs, user characteristics, and design requirements for the hygiene learning game. The main initial informant was the school principal, who was selected because she had authority over school learning activities and understood the hygiene routines practiced in the kindergarten. The researcher also conducted classroom observation and discussed the feasibility of the design with the teacher during the preparation and testing process.

A raw game visualization was prepared using Canva before the interview. This visualization helped the informant understand the proposed game concept, including the planned hygiene activities, visual objects, interaction flow, and possible game structure. Feedback was recorded as interview notes and then grouped into design requirements related to target users, learning content, visual design, interaction style, audio support, and classroom feasibility.

Table 3.2 Interview Guide for Initial Requirement Analysis

Category	Focus of Questions	Examples of Information Collected
Hygiene learning practices	Existing hygiene education, routines taught at school, and hygiene topics that are difficult for children.	Handwashing, brushing teeth, cleaning the classroom, waste disposal, and repeated teacher reminders.
Child characteristics	Children's age, reading ability, learning readiness, and ability to follow instructions.	The game should be suitable for kindergarten children, especially those who can follow simple visual and audio instructions.
Design preferences	Preferred colors, object clarity, screen orientation, navigation, and use of voice or animation.	Bright colors, clear hygiene objects, simple interaction, and audio support were needed to help children understand tasks.
Implementation feasibility	Suitability of the game for classroom use, independence level, teacher assistance, and possible improvements.	The game should be playable with teacher assistance and should reflect hygiene routines that children recognize from school life.

3.3.2 Build/Revise Prototype Phase

The Build/Revise Prototype phase began with the development of a visual prototype in Figma. The first prototype included the main menu, level selection menu, hygiene activity screens, instruction flow, and quiz design. This prototype was used to check whether the visual layout, object placement, colors, and activity sequence were understandable before the game was implemented in Unity.

After the first feedback cycle, the prototype was implemented in Unity as a two-dimensional Android game. The second prototype included game scenes, drag-and-drop interactions, tap-based interactions, quiz mechanics, narration, background audio, feedback responses, and level progression. Revisions from the previous iteration were applied to improve visual clarity, object recognition, button size, activity flow, and audio suitability. The final development stage refined the Unity prototype into a classroom-ready Android APK, including final adjustments to narration volume and background audio before game testing.

3.3.3 Customer Test Drives Prototype

The Customer Test Drives Prototype phase was conducted through two main prototype testing activities. In the first iteration, the Figma prototype was demonstrated to the teacher and children to evaluate the initial visual design, content suitability, navigation flow, and quiz structure. In the second iteration, the Unity prototype was tested in the classroom to evaluate

whether the implemented interaction, animation, button size, sound, and gameplay flow were appropriate for children.

Teacher feedback and children's feedback were collected separately because their roles and language abilities were different. Teacher feedback focused on learning content, classroom suitability, visual appropriateness, interaction design, and technical feasibility. Children's feedback was gathered using simpler questions, observation, and informal responses about whether the game looked interesting, was easy to understand, and was enjoyable to play. The feedback from each iteration was used as the basis for revising the next prototype version.

3.4 Research Instruments

Several instruments were used to support the development and evaluation process. The instruments consisted of an initial interview guide, prototype feedback forms, a pre/post hygiene knowledge test, an adapted SUS questionnaire, and qualitative validation questions. Each instrument had a different role in the methodology, as summarized in Table 3.3.

Table 3.3 Summary of Research Instruments

Instrument	Respondent / Source	Purpose
Initial interview guide	School principal	To identify hygiene learning practices, child characteristics, and initial game design requirements.
Prototype feedback form - first iteration	Teacher and children	To evaluate the Figma prototype in terms of visual design, gameplay flow, content suitability, and quiz design.
Prototype feedback form - second iteration	Teacher and children	To evaluate the Unity prototype in terms of interaction, animation, button size, sound, and gameplay refinement.
Pre/post hygiene knowledge test	Children, with assistance when needed	To measure children's hygiene knowledge before and after using the game.
Adapted SUS questionnaire	Children, with assistance when needed	To evaluate children's perceived usability of the developed game.
Qualitative validation questions	Teacher and children	To explain the quantitative results and obtain contextual feedback about the game experience.

3.4.1 Interview Guide and Prototype Feedback Forms

The initial interview guide was organized into four categories: hygiene learning practices, child characteristics, design preferences, and implementation feasibility. This categorization made the instrument more systematic and helped connect the collected feedback with concrete design requirements. Prototype feedback questions were also separated between teacher-

oriented questions and child-oriented questions so that the language and focus of the questions matched the respondents.

Table 3.4 Prototype Feedback Focus for Teacher and Children

Testing Stage	Respondent	Feedback Focus
First iteration: Figma prototype	Teacher	Suitability of the design for children, appropriateness of hygiene material, clarity of activity flow, number of quiz questions, and suggestions for improvement.
	Children	Whether the pictures looked clear, whether the colors were attractive, whether the activity seemed easy to understand, and how they felt after seeing the prototype.
Second iteration: Unity prototype	Teacher	Page flow, object clarity, animation sufficiency, button size, sound selection, quiz suitability, and revision suggestions.
	Children	Whether the game was easy to play, whether the objects and buttons were clear, whether the sound was understandable, and whether they enjoyed the game.

3.4.2 Pre/Post Hygiene Knowledge Test

The hygiene knowledge test was used to evaluate children's understanding of hygiene routines before and after using the game. The test consisted of ten multiple-choice items with two answer options for each item. The same set of items was used for both the pre-test and post-test, but the order was rearranged in the post-test to reduce direct recall. Each correct answer was scored as 10 points and each incorrect answer was scored as 0 points, resulting in a total score range from 0 to 100.

Table 3.5 Blueprint of the Pre/Post Hygiene Knowledge Test

No	Hygiene Topic	Indicator	Number of Items
1	Personal cleanliness	Identifying correct bathing habits and tools to keep the body clean.	2
2	Toothbrushing	Understanding the importance of brushing teeth and recognizing correct toothbrushing tools.	2
3	Toy organization	Identifying what children should do after playing with toys.	1
4	Classroom cleanliness	Identifying actions that help keep the classroom clean.	2
5	Waste management	Recognizing the importance of putting waste into the correct bin.	2
6	Handwashing	Identifying the need to wash hands before eating.	1
Total			10

The content validity of the test items was reviewed by the classroom teacher as the expert validator. The validation focused on the relevance of each item to kindergarten hygiene routines, the clarity of language for children aged 4–6 years, and the appropriateness of item difficulty. This review was conducted before the test was used in the classroom so that the instrument matched the children’s developmental level and the hygiene content presented in the game.

3.4.3 Adapted System Usability Scale (SUS)

The System Usability Scale (SUS) was used to evaluate the usability of the developed game. Because the respondents were kindergarten children, the SUS statements were adapted into simpler Indonesian language and supported with facial-icon response options. This adaptation was necessary because young children may have limited reading ability and may understand visual choices more easily than abstract Likert-scale labels. Children who could read completed the questionnaire independently, while younger children answered after the researcher or teacher read and explained the statement.

Table 3.6 Adapted SUS Questionnaire

No	Statement	Option				
		1	2	3	4	5
1	I love the game.	Hate it	Dislike	Normal	Like	Love it
2	I often feel confused while playing.	Not confused at all	Not confusing	Normal	Confusing	Very Confusing
3	The game is easy to understand.	Very hard	Hard	Normal	Easy	Very easy
4	I needed a lot of help before I could play this game independently.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree
5	The game makes me remember about keeping clean.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree
6	The game is hard to play.	Very easy	Easy	Normal	Hard	Very hard
7	The graphics of the game are easy to understand.	Very hard	Hard	Normal	Easy	Very easy
8	The game frustrated me while completing the levels.	Very enjoy	Enjoying	Normal	Frustrating	Very frustrating
9	The sound from the game is clear.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree
10	The game buttons are hard to control.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree

SUS scores were interpreted using acceptability ranges, adjective ratings, and grade-scale interpretation. These categories helped describe whether the game was perceived as usable and acceptable for young learners.

3.4.4 Qualitative Validation Questions

Qualitative validation was conducted to support the interpretation of quantitative results. The teacher interview and children's informal conversations were used to identify possible reasons why some post-test scores increased, remained the same, or decreased. The questions also explored children's experience with visual appearance, sound clarity, ease of use, and hygiene content.

Table 3.7 Qualitative Validation Focus

Respondent	Focus of Questions
Teacher	General post-test condition, possible factors influencing score differences, children's focus and fatigue, reasons for decreased scores, reasons for unchanged scores, and possible causes of score improvement.
Children	Perceived ease of the lesson after playing, feelings during the post-test, confusing parts of the questions or game, remembered hygiene materials, and reasons why their scores increased, stayed the same, or decreased.

3.5 Data Collection Procedure

The data collection procedure followed the sequence of the Prototyping Model and the final classroom testing stage. First, the researcher conducted initial problem identification and requirement gathering through classroom observation, principal interview, and discussion of the Canva-based raw visualization. Second, the Figma prototype was developed and tested to obtain feedback about visual design, activity flow, and content suitability. Third, the revised prototype was implemented in Unity and tested again to evaluate interaction, animation, audio, and gameplay usability.

After the prototype reached a stable version, the final game was exported as an Android APK and implemented in the classroom. During game testing, children first completed the hygiene knowledge pre-test. After that, they played the game under the supervision of the researcher and classroom teacher. When the play session ended, children completed the post-test and adapted SUS questionnaire with assistance when needed. Teacher interview and

informal child responses were then collected to support the interpretation of the quantitative results.

Ethical and administrative considerations were addressed before and during the study. The research was conducted with permission from the participating kindergarten, and the classroom teacher assisted the testing process to ensure that the activity remained safe, comfortable, and appropriate for the children. The testing was conducted during regular classroom hours, and children were not forced to continue if they felt uncomfortable. The data were reported anonymously using participant codes, and no children's names were disclosed in the analysis.

3.6 Data Analysis Techniques

The collected data consisted of pre-test scores, post-test scores, item-level responses, SUS questionnaire responses, and qualitative feedback. The analysis combined descriptive statistics, reliability analysis, statistical comparison of pre-test and post-test scores, SUS scoring, and qualitative thematic interpretation.

3.6.1 Pre/Post-Test Data Descriptive Analysis and Scoring

The pre-test and post-test data were organized by participant code. This pairing was important because the analysis compared two scores from the same child, not scores from two independent groups. For the knowledge test, each item-level response was coded as 1 for a correct answer and 0 for an incorrect answer. The total score for each participant was then calculated using equation (3.1).

$$\text{Total Score} = \text{Number of Correct Answers} * 10 \quad (3.1)$$

Based on this formula, the minimum possible score was 0 and the maximum possible score was 100. The paired dataset contained each child's pre-test total score, post-test total score, and gain score. The gain score was calculated using equation (3.2).

$$\text{Gain Score} = \text{Post test Score} - \text{Pre test Score} \quad (3.2)$$

Descriptive statistics were used to summarize the pre-test and post-test results. The values reported included the mean, median, standard deviation, minimum score, maximum score, and gain score. The mean and median were used to describe the general score tendency, while the standard deviation was used to describe score variation among participants. The gain score was used to show the direction and size of change after the children used the game. The final interpretation combined the p-value with the descriptive statistics, because the p-value explains statistical significance while the mean or median difference explains the direction of the score change.

3.6.2 Reliability Analysis of the Test Instrument

Before interpreting the learning outcome data, the internal consistency of the pre/post-test instrument was examined using Cronbach's alpha. Reliability analysis was performed using the item-level responses rather than the total scores. This step was used to check whether the ten test items consistently measured children's hygiene knowledge. The reliability result was reported before the inferential analysis so that the quality of the test instrument could be considered when interpreting the pre/post-test findings.

3.6.3 Normality Test and Inferential Test

After the pre-test and post-test scores were paired and the instrument reliability was checked, the score distribution was examined using the Shapiro-Wilk normality test. The normality test was used to determine whether the data met the assumption required for a parametric paired-samples t-test. The hypotheses for the normality test were formulated as follows: H0 means that the pre-test and post-test score distributions are normally distributed, while H1 means that the score distributions are not normally distributed.

The inferential test was selected based on the result of the normality test. If the p-value from the Shapiro-Wilk test was greater than 0.05, the normality assumption would not be rejected and a paired-samples t-test could be used. If the p-value was less than or equal to 0.05, the data would be treated as not normally distributed and the Wilcoxon signed-rank test would be used. For the pre-test and post-test comparison, H0 states that there is no significant difference between children's hygiene knowledge scores before and after using the game, while H1 states that there is a significant difference between the two scores. If the inferential test produces a p-value less than 0.05, H0 is rejected and the result is interpreted as statistically significant.

3.6.4 SUS Scoring

The SUS score for each participant was calculated using the standard scoring procedure (Sauro & Lewis, 2012). For positive items (odd number of statement), the response value was subtracted by one, whereas for negative items (even number of statement), the response value was subtracted from five. The sum of the adjusted scores was then multiplied by 2.5 to produce a usability score ranging from 0 to 100.

$$\text{SUS Score} = \left((R1 - 1) + (5 - R2) + (R3 - 1) + (5 - R4) + (R5 - 1) + (5 - R6) + (R7 - 1) + (5 - R8) + (R9 - 1) + (5 - R10) \right) * 2.5 \quad (3.3)$$

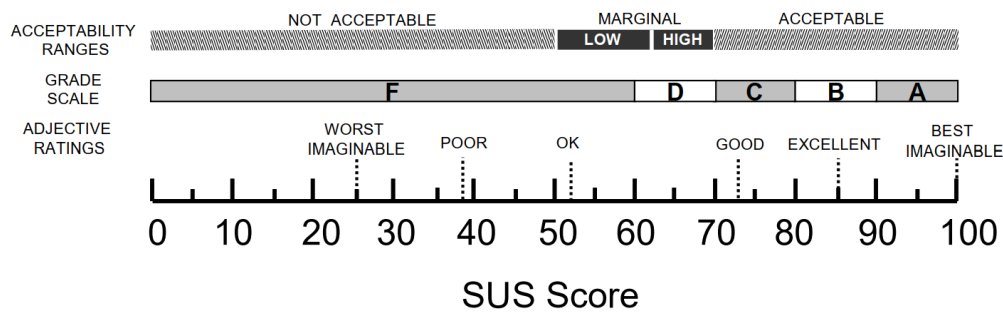


Figure 3.2 SUS Score Category

Based on Figure 3.2, SUS scores are interpreted through three primary categories as:

- Acceptability range represents user perception by categorizing the system into levels such as “Acceptable,” “Marginal,” and “Not Acceptable.”
- Adjective ratings translates numerical scores into descriptive labels, including “Best Imaginable,” “Excellent,” “Good,” “OK,” “Poor,” and “Worst Imaginable,” to convey overall user perception.
- Grade scale express usability using letter grades, where “A” denotes excellent usability and “F” indicates poor usability.

Together, these categories offer a comprehensive evaluation of system usability and help highlight areas that require improvement.

3.6.5 Qualitative Validation Analysis

Qualitative responses from the teacher interview and children’s informal conversations were analyzed thematically. The responses were grouped into themes such as ease of use,

clarity of instructions, visual attractiveness, audio clarity, relevance to daily hygiene routines, and factors affecting post-test performance. These themes were then compared with the quantitative findings to explain the learning outcome and usability results more clearly.

Table 3.8 Summary of Data Analysis Techniques

Data Source	Analysis Technique	Purpose
Pre-test and post-test total scores	Descriptive statistics and gain score	To describe score changes before and after using the game.
Item-level test responses	Cronbach's alpha	To examine the internal consistency of the knowledge test.
Pre-test and post-test paired scores	Shapiro-Wilk test followed by paired-samples t-test or Wilcoxon signed-rank test based on normality	To determine whether the score difference was statistically significant.
SUS questionnaire responses	Standard SUS scoring and usability interpretation	To measure perceived usability of the game.
Teacher and child feedback	Thematic qualitative analysis	To explain user experience and contextual factors affecting the results.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Data Collection Results: Listen to Customer

This section presents the results of the initial requirement analysis conducted at TK Sultan Agung on June 4, 2025. The activity introduced an early two-dimensional drag-and-drop game concept to the principal to validate whether the proposed learning content, visual style, and interaction flow were suitable for kindergarten children. The initial concept included a main menu, a level selection menu, gameplay instruction screens, routine-based hygiene activities, and short quizzes. The early concept was first visualized using Canva so that the principal could review the idea before it was developed into a prototype, as shown in Figure 4.1.



Figure 4.1 Early Concept Illustration

Table 4.1 Feedback for Game Early Concept from the Principal

No	Question	Respond
1	From what age is it appropriate to teach children about cleanliness?	Since theyre being able to communicate, but for the school period starting at the age of 3. kid ages 4-6 years old is when they start to be taught to be independent and build habits.
2	In this kindergarten, what hygiene education is taught to students?	Brushing teeth, washing hands, cleaning together (sweeping is not mandatory), sort out rubbish.
3	Are there any media used to help teach about cleanliness? If so, what media usually be used to teach cleanliness to children (e.g., storybooks, videos, posters, or apps/games)?	Video collaboration with UII Faculty of Medicine, poster, and else.

4	How this kindergarten usually teach cleanliness to children?	In practice, according to the doctor's advice, sometimes we use songs.
5	Have this kindergarten ever used games (digital or non-digital) as a learning medium in the classroom? If so, what types of games usually use?	Never on a cell phone, but matching picture games on a computer have been played, but rarely since the popularity of cell phones.
6	In your opinion, does learning with the help of games make it easier for children to understand the material?	Yes it does.
7	What material or aspect of hygiene is most difficult for children aged 4–6 years to understand or practice?	Throw garbage in its place.
8	What are the main factors that cause children to have difficulty understanding or implementing clean living habits?	Factors from home, home education does not emphasize habits enough, teachers do not communicate enough.
9	How to deal with children who don't understand or are not interested in cleanliness lessons?	Teachers must keep reminding them.
10	Do you prefer games that children can play independently, or games that they can play with teachers/parents in class or at home?	For ages 4-5, they are still need to be accompanied by a teacher, for ages 5-6 they can play independently.
11	Do you have a preference for game display mode (portrait or landscape) that is more suitable for young children?	Landscape.
12	In your opinion, should the design and colors of educational games be made brighter or more subdued to make them comfortable for children?	Bright colors, not soft, color better not clash with other elements, given their own fake brand (eg., aqua becomes akua, taro becomes tara)
13	Can the average child here read? Do you think there should be voice instructions or animations in the game to help children understand the tasks or activities in the game?	Not all of them, so it can be assisted by sound, and writing, not just pictures.
14	By seeing the design, are the objects and images in the game look very clear and easy for children to recognize?	Some need to be adjusted, such as the picture of the faucet
15	In your opinion, is the game about cleanliness more suitable for children aged 4–5 years or 5–6 years (grade A or grade B)? Please provide the reasons.	Grade B is more recommended, because grade A must be introduced from the very beginning.
16	Does the material for the educational game that have chosen cover all the important aspects related to cleanliness that need to be taught?	Yes it does, make sure the flow is adjusted according to expert advice.
17	Is the flow of activities in this canva designed educational game easy for children to understand?	It's enough, but the flow needs to be improved again according to the doctor and the image needs to be developed again.
18	Can educational games be applied in children's daily lives and help instill the habit of maintaining cleanliness?	Yes it can.
19	What features or elements do you think need to be added to make educational games about cleanliness more educational and fun for children?	It is recommended to choose activities that are taught in this kindergarten, such as washing hands, brushing teeth, cleaning together, and sorting waste. Add congratulatory voice

		feedback and engaging music after each activity. Use clear object images, such as sink faucets and other hygiene tools.
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The interview results in Table 4.1 produced several design requirements that became the basis for the Figma and Unity prototypes.

- a. The main target users were kindergarten children aged 4-6 years, with the second-year or grade B class considered the most suitable testing group because most children were able to follow simple instructions.
- b. The six activities were selected through a traceability line from interview findings, hygiene domain, developmental relevance, and game task feasibility. This line was used to make sure that each activity had a clear reason for inclusion.
- c. Toothbrushing was selected because the principal stated that brushing teeth is taught at TK Sultan Agung. It represents oral hygiene and a daily self-care routine that can be shown through familiar tools such as a toothbrush, toothpaste, and clean teeth.
- d. Handwashing before eating was selected because the principal stated that handwashing is taught at the kindergarten. It represents personal hygiene and disease-prevention behavior that children can practice before eating.
- e. Waste sorting was selected because the principal mentioned waste disposal and sorting waste, and also identified throwing garbage in the correct place as a difficult hygiene behavior for children. It represents environmental cleanliness and sanitation.
- f. Classroom cleaning was selected because the principal mentioned cleaning together or gotong royong as part of hygiene education at the school. It represents shared responsibility for keeping the classroom environment clean.
- g. Bathing was selected because it represents personal hygiene and self-care through body cleaning, use of hygiene tools, and keeping the body clean. This activity supports independence and habit formation in early childhood hygiene learning skills (Berk, 2013; Haryani, 2024; Pradhan et al., 2020).
- h. Tidying toys was selected because it represents environmental cleanliness, object organization, and responsibility after play. This activity connects hygiene learning with keeping shared objects and learning spaces clean, which is relevant for children's daily routines and responsibility development skills (Berk, 2013; Haryani, 2024; Pradhan et al., 2020; Wulandari, 2019).

- i. Therefore, the final six activities were selected to form a balanced set of personal hygiene, oral hygiene, environmental cleanliness, sanitation, and responsibility routines that could be translated into simple, concrete, and repeatable game interactions for kindergarten children (Khotimah & Agustini, 2023).
- j. The visual design needed to use bright colors, clear object shapes, large buttons, and a landscape orientation so that children could recognize the objects and actions easily.
- k. Landscape orientation is preferred, bright primary colors (not soft pastels), voice narration mandatory since not all children can read yet, plus congratulatory audio with engaging music.
- l. Objects like a food packaging or bottle require atleast fake brand (eg., Akua, Tara branding) and clear object design recognition (eg., faucet design) for kids.
- m. The interaction style needed to remain simple through drag-and-drop, tapping, and short quizzes so that the game could support classroom hygiene learning without overwhelming the children.

These requirements transformed the early concept into a clear design direction for the next stage. The development was therefore based not only on the researcher's initial idea, but also on school needs, classroom routines, and children's learning characteristics. The summary of the design decisions derived from the Listen to Customer phase is presented in Table 4.2, and documentation of this activity is shown in Figure 4.2.

Table 4.2 Design Requirements Derived from the Listen to Customer Phase

Requirement Aspect	Requirement Decision
Target users	Kindergarten children aged 4–6 years, with the main testing group taken from the second-year class recommended by the school.
Learning content	Six hygiene routines were selected: bathing, toothbrushing, tidying toys, cleaning the classroom, waste sorting, and handwashing before eating.
Visual design	Objects had to be clear, familiar, and easy to recognize, such as soap, toothbrush, towel, faucet, trash bin, and classroom cleaning tools.
Interaction style	The game interaction had to be simple, using tap and drag-and-drop mechanics that could be understood by children.
Audio support	Narration and sound feedback were needed because some children still had limited reading ability.
Classroom feasibility	The game had to be usable in a classroom setting with teacher assistance and short play duration.



Figure 4.2 Data collecting documentation

4.2 Prototype Development and Testing

After requirement analysis, the prototype was developed and tested through two main iterations. The first iteration focused on visual layout and activity flow in Figma, while the second iteration focused on functional interaction in Unity. This section emphasizes the evolution of the prototype, the feedback obtained, and the revisions applied. Detailed source-code documentation is provided in the APPENDIX D.

4.2.1 Figma Prototype Development: Build/Revise Prototype

The Figma prototype was developed as the first visual representation of the game before it was implemented in Unity. This stage translated the design requirements from the data collection phase into a clearer interface structure, activity flow, and visual layout. The prototype included the main menu, level selection menu, hygiene activity screens, and quiz interface. At this stage, the prototype was not yet fully functional as a game; it was used to evaluate whether the visual design, object placement, navigation flow, and activity sequence were understandable for kindergarten children.

The Figma prototype was important because the target users were young children who may have limited reading ability and need clear visual guidance. Therefore, the design emphasized bright colors, large objects, simple navigation, familiar hygiene tools, and routine-

based activity flow. Audio narration was not yet implemented in this stage because the first prototype mainly focused on testing visual clarity and game structure. Audio support was planned for the Unity prototype after the visual and interaction design had been reviewed.

A. Main Menu and Level Selection Interface

The main menu was designed as the first screen displayed when the game is opened. It uses a simple layout with large and clearly separated buttons so that young children can recognize the available actions without complex reading. The mascot character, Denis, was placed on the screen to create a friendly learning atmosphere and to maintain visual continuity throughout the game. The main menu provides access to the play function and the activity selection function, as shown in Figure 4.3.



Figure 4.3 Iterated Design of the Main Menu

The activity/level selection menu was designed to organize the hygiene routines into a structured sequence. The six activities were presented as separate levels so that children could understand that each activity represented a different hygiene routine. A lock or progression mechanism was included to guide children through the activities step by step. This design was intended to make the learning flow more directed rather than presenting all activities without structure, as shown in Figure 4.4.



Figure 4.4 Iterated Design of the Level Selection Menu

B. Hygiene Activity Interface

The hygiene activity screens were designed to transform daily kindergarten routines into simple visual tasks. Each activity screen presents a familiar hygiene situation and asks children to complete a specific action, such as choosing hygiene tools, moving objects, or following a cleaning routine. The activity design was made simple because kindergarten children need concrete and direct interaction rather than abstract explanation.

Level 1, Taking a Shower, introduces the sequence of cleaning the body. In this activity, the player helps Denis use familiar hygiene tools such as soap, shampoo, and a towel. The design emphasizes object recognition and routine order so that children can associate each object with its correct hygiene function, as shown in Figure 4.5.

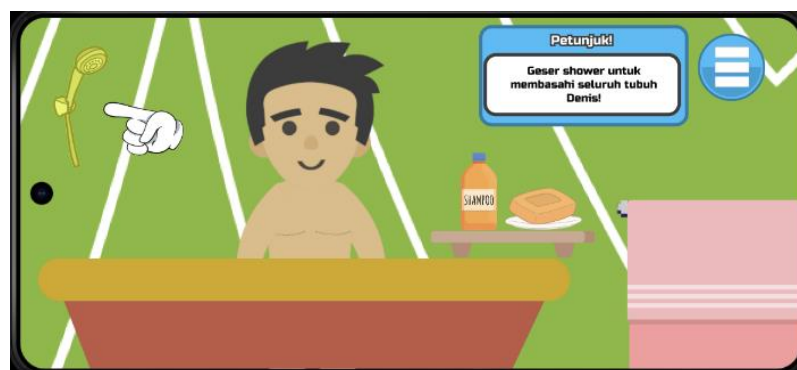


Figure 4.5 Iterated Design of the Taking a Shower Level

Level 2, Brushing Teeth, focuses on oral hygiene. The player helps Denis prepare the toothbrush, apply toothpaste, brush his teeth, and complete the grooming routine. The screen was designed with large objects and clear visual cues so that children can identify the tools used for brushing teeth, as shown in Figure 4.6.



Figure 4.6 Iterated Design of the Brushing Teeth Level

Level 3, Tidying Toys, introduces the habit of putting objects back in their proper place after playing. The player is expected to move scattered toys into a toy basket. This activity was included because tidying toys is a routine that children commonly practice in kindergarten and at home, as shown in Figure 4.7.



Figure 4.7 Iterated Design of the Tidying Toys Level

Level 4, Cleaning the Classroom, represents environmental cleanliness in the classroom. The player completes cleaning tasks such as collecting rubbish, cleaning the board, and dusting the table. This activity connects the game with classroom routines practiced at TK Sultan Agung, as shown in Figure 4.8.



Figure 4.8 Iterated Design of the Cleaning Classroom Level

Level 5, Waste Sorting, introduces the basic concept of separating waste based on type. The player categorizes objects such as plastic bottles, paper, and food wrappers into the appropriate bins. The objects were designed with recognizable shapes, labels, and colors to help children distinguish between different waste categories, as shown in Figure 4.9.



Figure 4.9 Iterated Design of the Waste Sorting Level

Level 6, Handwashing, focuses on washing hands before eating. The player helps Denis move to the faucet, use soap, rinse his hands, and complete the routine before eating. This sequence was designed to reinforce a hygiene habit that is directly related to daily classroom routines, as shown in Figure 4.10.

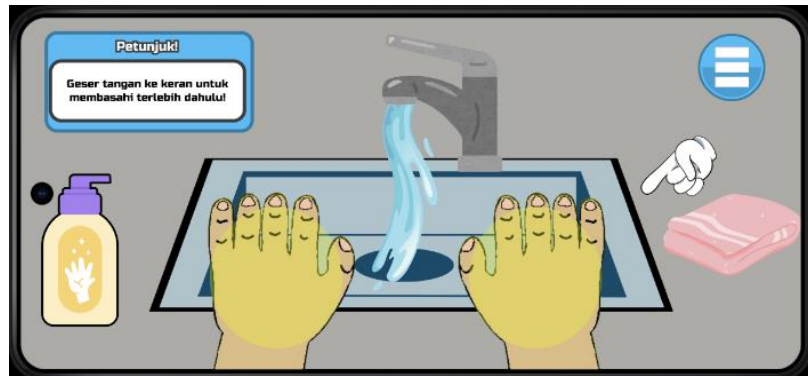


Figure 4.10 Iterated Design of the Handwashing Level

C. Quiz Interface

The quiz interface was designed as a short reinforcement activity after the hygiene routines. The quiz screens used large answer buttons, clear visual objects, and a limited number of answer choices to reduce the reading burden for kindergarten children. In the Figma stage, the quiz function was represented visually to confirm its layout, answer placement, and readability before the quiz mechanics were implemented in Unity, as shown in Figure 4.11.

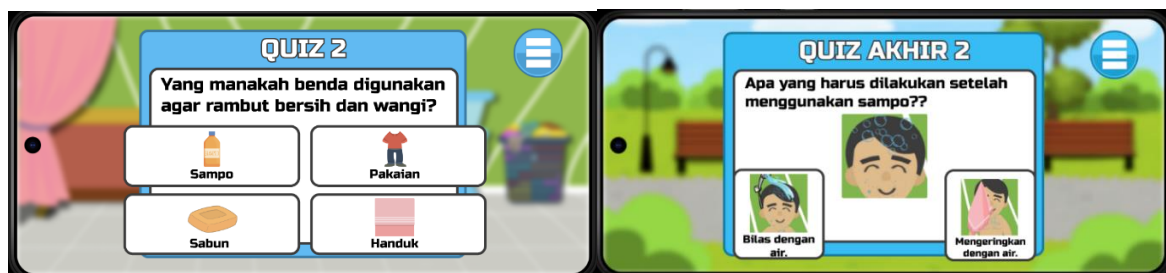


Figure 4.11 Iterated Design of the Quiz

Overall, the Figma prototype served as the first iteration of the game design. The main output of this stage was not a final playable game, but a visual prototype that could be reviewed by the teacher and children. The feedback from this stage was then used to refine the interface, improve object clarity, adjust the activity flow, and prepare the design for implementation in Unity.

4.2.2 Figma Prototype Testing (First Iteration): Customer Test Drives Prototype

The first iteration was conducted on July 31, 2025 by presenting the Figma prototype to the classroom teacher and students. This testing focused on visual clarity, activity flow,

suitability of hygiene content, and the readability of quiz elements. The feedback for first iteration shown in Table 4.3.

Table 4.3 First Iteration Feedback

No	Question	Respond	
		Teacher	Average Students
1	Does the game design suit the students' needs?	Already Does.	Average students felt they understood the object.
2	Are the colors good enough? Or do they need adjustment?	No, the color is good enough.	Students can already differentiate various objects by color.
3	Is the image design clearly visible and easy to identified?	It's clearly visible.	Students can differentiate objects well.
4	Is the gameplay easy to understand for kids?	Already understood.	The students already understand the flow by how fluently they answer the questions in the quiz.
5	Is the hygiene education material in the game suitable for early childhood?	Already suitable.	
6	Are the number of questions in the final quiz sufficient, do they need to be reduced or added?	No need to add more.	
7	Are 4 answer options in multiple choice questions enough, or do they need to be reduced?	Just reduce the questions that require a lot of reading.	Most of the student can't read yet.
8	What suggestions would you like me to make the so the game will be better?	Give sound and music to make the game more interesting.	
9	How did you feel after seeing the prototype of this game?	A little bored because there is no absence of music.	The student feel bored because there is no music but the pictures and animation are good.

The teacher and students generally understood the prototype flow and considered the hygiene content appropriate for children. The main visual requirements, such as bright colors and recognizable objects, were also confirmed during this iteration.

The most important improvement identified in this stage was the need for sound and narration. Although the visual prototype was understandable, audio elements were needed to reduce boredom and support children who could not read fluently. This finding became the basis for adding narration, feedback sounds, and background music in the Unity prototype. Previous research in early childhood learning media emphasizes that audio-visual elements can significantly support children's comprehension and engagement during interactive learning

activities (Candra & Rahayu, 2021). Documentation of the first iteration is shown in Figure 4.12.



Figure 4.12 First iteration documentation

4.2.3 Unity Prototype Development: Build/Revise Prototype

The second prototype was implemented in Unity as a functional Android-oriented game. This stage transformed the Figma design into a playable two-dimensional game that allowed children to interact directly with hygiene activities through tapping, dragging, dropping objects, following animations, listening to audio instructions, and answering quiz questions. Unlike the Figma prototype, the Unity prototype was used to test not only visual clarity, but also interaction, feedback, game flow, and technical readiness for classroom use.

A. Navigation and Core Game Flow

The navigation and core game flow were developed first because they determine how children move from one activity to another. This part included the level opening panel, pause panel, main menu, level selection menu, and progression system. These features were designed to make the game flow predictable, structured, and easy to follow during classroom use.

The level opening panel introduces each hygiene activity before the child begins playing. This panel helps prepare children for the task by presenting the activity first, instead of moving directly into the interaction screen. This was important because kindergarten children need simple guidance before starting a new task, as shown in Figure 4.13.

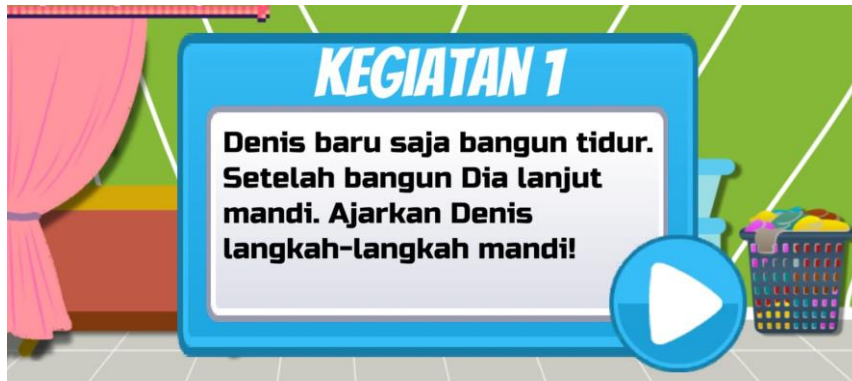


Figure 4.13 Level Opening Design Panel

The pause panel was developed to support classroom testing and to allow the game session to be stopped when needed. In a classroom environment, children may need teacher assistance or short interruptions, so the pause feature helps the researcher and teacher manage the activity without restarting the game. The pause panel design is shown in Figure 4.14.



Figure 4.14 Pause Panel Design

A progression mechanism was also implemented so that completed activities could unlock the next activity. This feature supports a step-by-step learning flow and prevents children from moving randomly between activities before understanding the intended sequence. The progression system also makes the level selection screen more meaningful because children can see which activities have been completed and which activities are still locked.

B. Main Menu Interface

The main menu interface was translated from the Figma prototype into an interactive Unity scene. The design was refined by simplifying the button area, improving the layout, and

adding an exit option. The purpose of this screen is to provide a clear starting point for children before they continue to the activity selection menu, as shown in Figure 4.15.



Figure 4.15 Refined Prototype of the Main Menu

The implemented main menu became the first access point of the game. The buttons, mascot, and background were arranged to maintain consistency with the visual identity developed in Figma. This screen also became the first opportunity to check whether the game could be opened and navigated smoothly before children entered the learning activities.

C. Activity/Level Interface

The level selection interface was developed to show the six hygiene routines in a structured order. In the Unity prototype, the wording was adjusted from the earlier Figma design, and a reset progress option was added so the researcher could repeat testing when needed. This screen allows children and teachers to see the available activities and understand the progression flow, as shown in Figure 4.16.



Figure 4.16 Refined Prototype of the Level Selection Menu

The level selection interface also supports the classroom testing process because the researcher can monitor whether the child has completed an activity and moved to the next one. This design helps maintain the sequence of hygiene learning from personal cleanliness to classroom and environmental cleanliness.

D. Hygiene Activity 1: Taking a Shower

The taking-a-shower activity was implemented to introduce personal body cleanliness. Several visual elements from the Figma prototype were refined in Unity, including the towel, clothes, and soap color, so that the objects looked clearer and did not clash with the background. The refined activity screen is shown in Figure 4.17.



Figure 4.17 Refined Prototype of the Taking a Shower Level

The interaction in this activity uses simple drag-and-drop actions. The child moves the highlighted object to the correct target area, such as placing dirty clothes into the laundry basket or using hygiene tools in the correct order. This mechanic was selected because it is direct, concrete, and suitable for young children.

After each correct action, the game provides visual feedback and moves to the next step. This step-by-step structure helps children understand that hygiene routines consist of several actions that must be completed in order.



Figure 4.18 Putting Dirty Clothes to Laundry Basket

The shower interaction was supported by animation to make the cleaning process more concrete. By showing the shower action visually, the game helps children connect the object interaction with the real-life activity of bathing, as shown in Figure 4.19.



Figure 4.19 Using a Shower

The final interaction in this level shows activity completion and prepares the player to move to the next hygiene routine. This completion feedback is important because it gives children a clear signal that they have finished one task before continuing, as shown in Figure 4.20.



Figure 4.20 Animation Before Go to Next Level/Activity

E. Hygiene Activity 2: Brushing Teeth

The brushing-teeth level was implemented to reinforce oral hygiene routines. The Unity version kept the main visual structure from Figma but adjusted some object colors and interaction flow to make the activity more efficient and clearer during gameplay. The refined activity screen is shown in Figure 4.21.



Figure 4.21 Refined Prototype of the Brushing Teeth Level

This level combines tap interaction and short animation. Children interact with objects such as the toothbrush, toothpaste, and faucet to complete the toothbrushing sequence. The interaction was designed to be simple so that children could focus on the hygiene routine rather than on complex controls.

A focused animation panel was used to show specific toothbrushing steps more clearly. This feature helps emphasize small but important actions, such as applying toothpaste or brushing the teeth, without making the main screen too crowded, as shown in Figure 4.22.



Figure 4.22 Animation Focus Panel to Apply Toothpaste

The activity ends by showing the completed toothbrushing process and saving the player's progress. The completion screen provides visual confirmation that the child has finished the level and can continue to the next activity, as shown in Figure 4.23 and Figure 4.24.



Figure 4.23 Brushing Teeth



Figure 4.24 Finishing Level to Save Players Progression

F. Hygiene Activity 3: Tidying Toys

The tidying-toys activity was implemented to introduce the habit of putting toys back after playing. This activity did not require major visual changes from the Figma prototype because the objects and interaction flow were already considered clear enough for children. The refined screen is shown in Figure 4.25.



Figure 4.25 Refined Prototype of the Tidying Toys Level

The main interaction in this level is dragging several toys into the correct basket. This mechanic supports concrete learning because children practice the same action that they are expected to perform in daily classroom or home routines.

The level is completed when all required toys have been placed correctly. This completion condition encourages children to finish the task fully, not only interact with one object. The completion result is shown in Figure 4.26.



Figure 4.26 Player Finish Level/Activity 3

G. Hygiene Activity 4: Cleaning the Classroom

The classroom-cleaning activity represents environmental hygiene in the school setting. The Unity version kept the main activity design but adjusted the gameplay flow so that the sequence of collecting rubbish, cleaning the board, and dusting the table could run more efficiently in the game engine. The refined activity screen is shown in Figure 4.27.



Figure 4.27 Refined Prototype of the Cleaning Classroom Level

This activity uses simple tapping and object placement to complete several classroom-cleaning tasks. These interactions were used to represent cleaning actions without requiring children to perform complex controls.

The multi-object interaction helps children understand that classroom cleanliness involves more than one action. Children must complete several small tasks before the activity can continue, such as picking up rubbish before moving to the next cleaning step, as shown in Figure 4.28.



Figure 4.28 Picking Up All Garbage Before Continue to Next Step

A focused animation panel was used to show cleaning the board more clearly. This makes the cleaning action easier to observe and prevents the activity from relying only on static images, as shown in Figure 4.29.

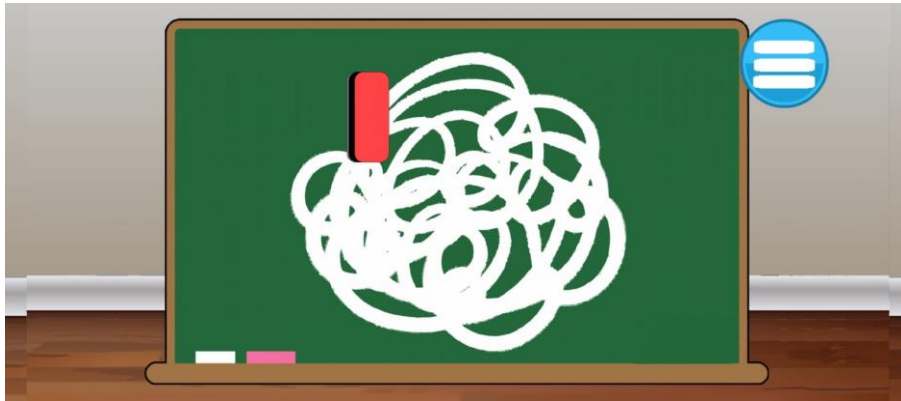


Figure 4.29 Animation Focus Panel to Clean Board

After completing the activity, the game provides a completion response and prepares the player to continue to the next activity. This feedback helps children recognize that the classroom-cleaning routine has been completed, as shown in Figure 4.30.

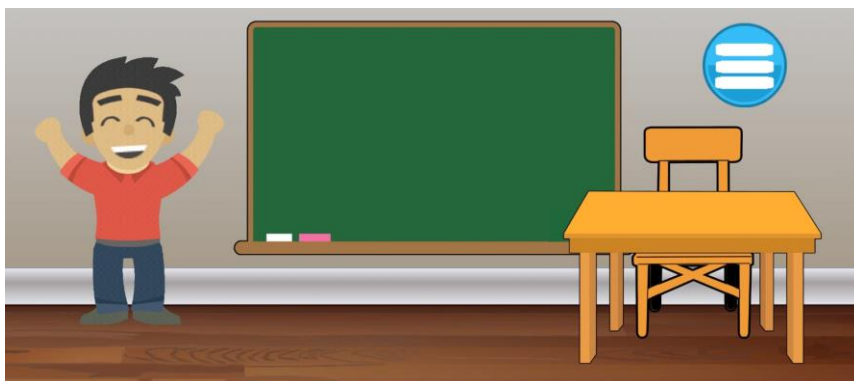


Figure 4.30 Player Finish Level/Activity 4

H. Hygiene Activity 5: Waste Sorting

The waste-sorting activity was implemented to introduce the concept of placing waste into the correct bin. This activity was important because the principal identified waste disposal as one of the hygiene behaviors that children still need to practice consistently. The refined activity screen is shown in Figure 4.31.



Figure 4.31 Refined Prototype of the Waste Sorting Level

The main interaction requires children to drag each waste object to the appropriate bin. The objects were designed to be visually distinct so that children could compare the waste item with the correct category.

The game only continues when the object is placed in the correct bin. This response helps reinforce the idea that waste should not only be thrown away, but should also be placed in the correct location. The completion result is shown in Figure 4.32.



Figure 4.32 Player Finish Level/Activity 5

I. Hygiene Activity 6: Washing Hands

The handwashing level was developed to reinforce the habit of washing hands before eating. The Unity version refined the faucet design so that it was more visible and did not blend into the background. The activity flow was also adjusted to make the sequence easier to follow, as shown in Figure 4.33.

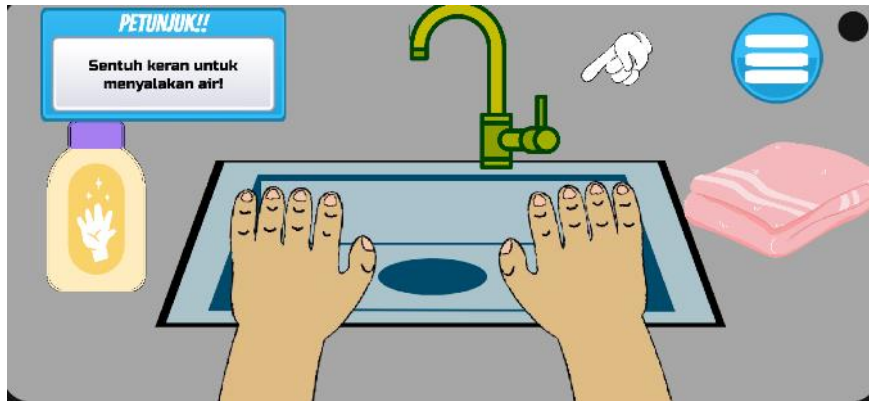


Figure 4.33 Refined Prototype of the Washing Hand Level

The activity combines character movement, tap interaction, object use, and animation. Children guide the character to the faucet, activate the water, use soap, and complete the handwashing sequence. This structure helps represent handwashing as a routine made of several concrete steps.

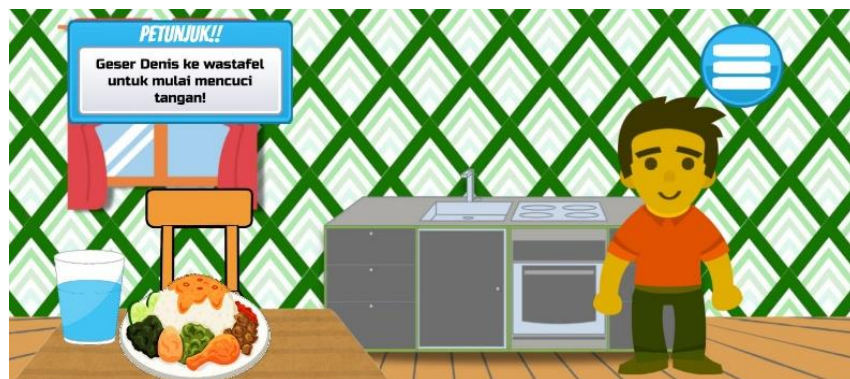


Figure 4.34 Dragging the character to the Faucet

The faucet interaction was implemented with visual animation so that children could see the relationship between tapping the faucet and water flowing. This feedback supports understanding because children receive an immediate visual response after performing the action, as shown in Figure 4.35.



Figure 4.35 Tap the Faucet to Trigger Water Flowing Animation

The sequence was divided into smaller interaction steps to keep the activity manageable for young children. This design prevents the handwashing routine from becoming too long or confusing in one screen.

The final interaction completes the routine and shows that the activity has been finished. This ending provides closure before children continue to the next stage of the game, as shown in Figure 4.36.



Figure 4.36 Player Finish Level/Activity 6

J. Quiz Mechanics and Final Progression

The quiz section was implemented after the hygiene activities to reinforce children's understanding of the routines presented in the game. Based on feedback, questions with too much text were reduced, and answer choices were simplified to make the quiz more suitable for kindergarten children.

The quiz navigation structure allows children to continue from the activity levels into the quiz section and then return to the game flow after completion. This structure ensures that the quiz functions as reinforcement rather than as a separate activity, as shown in Figure 4.37.



Figure 4.37 Navigation After Finishing Quiz

For matching and ordering questions, children interact with visual objects or labels and place them in the correct position. This format was used because it allows children to answer through concrete interaction, not only by reading text. The quiz types are shown in Figure 4.38.



Figure 4.38 “Match the Name to the Picture” and “Order the Items” Quiz Type

After a correct answer, the quiz moves to the next step so that children can continue without needing complex navigation. This keeps the quiz flow simple and reduces the possibility of confusion.

The multiple-choice quiz was used for questions that required children to choose one or more correct answers. The answer options were visually supported to reduce the reading burden and make the task more understandable for young users, as shown in Figure 4.39.

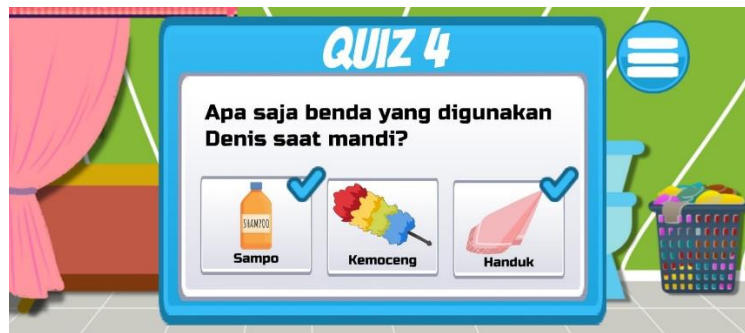


Figure 4.39 Multiple-Choice Quiz Type

True-or-false and correct-answer questions were added to provide variation in the quiz format. These formats help children practice recognizing whether a hygiene-related statement or object choice is correct, as shown in Figure 4.40.

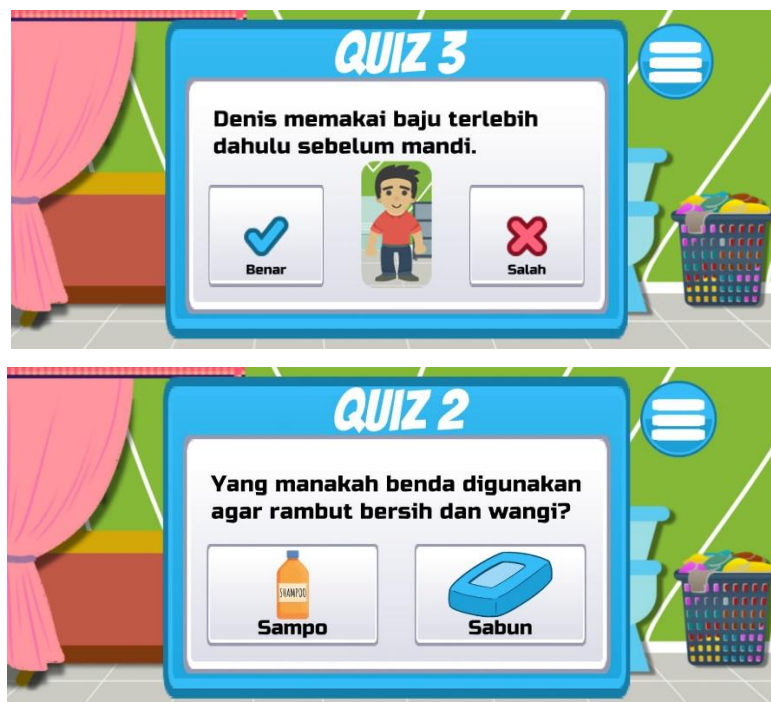


Figure 4.40 “True or False” and “Correct Answer” Quiz Type

After the final quiz is completed, the game saves the player’s progress and unlocks the next available activity. This final progression step completes the Unity prototype flow and prepares the game for classroom testing.

Overall, the Unity prototype represented the second major development result of the game. The main output of this stage was a playable prototype that combined visual design,

child-friendly interaction, animation, quiz mechanics, narration, background audio, and level progression. This prototype was then tested in the classroom to identify remaining usability issues before the final Android APK was prepared.

4.2.4 Unity Prototype Testing (Second Iteration) : Customer Test Drives Prototype

The second iteration was conducted on January 9, 2026 by testing the Unity prototype with the teacher and students in the classroom. This testing focused on whether the implemented game was usable as a classroom learning medium, especially in terms of page flow, object clarity, animation, button size, sound, and quiz difficulty. The feedback for second iteration shown in Table 4.4.

Table 4.4 Second Iteration Feedback

No	Question	Respond	
		Teacher	Average Student
1	Does this design display suit the students' needs?	Yes, it does, the students are very interested in the design display.	Yes, it does.
2	Are the colors good enough? Or do they need adjustment?	It's good and suitable.	Already suitable.
3	How do you think the flow of each page of this game is? Is it easy to understand?	Understandable.	Easy to understand.
4	Is the image design clearly visible and easy to identified?	Yes, it is.	
5	Is the part of the animation enough?	Already good.	
6	Is the button size suitable, does it not interfere with the game?	Yes, and its not interfere with the game.	
7	Is the sound selection suitable, does the volume need to be adjusted?	The voice narration is not loud enough, it is still too low.	The voice narration is not heard
8	Are the questions in the quiz sufficient, or do they need to be adjusted further?	That's it, the student understand.	According to the students it is not too difficult to understand.
9	What suggestions would you like me to make the so the game will be better?	That's it.	Its enough.
10	How did you feel after seeing the prototype of this game?	Very exciting.	Very enjoyable.

Based on the teacher and student feedback, the Unity prototype was generally considered suitable for classroom use. The design display was well received, the colors were appropriate, the page flow was understandable, and the images were clear and easy to identify. The

animation and button size were also considered adequate, showing that the visual interface and interaction layout had already met the students' needs.

The quiz structure was considered sufficient and not too difficult, so no major changes were needed in the content. However, the sound narration still required improvement because the volume was too low compared with the background music. Therefore, the main revision before final testing was audio balancing, especially increasing narration clarity. Documentation of the second iteration is shown in Figure 4.41.



Figure 4.41 Second iteration documentation

4.3 Final Game Development Result

After the second prototype testing, the game was finalized into a classroom-ready Android application. The final development stage focused on preparing the stable game build, refining the audio balance, checking the six activity levels, ensuring that quiz navigation worked properly, and preparing the APK file for classroom testing. The final game included six hygiene levels, a level selection menu, narration, background music, animation feedback, progress saving, and a final quiz.

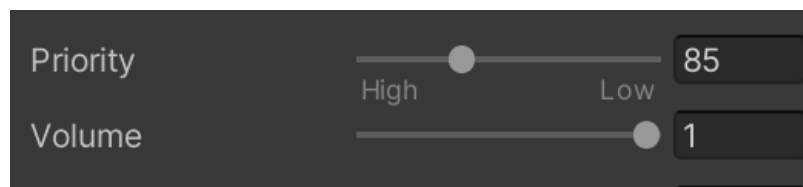


Figure 4.42 Narration Audio Source Adjustment

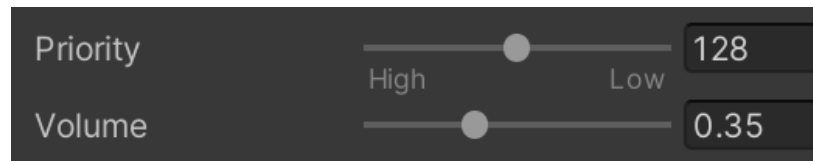


Figure 4.43 Background Audio Source Adjustment

The last technical revision focused on narration and background audio. The narration volume was increased so that children could hear instructions more clearly during play, while the background music was adjusted to avoid masking the voice-over. After these revisions, the project was exported as an Android APK. The output of this stage was a functional Android-based hygiene learning game with finalized visual, interaction, and audio elements. The APK information is presented in Table 4.5.

Table 4.5 The Game APK File Info

Game Name:	Hygiene Hero: clean up buddies
Game App Logo:	
Platform:	Android
Game File Size:	390 MB

Viewed through the Four-Dimensional Framework, the final game design addressed four educational considerations. The learner dimension was supported through simple visuals, short tasks, audio guidance, and basic tap or drag interactions. The pedagogy dimension appeared through repeated practice of hygiene routines and feedback after task completion. The representation dimension was shown through two-dimensional scenes, recognizable objects, animation, narration, and quiz activities. The context dimension was reflected in the preparation of the game for classroom testing at TK Sultan Agung, with teacher assistance and routines that children could relate to at school or at home.

Therefore, the final development result can be considered ready for evaluation because the prototype had passed two feedback cycles and the remaining audio issue had been addressed before the testing session.

4.4 Game Testing and Data Analysis

The game testing and data analysis phase was conducted on January 27, 2026 with 19 kindergarten children. The purpose of this phase was to evaluate the learning outcome and usability of the final game after the development process was completed. Children completed the pre-test, played the game, completed the post-test, and then answered the adapted SUS questionnaire with assistance when needed.

The average completion time of the game session was approximately 15 to 20 minutes. This duration indicates that the game could be completed within a normal short classroom learning activity for kindergarten children. Similar studies on digital educational games for preschool children have also used short game sessions of around 20 to 25 minutes, showing that this duration is still reasonable for young learners when the activity is structured, purposeful, and supported by the teacher (Sop & Hançer, 2025). This also aligns with the view that educational digital media for children should promote active, engaged, meaningful, and socially supported learning rather than passive screen use (Hirsh-Pasek et al., 2015).

The analysis was conducted in stages: data checking, scoring, reliability analysis, normality testing, inferential test selection, descriptive statistics, SUS scoring, and qualitative interpretation. Documentation of the testing activity is shown in Figure 4.44.



Figure 4.44 Students testing the game

4.4.1 Pre/Post-Test

The pre-test and post-test were used to examine whether children's hygiene knowledge changed after using Hygiene Hero: Clean Up Buddies. Because the same children completed both tests, the scores were treated as paired data. The interpretation of this result was made carefully because the study used a one-group pre-test and post-test design without a control group.

A. Descriptive Statistics and Gain Score Analysis

The data processing began by coding each child's answer into binary item scores. A correct answer was coded as 1, while an incorrect answer was coded as 0. Because the instrument contained ten questions, the total number of correct answers was converted into a score on a 0-100 scale by multiplying the number of correct answers by ten. This conversion was applied consistently to both the pre-test and post-test results.

After scoring, the data were checked for completeness and paired consistency. All 19 participants completed both the pre-test and the post-test, so no respondent was removed from the analysis. Each respondent's post-test score was then paired with the same respondent's pre-test score, and the gain score was calculated by subtracting the pre-test score from the post-test

score. The complete scores are presented in Table 4.6, while Figure 4.45 visualizes the comparison between the pre-test and post-test score ranges.

Table 4.6 Pre-Test and Post-Test Scores

Respondent	Gender	Age	Pre-Test	Post-Test	Gain
Respondent 1	Boy	6 Years-old	100	100	0
Respondent 2	Boy	6 Years-old	100	100	0
Respondent 3	Boy	6 Years-old	80	90	+10
Respondent 4	Boy	6 Years-old	100	100	0
Respondent 5	Boy	6 Years-old	90	70	-20
Respondent 6	Boy	6 Years-old	100	100	0
Respondent 7	Boy	4 Years-old	90	90	0
Respondent 8	Boy	6 Years-old	80	80	0
Respondent 9	Girl	5 Years-old	40	70	+30
Respondent 10	Girl	5 Years-old	50	80	+30
Respondent 11	Girl	6 Years-old	50	90	+40
Respondent 12	Girl	6 Years-old	60	80	+20
Respondent 13	Girl	6 Years-old	80	90	+10
Respondent 14	Girl	6 Years-old	80	90	+10
Respondent 15	Girl	6 Years-old	80	90	+10
Respondent 16	Girl	5 Years-old	80	90	+10
Respondent 17	Girl	6 Years-old	90	100	+10
Respondent 18	Girl	6 Years-old	90	100	+10
Respondent 19	Girl	6 Years-old	100	90	-10

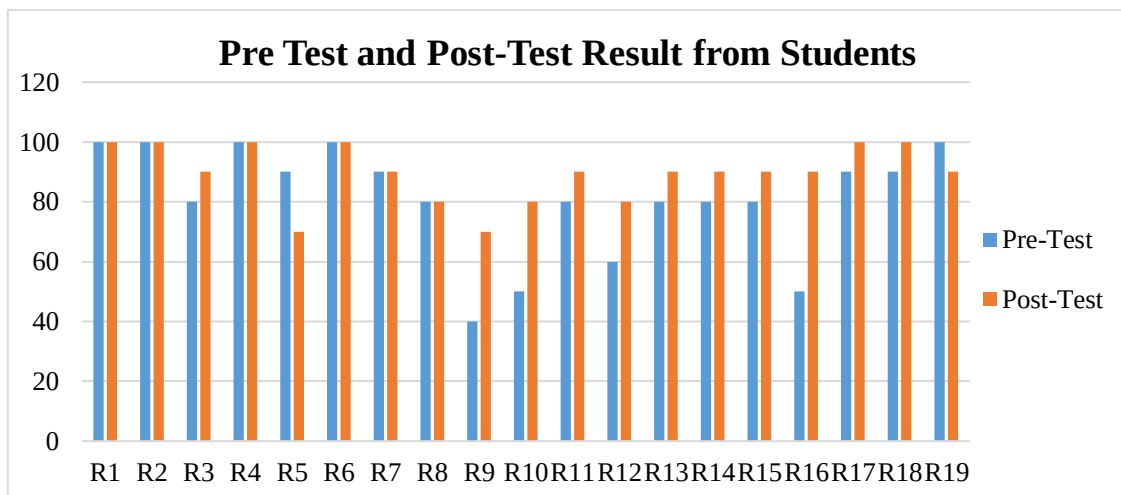


Figure 4.45 A Graph Comparing Pre-Test and Post-Test Results by Score Range

Overall, the score pattern increased after the game session. The mean pre-test score was 81.05, while the mean post-test score increased to 89.47, producing an average gain of 8.42 points. The standard deviation decreased from 18.53 to 9.70, indicating that the post-test scores

became more concentrated. This suggests that after the game session, children's hygiene knowledge was not only higher on average but also more consistent across participants.

These descriptive results indicate positive short-term knowledge improvement after children interacted with the game. However, because the research design did not include a comparison group, the finding should be interpreted as evidence of improvement within the tested class rather than definitive causal proof that the game alone caused all changes (Amalia et al., 2020; Azarys et al., 2024; Kumar K et al., 2022; Latif et al., 2023; Nurjanah et al., 2025).

B. Reliability Analysis of the Test Instrument

The internal consistency of the ten-item hygiene knowledge test was examined using Cronbach's alpha. This step was used to check whether the items in the test measured a reasonably consistent construct. Based on the pre-test responses (10 items, $N = 19$), the analysis produced a reliability coefficient of $\alpha = 0.644$. This value indicates moderate internal consistency and is considered acceptable for an early-stage educational evaluation involving young children, especially because the test was short and consisted of only ten items. Post-test reliability was not interpreted because the post-test scores became highly homogeneous after the intervention, resulting in very low variance across items ($\alpha = 0.035$).

C. Normality Test and Inferential Test Selection

The normality of the pre-test and post-test score distributions were examined using the Shapiro-Wilk test. The Shapiro-Wilk results showed that the pre-test score distribution was not normally distributed ($p = 0.006$), and the post-test score distribution was also not normally distributed ($p = 0.006$). Because both p -values were lower than 0.05, the normality assumption was not fulfilled. Therefore, the Wilcoxon signed-rank test was selected as the main inferential statistical method for comparing the paired pre-test and post-test scores.

The Wilcoxon signed-rank test showed a statistically significant difference between the pre-test and post-test scores ($Z = -2.262$, $p = 0.024$). Since the p -value was lower than 0.05, the null hypothesis was rejected. This means that the score difference in the one-group pre/post evaluation was statistically significant. Because the mean post-test score was higher than the mean pre-test score, the direction of the difference indicates improved hygiene knowledge after the game session.

D. Learning Outcome Interpretation

These findings suggest that Hygiene Hero: Clean Up Buddies can function as a complementary reinforcement medium for hygiene learning in early childhood education. The game helped children review familiar routines through visual guidance, simple interaction, narration, and immediate feedback. Nevertheless, the result should be understood as short-term learning evidence from one classroom context, not as proof of long-term behavior change. A summary of the statistical results is presented in Table 4.7, and the testing documentation is shown in Figure 4.46.

Table 4.7 Summary of Pre-Test and Post-Test Statistical Result

Measure	Value
Number of participants (N)	19
Cronbach`s alpha	0.644
Mean pre-test score	81.05
Standard deviation (pre-test)	18.53
Average gameplay time	15-20 Minutes
Mean post-test score	89.47
Standard deviation (post-test)	9.70
Mean difference	8.42
Standard deviation of difference	14.25
Shapiro-Wilk p (pre-test)	0.006
Shapiro-Wilk p (post-test)	0.006
Normality decision	Not normal
Selected test	Wilcoxon signed-rank
Wilcoxon Z	-2.262
p-value	0.024



Figure 4.46 Pre/Post-testing documentation

4.4.2 System Usability Scale (SUS) Testing

The usability evaluation was conducted using an adapted SUS questionnaire. The statements were simplified and supported with facial icons so that children could respond more easily. The detailed participant responses and calculated SUS scores are presented in Table 4.8.

Table 4.8 System Usability Scale (SUS) Result

GB	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Boy	6	5	1	5	1	5	1	5	1	5	1	100
Boy	6	5	1	5	1	5	1	5	1	5	1	100
Boy	6	4	2	4	2	5	1	5	1	4	1	87.5
Boy	6	4	2	4	2	5	1	5	1	4	1	87.5
Boy	6	5	1	5	1	5	1	5	1	5	1	100
Boy	6	5	1	5	1	5	1	5	3	5	1	95
Boy	4	5	1	5	1	5	1	4	2	5	1	95
Boy	6	4	1	4	2	4	2	4	1	4	2	80
Girl	5	5	1	5	1	4	1	4	1	4	1	92.5
Girl	5	2	3	2	3	5	1	4	2	5	2	67.5
Girl	6	4	1	3	2	5	1	5	1	5	2	87.5
Girl	6	5	2	4	1	5	1	4	1	5	1	92.5
Girl	6	4	1	4	2	5	2	4	1	4	2	82.5
Girl	6	5	1	5	1	5	1	5	1	5	1	100
Girl	6	4	2	5	2	4	2	5	3	4	1	80
Girl	5	5	2	5	2	4	1	5	2	4	2	85
Girl	6	5	1	5	1	4	1	5	1	4	2	92.5
Girl	6	5	2	4	2	5	2	5	1	5	1	90
Girl	6	3	1	2	2	5	2	3	4	1	1	65
Mean		4.42	1.42	4.26	1.58	4.74	1.26	4.58	1.53	4.37	1.31	88.42

As shown in Table 4.8, the average SUS score obtained from the 19 participants was 88.42. According to the adjective rating scale developed by (Bangor et al., 2009), a SUS score around 85.5 corresponds to Excellent usability, while scores approaching 90.9 fall into the Best Imaginable category. Therefore, the Hygiene Hero game can be interpreted as having Excellent to Best Imaginable usability, indicating that the children perceived the system as highly easy to use and satisfying. These results demonstrate that the game's interface and interaction design were well accepted by the children during gameplay. The SUS score and its corresponding adjective rating are illustrated in Figure 4.47.

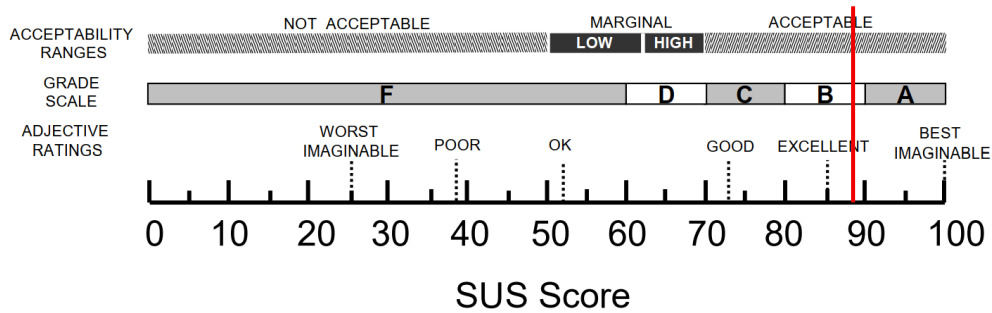


Figure 4.47 SUS Rating Scale

The high SUS score of 88.42 indicates that the Hygiene Hero game's interface, navigation, and interaction design were highly suitable for the target age group. Falls well within the "Acceptable" range, meaning the system meets the requirements for user satisfaction and functional clarity, rated between the "Excellent" to "Best Imaginable" categories, earns a Grade "A," which denotes excellent usability for the target audience. Consequently, the application proves to be a highly viable digital resource for early childhood settings.

The item-level pattern supports this interpretation. Positive items related to liking the game, ease of understanding, remembering cleanliness, graphics, and sound obtained high mean scores, while negative items related to confusion, difficulty, frustration, and hard-to-control buttons received low mean scores. This suggests that the high usability score was supported by clear visuals, simple interaction, understandable sound, suitable button control, and familiar hygiene routines. Therefore, the usability result strengthens the finding that the game was not only educationally relevant but also practical for kindergarten children. This level of usability supports user engagement and learning effectiveness, as prior studies have shown that complex or unintuitive interfaces can reduce children's engagement and learning outcomes (Prihadi & Dellia, 2024). The testing documentation are shown in Figure 4.48.



Figure 4.48 SUS testing documentation

4.4.3 Qualitative Validation Interview

Qualitative validation was conducted to support the interpretation of the quantitative results from the pre-test, post-test, and SUS questionnaire. This validation used a teacher interview and informal child responses after the game testing activity. The teacher interview helped explain classroom conditions and possible factors that affected score differences, while the children's responses provided additional insight into how they experienced the game and the post-test. The results of the classroom teacher interview are presented in Table 4.9.

Table 4.9 Interview Results With the Teacher

No	Question	Respond
For general post test conditions		
1	In general, how do you view the results of pre-test and post-test? Students' scores varied, with some increasing, others remaining the same, and others decreasing. In your opinion, what factors might have influenced these differences?	Those who remained same (already at 100) were likely due to their ability to read and understand. Those who improved were due to their ability to remember the correct answers better after playing the game, or those who simply understood them logically. Those who remained same (below 100) and decreased were likely due to confusion due to not being able to read yet and missing out when the teacher explained the questions, simply following their friends.
2	How were the children's conditions during the post-test? For example, in terms of focus, fatigue, or classroom atmosphere.	In a hurry because it was close to going home, and tired because in the last hour, some were not focused and daydreaming.
For students whose grades have dropped		
3	For students whose grades have dropped, what do you think is the cause?	It's possible that they went down because they were confused about the problem because they couldn't read yet and missed out when the teacher explained the problem, just following their friends.
4	Could the timing of the post-test being close to home time affect their results? Why is that?	It can be, because children become more rushed in doing their work and want to finish quickly.
For students whose grades remain the same		
5	For students whose grades remain the same, what do you think is the cause? Did they already master the material before using the game, or are there other factors?	For those who remain consistent (with a score of 100), this is because the child can already read and understands the material. For children whose scores remain constant (below 100), it's likely that their understanding is limited to that level, or they're not focused and paying attention, so they're just filling things out.
For students whose grades have increased		
6	What might have caused some students to experience an increase in their scores on the post-test compared to the pre-test?	They already know the answer because they were helped by the game, and probably helped by their friend who can already read.

Based on the teacher interview, the variation in children's pre-test and post-test scores was influenced by several classroom and learner-related factors. Children who obtained perfect scores in both tests were considered to already have good reading ability and prior understanding of the hygiene material. For these children, the game functioned mainly as reinforcement rather than as a completely new source of knowledge. Meanwhile, children

whose scores increased were considered to have benefited from the game because the visual activities helped them remember the correct hygiene answers more easily.

However, the teacher also explained that some children who obtained the same lower score or decreased score may have been influenced by limited reading ability, confusion when reading the questions, lack of focus, or following friends' answers. The timing of the post-test was also an important factor because it was conducted close to dismissal time. Some children were tired, rushed, or less focused during the post-test. Therefore, the teacher's explanation should be understood as supporting context, not as the only causal explanation for the score differences.

Table 4.10 Summary of Children's Qualitative Feedback

Response Theme	Summary of Children's Responses	Interpretation
Learning became easier	Most responding children stated that the lesson became easier after playing the game.	The game was perceived as helpful and understandable by many children.
Game helped recall hygiene material	Several children stated that the game helped them remember some hygiene routines or answers.	The game may have supported short-term recall of hygiene knowledge.
Peer assistance	Some children mentioned that friends helped them during the activity or test.	Score improvement may also have been influenced by classroom interaction, not only the game.
Already understood the material	Some children with stable high scores said the questions were easy or already understood.	Some participants may already have had strong prior knowledge before playing the game.
Confusion and limited reading ability	Some children reported confusion, and the teacher also noted that reading ability affected test performance.	Children's comprehension of test questions may have influenced the score results.
Fatigue and desire to go home	A child whose score decreased reported feeling tired, sleepy, and wanting to go home.	Post-test timing and fatigue may have affected performance.

In addition to the teacher interview, children's informal responses were analyzed to strengthen the qualitative validation. Most responding children stated that the lesson became easier after playing the game. Several children reported that the game helped them remember hygiene material, while some also mentioned that friends helped them during the activity or test. Children whose scores remained high generally said that the questions were easy because they already understood the material. Meanwhile, a child whose score decreased reported feeling tired, sleepy, and wanting to go home. These responses show that the learning results

were influenced by the game experience, prior knowledge, peer support, reading ability, and classroom testing conditions.

From an educational perspective, these score differences show that children's learning outcomes were shaped not only by the learning media, but also by developmental readiness and classroom conditions. Kindergarten children are still developing reading ability, attention control, independence, and the ability to follow test instructions. Therefore, some children could benefit more directly from the visual and interactive activities, while others still needed teacher guidance, repetition, or peer support to understand the task. This situation is consistent with early childhood learning principles, where children learn more effectively through concrete visual support, guided practice, and social assistance rather than through written questions alone.

Overall, the qualitative validation supports the quantitative findings by showing that the game was positively received by many children and helped reinforce hygiene concepts. However, the findings also show that the pre-test and post-test results should be interpreted carefully. Since this study used a one-group pre-test and post-test design, the score improvement indicates short-term knowledge improvement after using the game, but it should not be interpreted as definitive causal proof. The qualitative findings provide important context by showing that children's reading ability, focus, fatigue, peer support, and classroom timing also influenced the evaluation results. Documentation of the qualitative validation interview is shown in Figure 4.49.



Figure 4.49 Qualitative validation interview documentation

CHAPTER V

CONCLUSION AND SUGGESTION

5.1 Conclusion

Based on the results of this study, the conclusion is:

- a. The game was developed as an Android-based Unity application entitled Hygiene Hero: Clean Up Buddies. The final product includes six hygiene routines: bathing, toothbrushing, tidying toys, classroom cleaning, waste sorting, and handwashing before eating. The game also uses child-friendly visuals, simple tap and drag-and-drop interactions, narration, audio feedback, and quiz activities to support children's understanding.
- b. The digital hygiene learning game was designed through an iterative prototyping process involving requirement analysis, Figma prototype development, Unity prototype implementation, and teacher-child feedback. This process helped align the game design with the needs of kindergarten learners and the hygiene routines practiced in the classroom.
- c. The evaluation in learning outcomes and usability using a recognized instrument showed an improvement in children's hygiene knowledge after using the game. The mean score increased from 81.05 in the pre-test to 89.47 in the post-test, and the Wilcoxon signed-rank test showed a significant difference between both scores ($Z = -2.262$, $p = 0.024$). The usability evaluation also produced an average SUS score of 88.42.
- d. Based on the evaluation results above, the game can be considered educationally meaningful and suitable for young learners within the testing context. The improvement in post-test scores shows that the game supported children's hygiene learning, while the high SUS score indicates high perceived usability and suggests that the interface was easy enough to understand and operate in the kindergarten testing context. Therefore, the game was practical and acceptable for kindergarten children to use.

Although the findings indicate positive potential, the main challenges were the differences in children's reading ability, prior hygiene knowledge, attention span, and classroom condition during testing. The post-test was also conducted close to dismissal time, which may have affected some children's focus and motivation. Several limitations should be considered is that the study involved only 19 children from one kindergarten and used a one-group pre-test and post-test design without a control group. Therefore, the results should be

interpreted as evidence of short-term knowledge improvement after using the game, rather than definitive causal evidence that can be generalized broadly to all kindergarten contexts.

5.2 Suggestion

Based on the findings and limitations of this study, the suggestions are divided into product development suggestions and future research suggestions. For product development, suggestions focus on improving the game as a learning product, several improvements can be considered as follows:

- a. Add more varied hygiene scenarios. The current game already includes six main routines, namely bathing, toothbrushing, tidying toys, classroom cleaning, waste sorting, and handwashing before eating. Future development can add other hygiene scenarios so that the content becomes richer and children do not easily become bored.
- b. Improve audio, narration, and interaction feedback. Since the users are kindergarten children, clear voice instructions, sound effects, and visual feedback are important to help them understand the tasks more easily.
- c. Add progression and reward features. The game can be developed with features such as stars, badges, simple achievements, or more varied level progression to increase children's motivation and sense of accomplishment.
- d. Optimize the game for broader classroom use. The game should be made lighter, more stable, and more compatible with different Android devices so that it can be used more flexibly in other kindergarten classrooms.

For future research, the study can be replicated in other early childhood education settings, particularly TK B or kindergarten classes with children aged five to six years. This age group is appropriate because children are generally more capable of following short instructions, recognizing visual objects, and completing simple digital interactions with teacher assistance. Replication would be most relevant in schools that already introduce clean and healthy living routines, such as handwashing, toothbrushing, classroom cleaning, waste sorting, and caring for shared classroom materials.

Future research suggestions focus on strengthening the evaluation process and academic contribution of similar studies. Several directions can be considered as follows:

- a. Involve more participants from different schools. Future studies should include a larger number of children from more than one kindergarten to improve the generalizability of the findings.

- b. Use a stronger evaluation design. Future research can use a comparison group or compare the game with other learning media to provide stronger evidence regarding its contribution to hygiene learning.
- c. Evaluate long-term habit formation. Further studies should not only measure short-term knowledge improvement, but also observe whether the game supports children's hygiene habits in daily classroom or home routines over a longer period.
- d. Explore broader evaluation aspects beyond SUS. Future research can include engagement observation, teacher acceptance, classroom integration, repeated-use evaluation, or parent feedback to provide a more complete understanding of the game's educational value.

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APPENDIX

APPENDIX A: Full Pre-Test and Post-Test Raw Data

Questions for the Pre-Test/Post-Test

No	Question	Option	
		A	B
1	What is used to clean the body when taking a bath?	Soap and shampoo.	Toys and sandals.
2	Why do we have to brush our teeth regularly?	So that the teeth change color.	To keep teeth healthy.
3	What do we use to brush our teeth?	Toothpaste.	Toy cars.
4	Why should scattered rubbish be thrown away in its place?	Because trash cans like to eat.	To keep the environment clean and healthy.
5	After playing with toys, what do you do?	Just leave it be.	Put it back in the toy basket.
6	If we see rubbish in class, what do we do?	Kick it out.	Picked it up and put it in the trash.
7	Where do we put paper waste?	In the paper bin.	In the gutter.
8	Before eating, what should we do?	Just eat it straight away.	Washing hands.
9	What do you use to clean a dusty table?	Food.	Feather duster.
10	After bathing, what do you use to dry your body?	Towel.	Soap.

Pre-Test Raw Data

[illegible]

Post-Test Raw Data

Gender	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Boy	6 Years-old	1	1	1	1	1	1	1	1	1	1	100
Boy	6 Years-old	1	1	1	1	1	1	1	1	1	1	100
Boy	6 Years-old	1	1	1	1	1	0	1	1	1	1	90
Boy	6 Years-old	1	1	1	1	1	1	1	1	1	1	100
Boy	6 Years-old	1	1	0	0	1	1	1	0	1	1	70
Boy	6 Years-old	1	1	1	1	1	1	1	1	1	1	100
Boy	4 Years-old	1	1	1	1	1	1	1	1	1	0	90
Boy	6 Years-old	1	1	0	1	1	1	1	0	1	1	80
Girl	5 Years-old	1	1	1	1	1	1	0	0	0	1	70
Girl	5 Years-old	1	1	1	1	0	1	1	0	1	1	80
Girl	6 Years-old	1	1	1	1	1	1	1	0	1	1	90
Girl	6 Years-old	1	1	1	1	1	1	0	0	1	1	80
Girl	6 Years-old	1	1	1	0	1	1	1	1	1	1	90
Girl	6 Years-old	1	1	1	1	1	1	1	1	0	1	90
Girl	6 Years-old	1	1	1	1	0	1	1	1	1	1	90
Girl	5 Years-old	1	1	1	1	0	1	1	1	1	1	90
Girl	6 Years-old	1	1	1	1	1	1	1	1	1	1	100
Girl	6 Years-old	1	1	1	1	1	1	1	1	1	1	100
Girl	6 Years-old	1	1	1	0	1	1	1	1	1	1	90

APPENDIX B: SUS Instrument and Respond

Questions for SUS Testing

No	Statement	Option				
		1	2	3	4	5
1	I love the game.	Hate it	Dislike	Normal	Like	Loveit
2	I often feel confused while playing.	Not confused at all	Not confusing	Normal	Confusing	Very Confusing
3	The game is easy to understand.	Very hard	Hard	Normal	Easy	Very easy
4	I needed a lot of help before I could play this game independently.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree
5	The game makes me remember about keeping clean.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree
6	The game is hard to play.	Very easy	Easy	Normal	Hard	Very hard
7	The graphics of the game are easy to understand.	Very hard	Hard	Normal	Easy	Very easy
8	The game frustrated me while completing the levels.	Very enjoy	Enjoying	Normal	Frustrating	Very frustrating
9	The sound from the game is clear.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree
10	The game buttons are hard to control.	Strongly Disagree	Disagree	Normal	Agree	Strongly agree

SUS Respond Raw Data

Gender	Age	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Boy	6 Years-old	5	1	5	1	5	1	5	1	5	1
Boy	6 Years-old	5	1	5	1	5	1	5	1	5	1
Boy	6 Years-old	4	2	4	2	5	1	5	1	4	1
Boy	6 Years-old	4	2	4	2	5	1	5	1	4	1
Boy	6 Years-old	5	1	5	1	5	1	5	1	5	1
Boy	6 Years-old	5	1	5	1	5	1	5	3	5	1
Boy	4 Years-old	5	1	5	1	5	1	4	2	5	1
Boy	6 Years-old	4	1	4	2	4	2	4	1	4	2
Girl	5 Years-old	5	1	5	1	4	1	4	1	4	1
Girl	5 Years-old	2	3	2	3	5	1	4	2	5	2
Girl	6 Years-old	4	1	3	2	5	1	5	1	5	2
Girl	6 Years-old	5	2	4	1	5	1	4	1	5	1
Girl	6 Years-old	4	1	4	2	5	2	4	1	4	2
Girl	6 Years-old	5	1	5	1	5	1	5	1	5	1
Girl	6 Years-old	4	2	5	2	4	2	5	3	4	1
Girl	5 Years-old	5	2	5	2	4	1	5	2	4	2
Girl	6 Years-old	5	1	5	1	4	1	5	1	4	2
Girl	6 Years-old	5	2	4	2	5	2	5	1	5	1
Girl	6 Years-old	3	1	2	2	5	2	3	4	1	1

APPENDIX C: Qualitative Validation Instrument

Qualitative Validation Questions for Teachers

No	Question
For general post test conditions	
1	In general, how do you view the results of pre-test and post-test? Students' scores varied, with some increasing, others remaining the same, and others decreasing. In your opinion, what factors might have influenced these differences?
2	How were the children's conditions during the post-test? For example, in terms of focus, fatigue, or classroom atmosphere.
For students whose grades have dropped	
3	For students whose grades have dropped, what do you think is the cause?
4	Could the timing of the post-test being close to home time affect their results? Why is that?
For students whose grades remain the same	
5	For students whose grades remain the same, what do you think is the cause? Did they already master the material before using the game, or are there other factors?
For students whose grades have increased	
6	What might have caused some students to experience an increase in their scores on the post-test compared to the pre-test?

Qualitative Validation Questions for Students

No	Question
For general post test conditions	
1	After playing the game, how did the lesson turn out? Easier, the same, or harder? Tell me about it.
2	How were the children's conditions during the post-test? For example, in terms of focus, fatigue, or classroom atmosphere.
For students whose grades have dropped	
3	Your score on the second test was lower than the first. Why do you think that is?
4	When you were working on the problem yesterday, how did you feel? Tired, sleepy, wanted to go home quickly, or just normal?
For students whose grades remain the same (below 100)	
5	Before playing the game, do you think you can do questions like that or not?
6	After playing the game, your scores on both tests yesterday were the same. Why do you think that is?
7	When you were answering on the questions, was there anything that made you confused or difficult? Which part?
For students whose grades remain the same (already 100)	
8	When you saw the questions, did you find them easy or difficult?
9	After playing the game, how did the lesson feel? Was it still as easy or different? Tell me about it.
For students whose grades have increased	
10	While playing the game, was there any material or things you didn't know or had forgotten before, and then remembered again? If so, what were they about?
11	Why do you think your score is higher than the initial one?

APPENDIX D: Scripts

MulaiButton.cs Script, Used in Every Activity/Level When it First Initialized

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class MulaiButton : MonoBehaviour
{
    [Header("Audio Source")]
    [SerializeField] AudioSource musicSource;
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip opening;
    public AudioClip background;
    public AudioClip clickSound;

    [Header("Game Panel")]
    public GameObject pembukaan;
    public GameObject gameplay;

```

```

    public void Awake() {
        PlayerPrefs.SetString("LastCompletedLevel",
SceneManager.GetActiveScene().name);
        PlayerPrefs.Save();
        musicSource.clip = background;
        HintAudSource.PlayOneShot(opening);
    }

    public void Trigger() {
        if (HintAudSource.isPlaying)
        {
            HintAudSource.Stop();
        }
        musicSource.Play();
        SFXSource.PlayOneShot(clickSound);

        gamePlay.SetActive(true);
        Destroy(pembukaan);
    }
}

```

PauseManager.cs Script, Used to Pause the Game During Interruptions

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class PauseManager : MonoBehaviour
{
    public static bool IsPaused = false;
    public GameObject pause;
    public string ulang = "Kegiatan";
    public string mainMenu = "Main Menu";

    [Header("Audio Source")]
    [SerializeField] AudioSource musicSource;
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;

    public void PauseGame() {
        if (HintAudSource.isPlaying)
        {
            HintAudSource.Stop();
        }
        if (SFXSource.isPlaying)
        {
            SFXSource.Stop();
        }
        IsPaused = true;
        musicSource.Pause();
        SFXSource.PlayOneShot(clickSound);
        Time.timeScale = 0;
        pause.SetActive(true);
    }
}

```

```

    public void Lanjut() {
        IsPaused = false;
        musicSource.Play();
        SFXSource.PlayOneShot(clickSound);
        Time.timeScale = 1;
        pause.SetActive(false);
    }

    public void Ulangi() {
        IsPaused = false;
        Time.timeScale = 1;
        LoadingScreenManager.Instance.SwitchToScene(ulang);
    }
    public void MainMenu() {
        IsPaused = false;
        Time.timeScale = 1;
        LoadingScreenManager.Instance.SwitchToScene(mainMenu);
    }
}

```

LevelManager.cs Script, Used to Manage Player Progression Data

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class LevelManager : MonoBehaviour
{
    public void UnlockNewLevel()
    {
        if (SceneManager.GetActiveScene().buildIndex >=
PlayerPrefs.GetInt("ReachedIndex"))
        {
            PlayerPrefs.SetInt("ReachedIndex",
SceneManager.GetActiveScene().buildIndex + 1);
            PlayerPrefs.SetInt("UnlockedLevel",
PlayerPrefs.GetInt("UnlockedLevel", 1) + 1);
            PlayerPrefs.Save();
        }
    }
}

```

MainMenuScrp.cs Script, Used to be the Main Control for the Game Main Menu

```

using UnityEngine;
using UnityEngine.SceneManagement;
using UnityEngine.UI;

public class MainMenuScrp : MonoBehaviour
{
    [Header("Audio Source")]
    [SerializeField] AudioSource musicSource;
    [SerializeField] AudioSource SFXSource;

    [Header("Audio Clip")]
    public AudioClip backgroundSound;
}

```

```

public AudioClip clickSound;

[Header("Game Panel")]
public GameObject menu;
public GameObject mainPanel;
public GameObject pilihLevel;
public GameObject yakinKeluar;
public GameObject yakinUlangProgress;

public void Awake()
{
    musicSource.clip = backgroundSound;
    musicSource.Play();
}

public void LanjutGim()
{
    string lastLevel = PlayerPrefs.GetString("LastCompletedLevel",
"Kegiatan1");
    SFXSource.PlayOneShot(clickSound);
    LoadingScreenManager.Instance.SwitchToScene(lastLevel);
}

public void PilihLevel()
{
    SFXSource.PlayOneShot(clickSound);
    mainPanel.SetActive(false);
    pilihLevel.SetActive(true);
}

public void BackMainPanel()
{
    SFXSource.PlayOneShot(clickSound);
    mainPanel.SetActive(true);
    pilihLevel.SetActive(false);
}

public void YakinKeluar()
{
    SFXSource.PlayOneShot(clickSound);
    yakinKeluar.SetActive(true);
}

public void Keluar()
{
    SFXSource.PlayOneShot(clickSound);
    Application.Quit();
}

public void TidakKeluar()
{
    SFXSource.PlayOneShot(clickSound);
    yakinKeluar.SetActive(false);
}

public void YakinUlangProgress()
{
    SFXSource.PlayOneShot(clickSound);
    yakinUlangProgress.SetActive(true);
}

public void TidakUlangProgress()
{
    SFXSource.PlayOneShot(clickSound);
    yakinUlangProgress.SetActive(false);
}

```

```
}  
}
```

LevelMenu.cs Script, Used as a Controller for the “*Pilih Level*” Menu in a Game, Allowing Players to Select Levels Based on Their Progress

```
using System.Collections;  
using System.Collections.Generic;  
using UnityEngine;  
using UnityEngine.SceneManagement;  
using UnityEngine.UI;  
  
public class LevelMenu : MonoBehaviour  
{  
  
    public GameObject yakinUlangProgress;  
    [Header("Audio Source")]  
    [SerializeField] AudioSource SFXSource;  
  
    [Header("Audio Clip")]  
    public AudioClip clickSound;  
    public AudioClip reset;  
    public Button[] buttons;  
    private void Awake()  
    {  
        int unlockedLevel = PlayerPrefs.GetInt("UnlockedLevel", 1);  
        for (int I = 0; I < buttons.Length; i++)  
        {  
            buttons[i].interactable = false;  
        }  
        for (int I = 0; I < unlockedLevel; i++)  
        {  
            buttons[i].interactable = true;  
        }  
    }  
  
    public void OpenLevel(string levelName)  
    {  
        SFXSource.PlayOneShot(clickSound);  
        LoadingScreenManager.Instance.SwitchToScene(levelName);  
    }  
  
    public void ResetLevelProgress()  
    {  
        SFXSource.PlayOneShot(reset);  
        yakinUlangProgress.SetActive(false);  
        PlayerPrefs.SetInt("ReachedIndex", 0);  
        PlayerPrefs.SetString("LastCompletedLevel", "Kegiatan1");  
        PlayerPrefs.SetInt("UnlockedLevel", 1);  
        PlayerPrefs.Save();  
  
        Debug.Log("Level progress reset");  
  
        int unlockedLevel = PlayerPrefs.GetInt("UnlockedLevel", 1);  
        for (int I = 0; I < buttons.Length; i++)  
        {  
            buttons[i].interactable = false;  
        }  
    }  
}
```

```

        for (int I = 0; I < unlockedLevel; i++)
        {
            buttons[i].interactable = true;
        }
    }
}

```

Drag.cs Script, Used to Handle Dragged Object

```

Using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.EventSystems;

public class Drag : MonoBehaviour
{
    private Collider2D col;
    private Vector3 startDragPosition;
    private Coroutine blinkCoroutine;
    private Color defaultColor;
    private SpriteRenderer spriteRenderer;
    public GameObject pointer;
    public GameObject sameObj;
    public GameObject hintPanel;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip correct;
    public AudioClip hintAudio;

    private void Start()
    {
        HintAudSource.PlayOneShot(hintAudio);
        col = GetComponent<Collider2D>();
        pointer.SetActive(false);
        spriteRenderer = GetComponent<SpriteRenderer>();
        defaultColor = spriteRenderer.color;
        StartBlinking();
    }

    private void OnMouseDown()
    {
        if (PauseManager.IsPaused)
            return;
        SFXSource.PlayOneShot(clickSound);
        startDragPosition = transform.position;
        transform.position = GetMousePositionInWorldSpace();
        StopBlinking();
        pointer.SetActive(true);
        sameObj.SetActive(false);
    }

    private void OnMouseDrag()
    {
        if (PauseManager.IsPaused)

```

```

        return;
        transform.position = GetMousePositionInWorldSpace();
    }

    private void OnMouseUp()
    {
        if (PauseManager.IsPaused)
            return;
        col.enabled = false;
        Collider2D hitCollider = Physics2D.OverlapPoint(transform.position);
        col.enabled = true;
        if (hitCollider != null && hitCollider.TryGetComponent(out IdropArea
basket))
        {
            basket.OnDropArea(this);
            StopBlinking();
            CorrectPlace();
            hintPanel.SetActive(false);
        }
        else
        {
            transform.position = startDragPosition;
            sameObj.SetActive(true);
            StartBlinking();
        }
        pointer.SetActive(false);
    }

    public Vector3 GetMousePositionInWorldSpace()
    {
        Vector3 p = Camera.main.ScreenToWorldPoint(Input.mousePosition);
        p.z = 0f;
        return p;
    }

    public void StartBlinking()
    {
        if (blinkCoroutine == null)
        {
            blinkCoroutine = StartCoroutine(BlinkYellow());
        }
    }

    public void StopBlinking()
    {
        if (blinkCoroutine != null)
        {
            StopCoroutine(blinkCoroutine);
            blinkCoroutine = null;
        }
        spriteRenderer.color = defaultColor;
    }

    private IEnumerator BlinkYellow()
    {
        while (true)
        {
            spriteRenderer.color = Color.yellow;
            yield return new WaitForSeconds(0.5f);
            spriteRenderer.color = defaultColor;
        }
    }

```

```

        yield return new WaitForSeconds(0.5f);
    }
}

public void CorrectPlace()
{
    if (HintAudSource.isPlaying)
    {
        HintAudSource.Stop();
    }
    SFXSource.PlayOneShot(correct);
    col.enabled = false;
}
}

```

IDropArea.cs Script, Used to Determine What Happens When the Object is Dropped in the Correct Spot

```

using UnityEngine;

public interface IDropArea
{
    void OnDropArea(Drag drag);
}

```

NextStep.cs Script, Used to Proceed to Next Step Before Completing The Level Without Triggering Animation

```

using UnityEngine;
using System.Collections;

public class NextStep : MonoBehaviour, IDropArea
{
    public GameObject CurrentStep;
    public GameObject NextStepObject;

    public void OnDropArea(Drag drag)
    {
        Destroy(drag.gameObject);
        Destroy(CurrentStep);
        NextStepObject.SetActive(true);
    }
}

```

NextAnimation.cs Script, Used to Proceed to Next Step Before Completing The Level and Trigger Animation

```

using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class NextAnimation : MonoBehaviour, IDropArea
{

```

```

public Animator protagonistAnimator;
public string animationTrigger;
public float delayBeforeNextStep = 3f;
public GameObject CurrentStep;
public GameObject NextStepObject;
public GameObject sameObj;
[SerializeField] AudioSource SFXSource;

public void OnDropArea(Drag drag)
{
    Destroy(drag.gameObject);
    protagonistAnimator.SetTrigger(animationTrigger);
    StartCoroutine(DelayNextStep(delayBeforeNextStep));
}

private IEnumerator DelayNextStep(float delayTime)
{
    float timeElapsed = 0f;

    while (timeElapsed < delayTime)
    {
        timeElapsed += Time.deltaTime;
        yield return null;
    }
    if (SFXSource.isPlaying)
    {
        SFXSource.Stop();
    }
    sameObj.SetActive(true);
    protagonistAnimator.SetTrigger(animationIdle);
    Destroy(CurrentStep);
    NextStepObject.SetActive(true);
}
}

```

NextSceneK2.cs Script, Used to Proceed to Next Level After Completion, Trigger Animation, and Save Progression

```

using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class NextSceneK2 : MonoBehaviour, IDropArea
{
    public Animator protagonistAnimator;
    public string animationTrigger;
    public float delayBeforeNextStep = 3f;
    public string nextSceneName = "Kegiatan3";

    private LevelManager levelManager;

    private void Start()
    {
        levelManager = FindObjectOfType<LevelManager>();
    }

    public void OnDropArea(Drag drag)
    {

```

```

        Destroy(drag.gameObject);
        levelManager.UnlockNewLevel();
        protagonistAnimator.SetTrigger(animationTrigger);
        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
        LoadingScreenManager.Instance.SwitchToScene(nextSceneName);
    }
}

```

TapAnim.cs Script, Used to Trigger an Animation Simply by Clicking on an Object

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.EventSystems;

public class TapAnim : MonoBehaviour
{
    private Collider2D col;
    private Coroutine blinkCoroutine;
    private Color defaultColor;
    private SpriteRenderer spriteRenderer;
    public GameObject pointer;
    public Animator protagonistAnimator;
    public string animationTrigger;
    public string animationIdle;
    public float delayBeforeNextStep = 3f;
    public GameObject CurrentStep;
    public GameObject NextStepObject;
    public GameObject hintPanel;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip hintAudio;

    private void Start()
    {
        HintAudSource.PlayOneShot(hintAudio);
        col = GetComponent<Collider2D>();
        spriteRenderer = GetComponent<SpriteRenderer>();
        defaultColor = spriteRenderer.color;
        pointer.SetActive(true);
        StartBlinking();
    }

    private void OnMouseDown()

```

```

{
    if (PauseManager.IsPaused)
        return;
    if (HintAudSource.isPlaying)
    {
        HintAudSource.Stop();
    }
    col.enabled = false;
    SFXSource.PlayOneShot(clickSound);
    protagonistAnimator.SetTrigger(animationTrigger);
    Destroy(pointer);
    hintPanel.SetActive(false);
    StopBlinking();
    StartCoroutine(DelayNextStep(delayBeforeNextStep));
}
private IEnumerator DelayNextStep(float delayTime)
{
    float timeElapsed = 0f;

    while (timeElapsed < delayTime)
    {
        timeElapsed += Time.deltaTime;
        yield return null;
    }
    if (SFXSource.isPlaying)
    {
        SFXSource.Stop();
    }
    protagonistAnimator.SetTrigger(animationIdle);
    Destroy(CurrentStep);
    NextStepObject.SetActive(true);
}

public void StartBlinking()
{
    if (blinkCoroutine == null)
    {
        blinkCoroutine = StartCoroutine(BlinkYellow());
    }
}

public void StopBlinking()
{
    if (blinkCoroutine != null)
    {
        StopCoroutine(blinkCoroutine);
        blinkCoroutine = null;
    }
    spriteRenderer.color = defaultColor;
}
private IEnumerator BlinkYellow()
{
    while (true)
    {
        spriteRenderer.color = Color.yellow;
        yield return new WaitForSeconds(0.5f);
        spriteRenderer.color = defaultColor;
        yield return new WaitForSeconds(0.5f);
    }
}
}

```

```
}
```

FocusAnim.cs Script, Used to Handle the Close-Up Animation

```
using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class FocusAnim : MonoBehaviour, IDropArea
{
    public float delayBeforeNextStep = 3f;
    public GameObject AnimationObj;
    public GameObject CurrentStep;
    public GameObject NextStepObject;

    public void OnDropArea(Drag drag)
    {
        Destroy(drag.gameObject);
        AnimationObj.SetActive(true);

        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
        Destroy(CurrentStep);
        Destroy(AnimationObj);
        NextStepObject.SetActive(true);
    }
}
```

Toy.cs Script, Similar to Drag.cs Script With Minor Adjusment (GameObject hintPanel;

Doesn't Need to Be Hidden Until All Objects Are Correctly Placed)

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.EventSystems;

public class Toy : MonoBehaviour
{
    private Collider2D col;
    private Vector3 startDragPosition;
    public GameObject pointer;
    private Coroutine blinkCoroutine;
    private Color defaultColor;
    private SpriteRenderer spriteRenderer;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
```

```

[Header("Audio Clip")]
public AudioClip clickSound;
public AudioClip correct;

private void Start()
{
    col = GetComponent<Collider2D>();
    pointer.SetActive(false);
    spriteRenderer = GetComponent<SpriteRenderer>();
    defaultColor = spriteRenderer.color;
    StartBlinking();
}

private void OnMouseDown()
{
    SFXSource.PlayOneShot(clickSound);
    startDragPosition = transform.position;
    transform.position = GetMousePositionInWorldSpace();
    if (PauseManager.IsPaused)
        return;
    pointer.SetActive(true);
    StopBlinking();
    Toy[] allToy = FindObjectsOfType<Toy>();
    foreach (Toy obj in allToy)
    {
        if (obj != this)
        {
            obj.StopBlinking();
        }
    }
}

private void OnMouseDrag()
{
    if (PauseManager.IsPaused)
        return;
    transform.position = GetMousePositionInWorldSpace();
}

private void OnMouseUp()
{
    if (PauseManager.IsPaused)
        return;
    col.enabled = false;
    Collider2D hitCollider = Physics2D.OverlapPoint(transform.position);
    col.enabled = true;
    if (hitCollider != null && hitCollider.TryGetComponent(out IBasket
basket))
    {
        basket.OnToyDrop(this);
        SFXSource.PlayOneShot(correct);
        StopBlinking();
    }
    else
    {
        transform.position = startDragPosition;
        StartBlinking();
    }
    pointer.SetActive(false);
}

```

```

        Toy[] allToy = FindObjectsOfType<Toy>();
        foreach (Toy obj in allToy)
        {
            if (obj != this)
            {
                obj.StartBlinking();
            }
        }
    }

    public Vector3 GetMousePositionInWorldSpace()
    {
        Vector3 p = Camera.main.ScreenToWorldPoint(Input.mousePosition);
        p.z = 0f;
        return p;
    }

    public void StartBlinking()
    {
        if (blinkCoroutine == null)
        {
            blinkCoroutine = StartCoroutine(BlinkYellow());
        }
    }

    public void StopBlinking()
    {
        if (blinkCoroutine != null)
        {
            StopCoroutine(blinkCoroutine);
            blinkCoroutine = null;
        }
        spriteRenderer.color = defaultColor;
    }

    private IEnumerator BlinkYellow()
    {
        while (true)
        {
            spriteRenderer.color = Color.yellow;
            yield return new WaitForSeconds(0.5f);
            spriteRenderer.color = defaultColor;
            yield return new WaitForSeconds(0.5f);
        }
    }
}

```

IBasket.cs Script, Same Function as IDropArea.cs Script but only Accepting Toy.cs Object

```

using UnityEngine;

public interface IBasket
{
    void OnToyDrop(Toy toy);
}

```

Basket.cs Script, Works by Counting Objects Placed in Drop Area and Proceeds to Next Level After Reaching Required Amount

```
using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class Basket : MonoBehaviour, IBasket
{
    private int toyCount = 0;
    public int targetToyCount = 5;
    public Animator protagonistAnimator;
    public string winTrigger = "win animation biru";
    public float delayBeforeSceneChange = 3f;
    public string nextSceneName = "Main Menu";
    public GameObject hintPanel;
    private LevelManager levelManager;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip correct;

    private void Start()
    {
        levelManager = FindObjectOfType<LevelManager>();
    }

    public void OnToyDrop(Toy toy)
    {
        Destroy(toy.gameObject);
        toyCount++;

        if (toyCount >= targetToyCount)
        {
            hintPanel.SetActive(false);
            if (HintAudSource.isPlaying)
            {
                HintAudSource.Stop();
            }
            SFXSource.PlayOneShot(correct);
            levelManager.UnlockNewLevel();
            protagonistAnimator.SetTrigger(winTrigger);
            StartCoroutine(DelaySceneChange(delayBeforeSceneChange));
        }
    }

    private IEnumerator DelaySceneChange(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
    }
}
```

```
        LoadingScreenManager.Instance.SwitchToScene(nextSceneName);  
    }  
}
```

TapAnimK4.cs Script, Simmilar With TapAnim.cs But This Does Not Require an Idle Animation

```
using System.Collections;  
using System.Collections.Generic;  
using UnityEngine;  
using UnityEngine.EventSystems;  
  
public class TapAnimK4 : MonoBehaviour  
{  
    private Collider2D col;  
    private Coroutine blinkCoroutine;  
    private Color defaultColor;  
    private SpriteRenderer spriteRenderer;  
    public GameObject pointer;  
    public Animator protagonistAnimator;  
    public string animationTrigger;  
    public float delayBeforeNextStep = 3f;  
    public GameObject CurrentStep;  
    public GameObject NextStepObject;  
    public GameObject hintPanel;  
  
    [Header("Audio Source")]  
    [SerializeField] AudioSource SFXSource;  
    [SerializeField] AudioSource HintAudSource;  
  
    [Header("Audio Clip")]  
    public AudioClip clickSound;  
    public AudioClip hintAudio;  
  
    private void Start()  
    {  
        HintAudSource.PlayOneShot(hintAudio);  
        col = GetComponent<Collider2D>();  
        spriteRenderer = GetComponent<SpriteRenderer>();  
        defaultColor = spriteRenderer.color;  
        pointer.SetActive(true);  
        StartBlinking();  
    }  
  
    private void OnMouseDown()  
    {  
        if (PauseManager.IsPaused)  
            return;  
        if (HintAudSource.isPlaying)  
        {  
            HintAudSource.Stop();  
        }  
        col.enabled = false;  
        SFXSource.PlayOneShot(clickSound);  
        protagonistAnimator.SetTrigger(animationTrigger);  
        hintPanel.SetActive(false);  
        Destroy(pointer);  
        StopBlinking();  
    }  
}
```

```

        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
        Destroy(CurrentStep);
        NextStepObject.SetActive(true);
    }

    public void StartBlinking()
    {
        if (blinkCoroutine == null)
        {
            blinkCoroutine = StartCoroutine(BlinkYellow());
        }
    }

    public void StopBlinking()
    {
        if (blinkCoroutine != null)
        {
            StopCoroutine(blinkCoroutine);
            blinkCoroutine = null;
        }
        spriteRenderer.color = defaultColor;
    }

    private IEnumerator BlinkYellow()
    {
        while (true)
        {
            spriteRenderer.color = Color.yellow;
            yield return new WaitForSeconds(0.5f);
            spriteRenderer.color = defaultColor;
            yield return new WaitForSeconds(0.5f);
        }
    }
}

```

MultiDrop.cs Script, Similar to basket.cs But Does Not Require an Animation Trigger and it Used Before the Level End

```

using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class MultiDrop : MonoBehaviour, IBasket
{
    private int objCount = 0;
    public int targetObjCount = 3;
    public GameObject CurrentStep;
    public GameObject NextStepObject;
}

```

```

public GameObject hintPanel;

[Header("Audio Source")]
[SerializeField] AudioSource SFXSource;
[SerializeField] AudioSource HintAudSource;

public void OnToyDrop(Toy toy)
{
    Destroy(toy.gameObject);
    objCount++;

    if (objCount >= targetObjCount)
    {
        hintPanel.SetActive(false);
        if (HintAudSource.isPlaying)
        {
            HintAudSource.Stop();
        }
        Destroy(CurrentStep);
        NextStepObject.SetActive(true);
    }
}
}

```

FocusAnimK4.cs Script, Similar to FocusAnim.cs Displays Animation Panel, and Activates Next Step and Script Panels After Animation

```

using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class FocusAnimK4 : MonoBehaviour, IDropArea
{
    public float delayBeforeNextStep = 3f;
    public GameObject AnimationObj;
    public GameObject CurrentStep;
    public GameObject NextStepObject;
    public GameObject NextScriptObject;
    [SerializeField] AudioSource SFXSource;

    public void OnDropArea(Drag drag)
    {
        Destroy(drag.gameObject);
        AnimationObj.SetActive(true);

        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
        if (SFXSource.isPlaying)
        {

```

```

        SFXSource.Stop();
    }
    Destroy(CurrentStep);
    Destroy(AnimationObj);
    NextStepObject.SetActive(true);
    NextScriptObject.SetActive(true);
}
}

```

FocusAnimNextScene.cs Script, Similar to FocusAnim.cs, But Used at the End of the Level

```

using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class FocusAnimNextScene : MonoBehaviour, IDropArea
{
    public Animator protagonistAnimator;
    public string animationTrigger;
    public float delayBeforeNextStep = 3f;
    public float delayBeforeNextScene = 3f;
    public GameObject AnimationObj;
    public GameObject CurrentStep;
    public string nextSceneName = "Kegiatan5";
    private LevelManager levelManager;
    [SerializeField] AudioSource SFXSource;
    public AudioClip win;

    private void Start()
    {
        levelManager = FindObjectOfType<LevelManager>();
    }

    public void OnDropArea(Drag drag)
    {
        Destroy(drag.gameObject);
        levelManager.UnlockNewLevel();
        AnimationObj.SetActive(true);
        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
        if (SFXSource.isPlaying)
        {
            SFXSource.Stop();
        }
        SFXSource.PlayOneShot(win);
        Destroy(CurrentStep);
        Destroy(AnimationObj);
    }
}

```

```

        protagonistAnimator.SetTrigger(animationTrigger);
        StartCoroutine(DelayNextScene(delayBeforeNextScene));
    }
    private IEnumerator DelayNextScene(float delayTime2)
    {
        float timeElapsed2 = 0f;
        while (timeElapsed2 < delayTime2)
        {
            timeElapsed2 += Time.deltaTime;
            yield return null;
        }
        LoadingScreenManager.Instance.SwitchToScene(nextSceneName);
    }
}

```

SpeciDrag.cs Script, Similar to Drag.cs but Requires Exact Match Between Object and Drop Area Using enum ObjectType;

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.EventSystems;

public class SpeciDrag : MonoBehaviour
{
    private Collider2D col;
    private Vector3 startDragPosition;
    private Coroutine blinkCoroutine;
    private Color defaultColor;
    private SpriteRenderer spriteRenderer;
    public GameObject pointer;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip correct;
    public AudioClip incorrect;

    public enum ObjectType { Object1, Object2, Object3 }
    public ObjectType objectType;

    private void Start()
    {
        col = GetComponent<Collider2D>();
        pointer.SetActive(false);
        spriteRenderer = GetComponent<SpriteRenderer>();
        defaultColor = spriteRenderer.color;
        StartBlinking();
    }

    private void OnMouseDown()
    {
        if (PauseManager.IsPaused)
            return;
        SFXSource.PlayOneShot(clickSound);
        startDragPosition = transform.position;
    }
}

```

```

        transform.position = GetMousePositionInWorldSpace();
        StopBlinking();
        pointer.SetActive(true);
        SpeciDrag[] allSpeciDrag = FindObjectsOfType<SpeciDrag>();
        foreach (SpeciDrag obj in allSpeciDrag)
        {
            if (obj != this)
            {
                obj.StopBlinking();
            }
        }
    }

    private void OnMouseDown()
    {
        if (PauseManager.IsPaused)
            return;
        transform.position = GetMousePositionInWorldSpace();
    }

    private void OnMouseUp()
    {
        if (PauseManager.IsPaused)
            return;
        col.enabled = false;
        Collider2D hitCollider = Physics2D.OverlapPoint(transform.position);
        col.enabled = true;

        if (hitCollider != null && hitCollider.TryGetComponent(out
ICustomDropArea customDropArea))
        {
            if (customDropArea is SpeciDrop speciDrop &&
speciDrop.IsCorrectDropArea(objectType))
            {
                SFXSource.PlayOneShot(correct);
                speciDrop.OnCustomDropArea(this);
                StopBlinking();
            }
            else
            {
                SFXSource.PlayOneShot(incorrect);
                transform.position = startDragPosition;
                StartBlinking();
            }
        }
        else
        {
            transform.position = startDragPosition;
            StartBlinking();
        }
        SpeciDrag[] allSpeciDrag = FindObjectsOfType<SpeciDrag>();
        foreach (SpeciDrag obj in allSpeciDrag)
        {
            if (obj != this)
            {
                obj.StartBlinking();
            }
        }
        pointer.SetActive(false);
    }
}

```

```

public Vector3 GetMousePositionInWorldSpace()
{
    Vector3 p = Camera.main.ScreenToWorldPoint(Input.mousePosition);
    p.z = 0f;
    return p;
}

public void StartBlinking()
{
    if (blinkCoroutine == null)
    {
        blinkCoroutine = StartCoroutine(BlinkYellow());
    }
}

public void StopBlinking()
{
    if (blinkCoroutine != null)
    {
        StopCoroutine(blinkCoroutine);
        blinkCoroutine = null;
    }
    spriteRenderer.color = defaultColor;
}

private IEnumerator BlinkYellow()
{
    while (true)
    {
        spriteRenderer.color = Color.yellow;
        yield return new WaitForSeconds(0.5f);
        spriteRenderer.color = defaultColor;
        yield return new WaitForSeconds(0.5f);
    }
}
}

```

**ICustomDropArea.cs Script, Same Function as IDropArea.cs Script but only Accepting
SpeciDrag.cs Object**

```

using UnityEngine;

public interface ICustomDropArea
{
    void OnCustomDropArea(SpeciDrag specidrag);
}

```

SpeciDrop.cs Script, Confirms the Valid Drop Using the IsCorrectDropArea() Method

```

using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class SpeciDrop : MonoBehaviour, ICustomDropArea
{
    private static int objCount = 0;
}

```

```

public int targetObjCount = 3;
public Animator protagonistAnimator;
public string winTrigger = "win animation biru";
public float delayBeforeNextStep = 3f;
public string nextSceneName = "Kegiatan6";
public GameObject hintPanel;
private LevelManager levelManager;

[Header("Audio Source")]
[SerializeField] AudioSource SFXSource;
[SerializeField] AudioSource HintAudSource;

[Header("Audio Clip")]
public AudioClip correct;

public Specidrag.ObjectType dropAreaType;

private void Awake()
{
    objCount = 0;
    levelManager = FindObjectOfType<LevelManager>();
}

public void OnCustomDropArea(Specidrag specidrag)
{
    Destroy(specidrag.gameObject);

    objCount++;

    if (objCount >= targetObjCount)
    {
        hintPanel.SetActive(false);
        if (HintAudSource.isPlaying)
        {
            HintAudSource.Stop();
        }
        levelManager.UnlockNewLevel();
        SFXSource.PlayOneShot(correct);
        protagonistAnimator.SetTrigger(winTrigger);
        StartCoroutine(DelaySceneChange(delayBeforeNextStep));
    }
}

public bool IsCorrectDropArea(Specidrag.ObjectType objectType)
{
    return dropAreaType == objectType;
}

private IEnumerator DelaySceneChange(float delayTime)
{
    float timeElapsed = 0f;
    while (timeElapsed < delayTime)
    {
        timeElapsed += Time.deltaTime;
        yield return null;
    }
    LoadingScreenManager.Instance.SwitchToScene(nextSceneName);
}
}

```

TapAnimFocus.cs Script, Simmilar With TapAnim.cs, But Used to Triggers to Activated
Animation Panel

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.EventSystems;

public class TapAnimFocus : MonoBehaviour
{
    private Collider2D col;
    private Coroutine blinkCoroutine;
    private Color defaultColor;
    private SpriteRenderer spriteRenderer;
    public GameObject pointer;
    public float delayBeforeNextStep = 3f;
    public GameObject CurrentStep;
    public GameObject AnimFocus;
    public GameObject NextStepObject;
    public GameObject SpawnObj;
    public GameObject hintPanel;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip hintAudio;

    private void Start()
    {
        HintAudSource.PlayOneShot(hintAudio);
        col = GetComponent<Collider2D>();
        spriteRenderer = GetComponent<SpriteRenderer>();
        defaultColor = spriteRenderer.color;
        pointer.SetActive(true);
        StartBlinking();
    }

    private void OnMouseDown()
    {
        if (PauseManager.IsPaused)
            return;
        if (HintAudSource.isPlaying)
        {
            HintAudSource.Stop();
        }
        col.enabled = false;
        SFXSource.PlayOneShot(clickSound);
        hintPanel.SetActive(false);
        AnimFocus.SetActive(true);
        Destroy(pointer);
        StopBlinking();
        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        yield return new WaitForSeconds(delayTime);
    }
}
```

```

        float timeElapsed = 0f;

        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }

        Destroy(CurrentStep);
        Destroy(AnimFocus);
        NextStepObject.SetActive(true);
        SpawnObj.SetActive(true);
    }

    public void StartBlinking()
    {
        if (blinkCoroutine == null)
        {
            blinkCoroutine = StartCoroutine(BlinkYellow());
        }
    }

    public void StopBlinking()
    {
        if (blinkCoroutine != null)
        {
            StopCoroutine(blinkCoroutine);
            blinkCoroutine = null;
        }
        spriteRenderer.color = defaultColor;
    }

    private IEnumerator BlinkYellow()
    {
        while (true)
        {
            spriteRenderer.color = Color.yellow;
            yield return new WaitForSeconds(0.5f);
            spriteRenderer.color = defaultColor;
            yield return new WaitForSeconds(0.5f);
        }
    }
}

```

TapAnimNextPt.cs Script, Used for Optimization, Dividing the Scene into Two Parts

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;
using UnityEngine.EventSystems;

public class TapAnimNextPt : MonoBehaviour
{
    private Collider2D col;
    private Coroutine blinkCoroutine;
    private Color defaultColor;
    private SpriteRenderer spriteRenderer;
    public GameObject pointer;
}

```

```

public Animator protagonistAnimator;
public string animationTrigger;
public float delayBeforeNextStep = 3f;
public GameObject hintPanel;
public string nextSceneName = "Main Menu";

[Header("Audio Source")]
[SerializeField] AudioSource SFXSource;
[SerializeField] AudioSource HintAudSource;

[Header("Audio Clip")]
public AudioClip clickSound;
public AudioClip hintAudio;

private void Start()
{
    HintAudSource.PlayOneShot(hintAudio);
    col = GetComponent<Collider2D>();
    spriteRenderer = GetComponent<SpriteRenderer>();
    defaultColor = spriteRenderer.color;
    pointer.SetActive(true);
    StartBlinking();
}

private void OnMouseDown()
{
    if (PauseManager.IsPaused)
        return;
    if (HintAudSource.isPlaying)
    {
        HintAudSource.Stop();
    }
    col.enabled = false;
    SFXSource.PlayOneShot(clickSound);
    protagonistAnimator.SetTrigger(animationTrigger);
    Destroy(pointer);
    hintPanel.SetActive(false);
    StopBlinking();
    StartCoroutine(DelayNextStep(delayBeforeNextStep));
}

private IEnumerator DelayNextStep(float delayTime)
{
    float timeElapsed = 0f;

    while (timeElapsed < delayTime)
    {
        timeElapsed += Time.deltaTime;
        yield return null;
    }
    if (SFXSource.isPlaying)
    {
        SFXSource.Stop();
    }
    LoadingScreenManager.Instance.SwitchToScene(nextSceneName);
}

public void StartBlinking()
{
    if (blinkCoroutine == null)

```

```

        {
            blinkCoroutine = StartCoroutine(BlinkYellow());
        }
    }

    public void StopBlinking()
    {
        if (blinkCoroutine != null)
        {
            StopCoroutine(blinkCoroutine);
            blinkCoroutine = null;
        }
        spriteRenderer.color = defaultColor;
    }

    private IEnumerator BlinkYellow()
    {
        while (true)
        {
            spriteRenderer.color = Color.yellow;
            yield return new WaitForSeconds(0.5f);
            spriteRenderer.color = defaultColor;
            yield return new WaitForSeconds(0.5f);
        }
    }
}

```

MulaiK6P2.cs Script, Is Called at the Beginning of Part 2 Scene

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class MulaiK6P2 : MonoBehaviour
{
    public Animator protagonistAnimator;
    public string animationTrigger;

    [Header("Audio Source")]
    [SerializeField] AudioSource musicSource;

    [Header("Audio Clip")]
    public AudioClip backgroundMusic;

    public void Awake()
    {
        protagonistAnimator.SetTrigger(animationTrigger);
        musicSource.clip = backgroundMusic;
        musicSource.Play();
    }
}

```

**TransformObjNextScene.cs Script, Used To Snaps Dragged Object to Center of Drop Area
and Applies Visual Change by Scaling Object, Simulating Proximity to Camera**

```
using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class TransformObjNextScene : MonoBehaviour, IDropArea
{
    public Animator protagonistAnimator;
    public string animationTrigger;
    public float delayBeforeNextStep = 3f;
    public string nextSceneName = "Main Menu";
    public float scaleIncreaseFactor = 1.2f;
    private LevelManager levelManager;
    private void Start()
    {
        levelManager = FindObjectOfType<LevelManager>();
    }

    public void OnDropArea(Drag drag)
    {
        drag.transform.position = transform.position;
        protagonistAnimator.SetTrigger(animationTrigger);
        ScaleDraggedObject(drag.gameObject);
        levelManager.UnlockNewLevel();

        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        float timeElapsed = 0f;
        while (timeElapsed < delayTime)
        {
            timeElapsed += Time.deltaTime;
            yield return null;
        }
        LoadingScreenManager.Instance.SwitchToScene(nextSceneName);
    }

    private void ScaleDraggedObject(GameObject draggedObject)
    {
        draggedObject.transform.localScale *= scaleIncreaseFactor;
    }
}
```

MulaiQK1.cs Script, Used When the Quiz Level is First Initialized

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class MulaiQK1 : MonoBehaviour
{
    public string nextKegiatan = "Kegiatan";
    public string ulang = "Kegiatan";
}
```

```

public string mainMenu = "Main Menu";

[Header("Audio Source")]
[SerializeField] AudioSource musicSource;
[SerializeField] AudioSource SFXSource;

[Header("Audio Clip")]
public AudioClip backgroundSound;
public AudioClip clickSound;

public void Awake()
{
    PlayerPrefs.SetString("LastCompletedLevel",
SceneManager.GetActiveScene().name);
    PlayerPrefs.Save();
    musicSource.clip = backgroundSound;
    musicSource.Play();
}

public void NextKegiatan() {
    LoadingScreenManager.Instance.SwitchToScene(nextKegiatan);
}

public void Ulangi() {
    LoadingScreenManager.Instance.SwitchToScene(ulang);
}

public void MainMenu() {
    LoadingScreenManager.Instance.SwitchToScene(mainMenu);
}
}

```

**QuizDrag.cs Script, Similar to Drag.cs But Does Not Require StartBlinking() and
GameObject pointer for Hints**

```

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.EventSystems;

public class QuizDrag : MonoBehaviour
{
    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip correct;
    public AudioClip incorrect;
    private Collider2D col;
    private Vector3 startDragPosition;

    public enum ObjectType { Object1, Object2, Object3, Object4, Object5,
Object6, Object7, Object8, Object9 }
    public ObjectType objectType;

    private void Start()
    {

```

```

        col = GetComponent<Collider2D>();
    }

    private void OnMouseDown()
    {
        if (PauseManager.IsPaused)
            return;
        startDragPosition = transform.position;
        transform.position = GetMousePositionInWorldSpace();
        SFXSource.PlayOneShot(clickSound);
    }

    private void OnMouseDrag()
    {
        if (PauseManager.IsPaused)
            return;
        transform.position = GetMousePositionInWorldSpace();
    }

    private void OnMouseUp()
    {
        if (PauseManager.IsPaused)
            return;
        col.enabled = false;
        Collider2D hitCollider =
        Physics2D.OverlapPoint(transform.position);
        col.enabled = true;

        if (hitCollider != null && hitCollider.TryGetComponent(out
        IQuizDropArea quizDropArea))
        {
            if (quizDropArea is MatchNameNextStep quizDrop &&
            quizDrop.IsCorrectDropArea(objectType))
            {
                quizDrop.OnQuizDropArea(this);
                col.enabled = false;
                SFXSource.PlayOneShot(correct);
            }
            else
            {
                transform.position = startDragPosition;
                SFXSource.PlayOneShot(incorrect);
            }
        }
        else
        {
            transform.position = startDragPosition;
        }
    }

    public Vector3 GetMousePositionInWorldSpace()
    {
        Vector3 p = Camera.main.ScreenToWorldPoint(Input.mousePosition);
        p.z = 0f;
        return p;
    }
}

```

IQuizDropArea.cs Script, Same Function as IDropArea.cs Script but only Accepting
QuizDrag.cs Object

```
using UnityEngine;

public interface IQuizDropArea
{
    void OnQuizDropArea(QuizDrag quizdrag);
}
```

MatchNameNextStep.cs Script, Handles Actions When QuizDrag item is Placed Correctly,
Similar to SpeciDrop.cs but Not Used at the End of the Game

```
using UnityEngine;
using UnityEngine.SceneManagement;
using System.Collections;

public class MatchNameNextStep : MonoBehaviour, IQuizDropArea
{
    private static int objCount = 0;
    public float delayBeforeNextStep = 3f;
    public float scaleIncreaseFactor = 1.2f;
    public GameObject CurrentStep;
    public GameObject NextStepObject;
    [Header("Audio Source")]
    [SerializeField] AudioSource HintAudSource;

    public QuizDrag.ObjectType dropAreaType;

    private void Awake()
    {
        objCount = 0;
    }

    public void OnQuizDropArea(QuizDrag quizdrag)
    {
        quizdrag.transform.position = transform.position;

        ScaleDraggedObject(quizdrag.gameObject);

        objCount++;

        if (objCount == 3 || objCount == 6 || objCount == 9)
        {
            if (HintAudSource.isPlaying)
            {
                HintAudSource.Stop();
            }
            StartCoroutine(DelaySceneChange(delayBeforeNextStep));
        }
    }

    public bool IsCorrectDropArea(QuizDrag.ObjectType objectType)
    {
        return dropAreaType == objectType;
    }
}
```

```

private IEnumerator DelaySceneChange(float delayTime)
{
    float timeElapsed = 0f;
    while (timeElapsed < delayTime)
    {
        timeElapsed += Time.deltaTime;
        yield return null;
    }
    Destroy(CurrentStep);
    NextStepObject.SetActive(true);
}

private void ScaleDraggedObject(GameObject draggedObject)
{
    draggedObject.transform.localScale *= scaleIncreaseFactor;
}
}

```

MultipleChoice.cs Script, Used to Handles Multiple-Choice Quiz System, Requiring the Player to Identify All Correct Options to Proceed

```

using System.Collections;
using UnityEngine;

public class MultipleChoice : MonoBehaviour
{
    public float delayBeforeNextStep = 3f;
    public GameObject CurrentStep;
    public GameObject NextStepObject;

    private int correctAnswerCount = 0;
    public int requiredCorrectAnswers = 2;

    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip correct;
    public AudioClip incorrect;

    [System.Serializable]
    public class Choice
    {
        public GameObject choiceObject;
        public bool isCorrect;
        public GameObject choiceFeedback;
        public bool hasAnswered;
    }

    public Choice[] choices;

    private bool hasCompletedQuiz = false;

    private void Start()
    {

```

```

        foreach (var choice in choices)
        {
            choice.choiceFeedback.SetActive(false);
            choice.hasAnswered = false;
        }
    }

    private void Update()
    {
        if (PauseManager.IsPaused)
            return;
        if (hasCompletedQuiz)
            return;

        if (Input.GetMouseButtonDown(0))
        {
            RaycastHit2D hit =
            Physics2D.Raycast(Camera.main.ScreenToWorldPoint(Input.mousePosition),
            Vector2.zero);

            if (hit.collider != null)
            {
                for (int i = 0; i < choices.Length; i++)
                {
                    if (hit.collider.gameObject == choices[i].choiceObject
                    && !choices[i].hasAnswered)
                    {
                        CheckAnswer(i);
                        break;
                    }
                }
            }
        }
    }

    private void CheckAnswer(int selectedIndex)
    {
        var selectedChoice = choices[selectedIndex];

        if (selectedChoice.isCorrect)
        {
            if (!selectedChoice.hasAnswered)
            {
                selectedChoice.choiceFeedback.SetActive(true);
                correctAnswerCount++;
                selectedChoice.hasAnswered = true;
                SFXSource.PlayOneShot(correct);
            }
        }
        else
        {
            if (!selectedChoice.hasAnswered)
            {
                selectedChoice.choiceFeedback.SetActive(true);
                selectedChoice.hasAnswered = true;
                SFXSource.PlayOneShot(incorrect);
            }
        }

        if (correctAnswerCount >= requiredCorrectAnswers)
    }

```

```

        {
            if (HintAudSource.isPlaying)
            {
                HintAudSource.Stop();
            }
            hasCompletedQuiz = true;
            StartCoroutine(DelayNextStep(delayBeforeNextStep));
        }
    }

    private IEnumerator DelayNextStep(float delayTime)
    {
        yield return new WaitForSeconds(delayTime);

        foreach (var choice in choices)
        {
            choice.choiceFeedback.SetActive(false);
        }

        Destroy(CurrentStep);
        NextStepObject.SetActive(true);
    }
}

```

**TrueFalse.cs Script, Used to Handles Binary Choice Quiz, Requiring the Player to Select
Between trueChoice and falseChoice**

```

using System.Collections;
using UnityEngine;

public class TrueFalse : MonoBehaviour
{
    public float delayBeforeNextStep = 3f;
    public GameObject CurrentStep;
    public GameObject NextStepObject;

    public GameObject checklist;
    public GameObject cross;

    private bool isAnswered = false;
    public bool correctAnswer;

    public GameObject trueChoice;
    public GameObject falseChoice;
    [Header("Audio Source")]
    [SerializeField] AudioSource SFXSource;
    [SerializeField] AudioSource HintAudSource;

    [Header("Audio Clip")]
    public AudioClip clickSound;
    public AudioClip correct;
    public AudioClip incorrect;

    private void Start()
    {
        checklist.SetActive(false);
        cross.SetActive(false);
    }
}

```

```

private void Update()
{
    if (PauseManager.IsPaused)
        return;
    if (Input.GetMouseButtonDown(0))
    {
        RaycastHit2D hit =
Physics2D.Raycast(Camera.main.ScreenToWorldPoint(Input.mousePosition),
Vector2.zero);

        if (hit.collider != null && !isAnswered)
        {
            if (hit.collider.gameObject == trueChoice)
            {
                CheckAnswer(true);
            }
            else if (hit.collider.gameObject == falseChoice)
            {
                CheckAnswer(false);
            }
        }
    }
}

private void CheckAnswer(bool playerAnswer)
{
    if (playerAnswer == correctAnswer)
    {
        isAnswered = true;
        checklist.SetActive(true);
        if (HintAudSource.isPlaying)
        {
            HintAudSource.Stop();
        }
        SFXSource.PlayOneShot(correct);
        StartCoroutine(DelayNextStep(delayBeforeNextStep));
    }
    else
    {
        cross.SetActive(true);
        isAnswered = false;
        SFXSource.PlayOneShot(incorrect);
    }
}

private IEnumerator DelayNextStep(float delayTime)
{
    yield return new WaitForSeconds(delayTime);
    checklist.SetActive(false);
    cross.SetActive(false);

    Destroy(CurrentStep);
    NextStepObject.SetActive(true);
}
}

```

SaveProgressScrp.cs Script, Used When the Quiz is Finished.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class SaveProgressScrp : MonoBehaviour
{
    private LevelManager levelManager;
    void Start()
    {
        levelManager = FindObjectOfType<LevelManager>();
        levelManager.UnlockNewLevel();
    }
}
```