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Designing an educational game "Cleantopia" to increase students' awareness of environmental cleanliness at Mekarsari Elementary School

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ABSTRACT

In general, knowledge of the types of waste in Indonesia still needs to be improved. This is one-factor causing problems in Indonesia's waste management system. The importance of knowing the kinds of waste must start from childhood. With the child's good memory, the knowledge can be absorbed more efficiently so that the application in the surrounding environment can run optimally. This research aims to increase students' awareness of environmental cleanliness at school. The object studied is taking samples from class 4A students of Mekarsari Elementary School using the Multimedia Development Life Cycle (MDLC) method. Based on the data processing results from respondents, the results obtained show that this educational game application, 'Cleantopia,' can run well and attract students' attention. In addition, with this application, students become aware of cleanliness in their school through observations made by researchers of student activities that become more orderly in disposing of garbage in its place and maintaining classroom cleanliness.

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INTRODUCTION

Environmental hygiene is crucial in almost all countries (Mustafa, 2005). One of them is the school environment. Keeping the environment clean means creating a healthy environment free from impurities like garbage. The level of awareness of the school environment in children still needs to be improved. Based on the researcher's observation in one of the elementary schools in Bandung, cleanliness in the school environment still needs to be improved, especially on the issue of student awareness of managing waste. This can be important because environmental cleanliness can affect many things, especially health. Human vulnerability to health attacks is very diverse (Mustafa, 2005). According to Pranungsari et al., (2019), waste has characteristics that can be grouped into several types, such as organic and inorganic waste.

Based on the Law of the Republic of Indonesia Number 18 of 2018 concerning waste management, waste is the residue of daily human activities and or natural processes in solid form (Undang-Undang Republik Indonesia Nomor 18 Tahun 2008 Tentang Pengelolaan Sampah, 2018). Humans no longer use waste, so it is destroyed and discarded (Suseno et al., 2016). Although there have been many slogans, calls, and sanctions to prohibit littering, awareness of how to dispose of

waste in its place still needs to be improved (Ahsan & Faud, 2016). People think waste is disgusting and dirty and must be disposed of and appropriately burned (Mulasari, 2012). The types of waste based on their nature can be divided into three types: organic, inorganic, and hazardous (B3) (Putri, 2022). Littering can cause severe health impacts, such as becoming a breeding ground for disease-transmitting vectors. Therefore, human awareness is needed in managing waste (Manyullei et al., 2022). Waste accumulation is caused by excessive volumes exceeding landfill capacity and the need for positive impacts of waste management and government policy support (Hasibuan & Syafaruddin, 2021). Generally, in Indonesia, knowledge about these three types of waste is minimal, so many people throw garbage in its place but not according to its kind. The management needs to be maximized because it must be sorted again.

The importance of knowing the types of waste must start from childhood; with the child's good memory, the knowledge is more accessible to absorb so that its application in the surrounding environment can run optimally. Changing mindsets and increasing awareness are challenging, but if caught early, upbeat personalities and habits can be formed (Ramadhan et al., 2020). One action that can be taken is to provide health education (Lestari et al., 2020). It is important to emphasize to the elementary school community the importance of disposing of waste in its place and classifying waste according to applicable criteria (Asmara et al., 2023); by transferring universal moral values, it is hoped that students can respect the lives of others and become good citizens from an early age to adulthood (Kusrahmadi, 2007). Other researchers argue that Teaching awareness of the environment, including waste management, is essential from an early age. This habit can form a sustainable character until adulthood (Siregar & Sudarmilah, 2019). Plus, according to Pratiwi (2016), in the learning process, children will deeply understand and better understand the concepts taught by what they see (visually).

Putra et al., (2016), in their journal entitled "Making Educational Games for Smart Choosing Trash," explain that research on making educational games about smart choosing trash that is interesting and interactive can help parents educate and teach their children about disposing of garbage properly. Children in elementary school can be educated to become prospective golden successors who are intelligent and moral. According to Kusrahmadi (2007), educating children from elementary school can affect changes and form the forerunner of children's behavior so that children as adults will be more responsible and respectful of others and can face the challenges of dynamically changing times. Children's education is inseparable from education at school. Therefore, schools, in this case, also play an essential role in providing knowledge of the types of waste to foster awareness of environmental cleanliness in students. The development of the times with increasingly sophisticated technological advances can make it easier to provide knowledge of the types of waste students. This phenomenon will also affect game development (Febrianti & Prasetyo, 2023).

Games have many types, including educational games that combine games and knowledge. Using game media can significantly develop and improve student intelligence during the learning process (Nurseptaji & Prasetio, 2021). This educational game can be one of the learning companion applications used by students under teacher supervision. Efendi (2019) states that educational games are " made to learn not only to intend to entertain but are also expected to add insight into knowledge." Therefore, users not only feel happy with the game that is packaged, but they also learn to stimulate thinking by completing each level to increase knowledge and awareness of the environment, especially in the garbage. This research contributes to the development of game media regarding environmental hygiene insights that are interesting, interactive, and educational.

METHOD

The research method in developing interactive learning media, especially making this game, requires a method that focuses on software development (Mustika et al., 2017), so one method that can be used is the Multimedia Development Life Cycle (MDLC) method of the Luther model. the reason the author uses this method is that the MDLC model is very suitable for designing multimedia applications that integrate various types of media, such as images, sound, video, and animation. The

steps in this model can be flexibly adjusted or moved according to the requirements of the research project. According to Rengganis et al., (2022), it is designed in six stages, as follows in Figure 1:

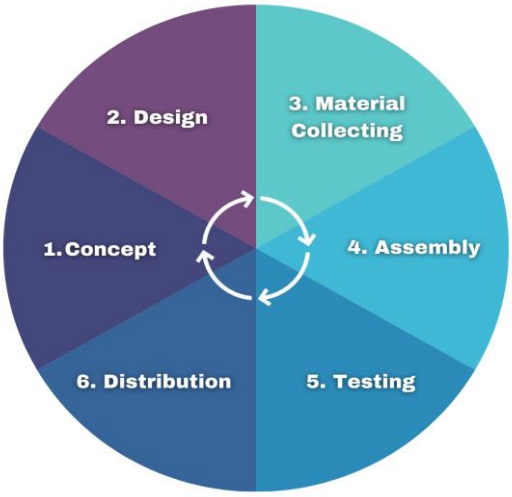

Figure 1. Multimedia Development Methods

The research method for developing interactive learning media, especially making this game, requires a method that focuses on software development (Mustika et al., 2017). One method that can be used is the Luther model's Multimedia Development Life Cycle (MDLC) method. The author uses this method because the MDLC model is suitable for designing multimedia applications integrating various media types, such as images, sound, video, and animation. The steps in this model can be flexibly adjusted or moved according to the requirements of the research project. According to Rengganis et al., (2022), it is designed in six stages as follows:

1. Concept
   This is the initial stage, where brainstorming is carried out by collecting ideas to determine the objectives and identify users of game products; this aims to make the appearance presented by the user's identity (Chusyairi, 2020). To the opinion above, at this stage, we brainstormed with the entire team, expressing their respective ideas; ultimately, we selected one idea that we would make: an educational game application targeting elementary-level students.
2. Design
   The design regarding the program architecture, appearance, and materials is carried out at this stage. This step includes a storyboard that explains the flow of the game. At this stage, we started making a rough storyboard with pencil and paper media. After it was deemed sufficient, it would be created digitally for this educational application; the storyboard can be seen in the Results and Discussion section below.
3. Material Collecting
   The stage where all product needs, such as logos, animations, and others, are collected is obtained by designing according to the design that has been made. At this stage, we started transferring all the assets we needed to create applications from manual form to digital form using the help of Adobe Illustrator software.
4. Assembly
   In this stage, all objects or materials in the game are created based on the design steps, such as storyboards, flowcharts, and navigation structures (Borman & Purwanto, 2019). At this stage, we started making the educational game using the help of Construct software. All assets that have been digitally created at this stage are arranged in such a way as to become an educational game that can be run.
5. Testing
   After completing the assembly stage, testing is carried out by running the game to the target users, namely elementary school children, to determine whether there are errors. At this stage, we went directly to Mekarsari Elementary School to test several students by trying to play

educational games that had been made in turn, which later, the results of this test we us conclude whether there needed to be improvements again or already be distributed to direct students. So that our research subjects know their mistakes in this educational game, we designed it like a garbage collection game where students have to collect garbage scattered on the road; students will be enriched with knowledge by reading pop-up information about the garbage taken from the road, to later reach a trash can, when participants arrive at the trash can, participants must choose which trash can is by the garbage that has been collected before, and if they have successfully managed into the appropriate trash can immediately proceed to the next level.

6. Distribution
   Distribution is the last stage, where the product application, in this case, the game, will be stored in storage media and distributed to students and teachers who need games about the types of waste. After seeing the results of the tests that have been carried out, we then spread the educational applications that have been made to the school so that they can be distributed directly to students of Mekarsari Elementary School.

RESULTS AND DISCUSSION

Results

In this section, the author will discuss the system design and the results of the user interface of the 'Cleantopia' educational game and will also differ the results of the testing that has been done to see whether there are errors, bugs, errors, or not in this educational game.

Navigation Structure

The navigation structure is a program flow that is an interconnected design between one area and another that can help organize all elements to create an application (Suharni et al., 2022). Researchers use a hierarchical navigation structure called a branched structure, where the data display is determined based on specific criteria.

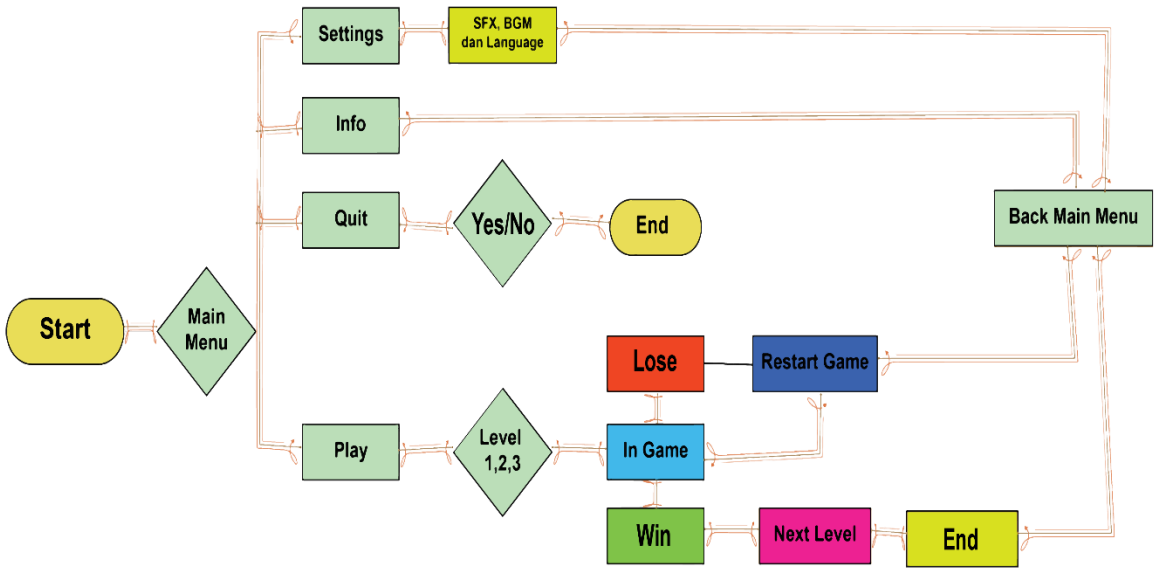

Figure 2. Navigation Structure of Educational Game

From the navigation structure in Figure 2 above, users can turn up or down the music in the game, select a language, view game info, open the game menu, and then close the application. The user can open the game menu, where three levels must be completed. The user must pass the given challenges to advance to the next level. When the user successfully passes all levels, the user will be directed to the main menu. Meanwhile, when the user loses, the user can restart the game so they can play it again.

Storyboard

According to Nurajizah (2016), a storyboard is a series of sketches presenting a story's flow. Storyboard is used to facilitate the design of the display in making Cleantopia educational games. A storyboard is also a reference in the making and can describe the path of the whole story from beginning to end (Huda, 2017). Analysis is carried out by media developers and learning designers who are accustomed to using storyboards (Kunto et al., 2021).

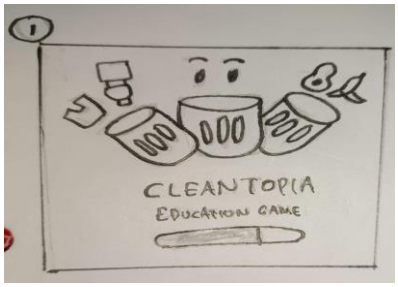

Figure 3. Displays the Loading Page Before the User enters the Next Page

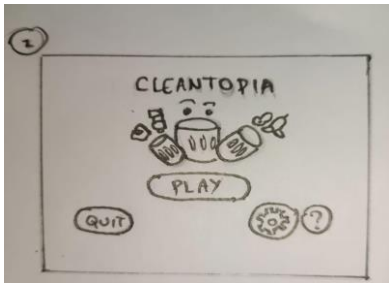

Figure 4. Play Menu Display

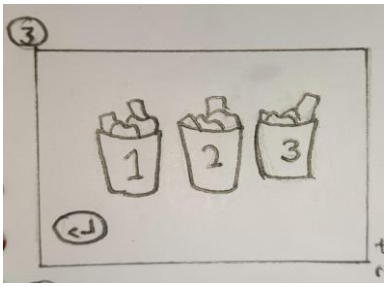

Figure 5. Display of user-selectable Levels 1, 2, and 3

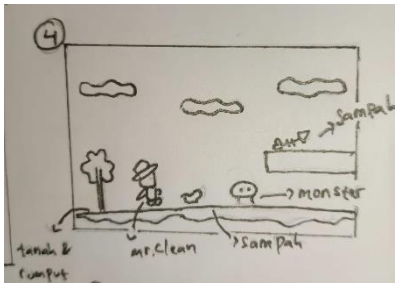

Figure 6. In Game View

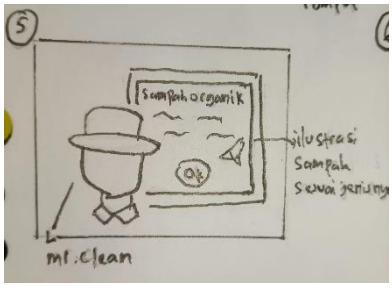

Figure 7. Pop-up Display of Information about Waste Types

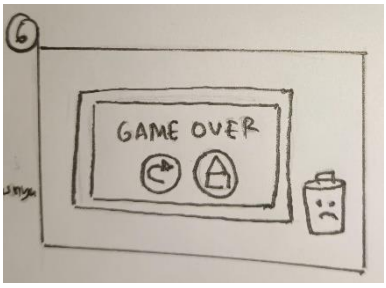

Figure 8. Pop-up Displays Losing or Winning Information When Playing

User Interface

According to Wibawanto & Nugrahani (2018), a User Interface is a tool or element used to manipulate digital objects. The user interface is good if it can function appropriately in the eyes of its users (Achmadi et al., 2017). The following displays the user interface of the "Cleantopia" educational game the author completed.

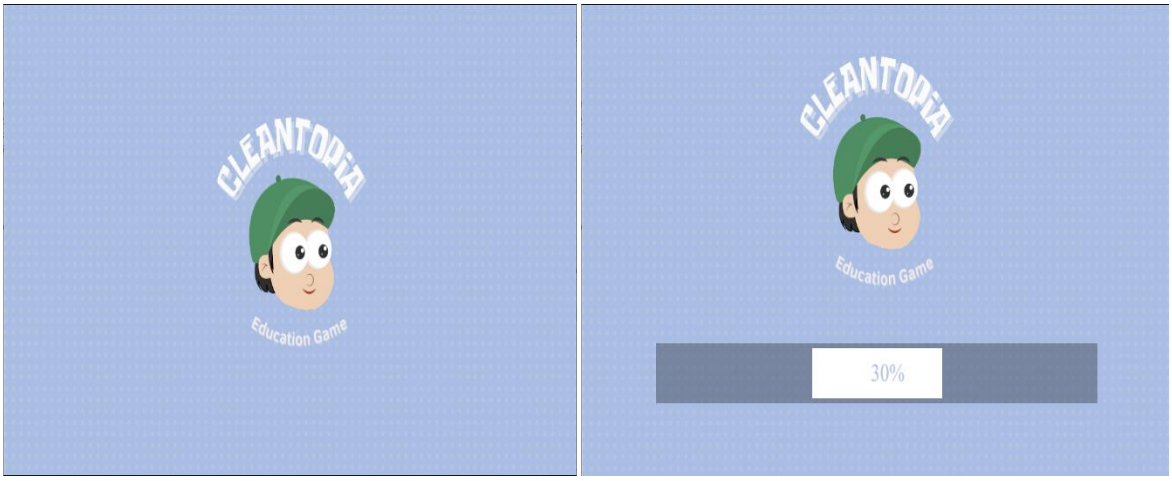

Figure 9. Game Start View

Figure 9 shows the appearance of the Splash Screen or the initial screen that is opened before the application is run, and the loading display in the 'Cleantopia' educational game will appear the first time the user enters this educational game.

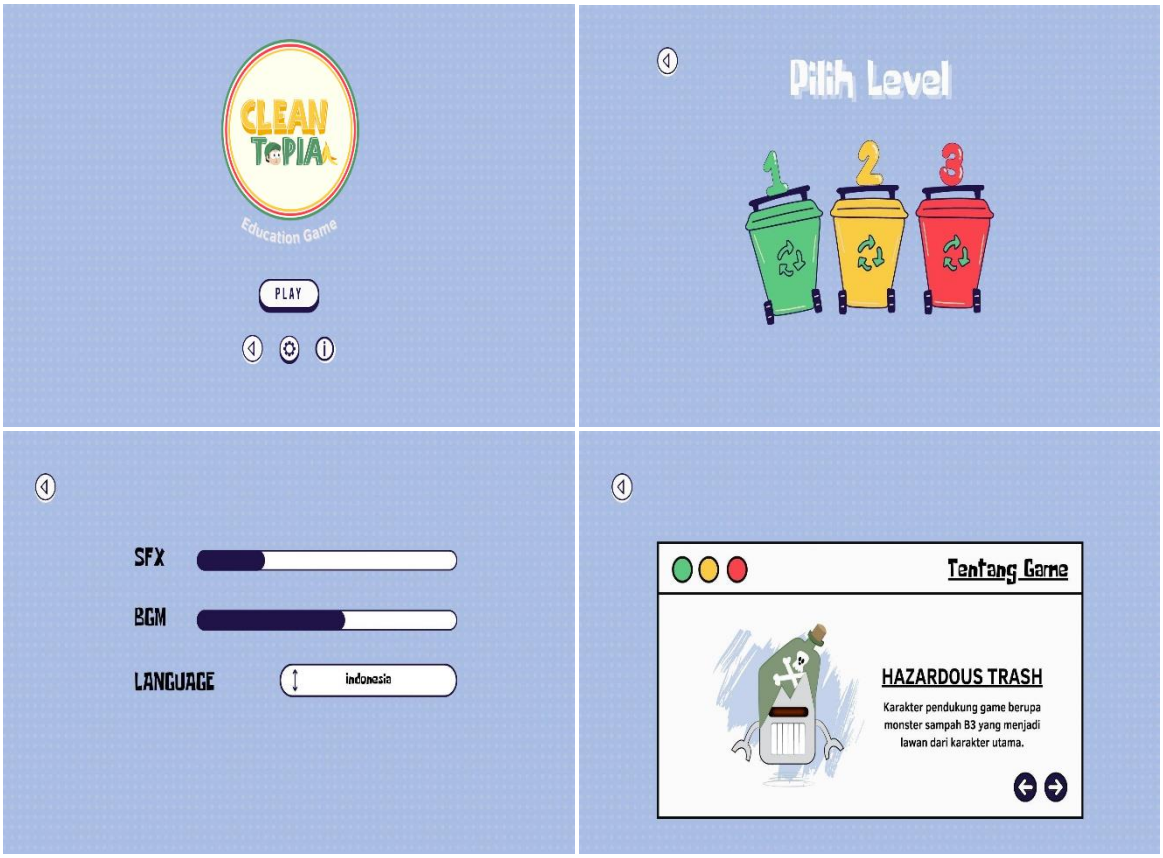

Figure 10. Game Menu Display

Figure 10 illustrates the main menu view, game menu view, settings menu view, and game info view. The main menu has four buttons that can be used. Play button, game info button, Setting button, and exit button. The play button contains three game levels. The game info button contains information about educational games, characters in educational games, and educational game makers. On the Setting button, the user can adjust the background and sound effects volume and change the language between English and Indonesian. This educational game will close automatically if the user presses the Exit button.

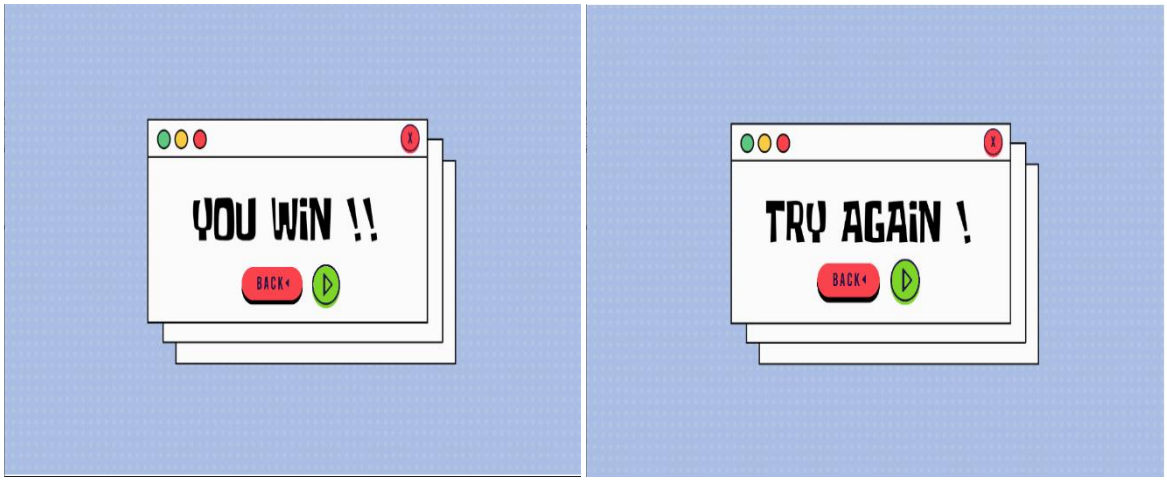

Figure 11. Content Display

Figure 11 shows the view that will appear if the user has successfully passed an obstacle in one of the levels, the view of failing to pass an obstacle at a certain level or has run out of time to reach the success point to be able to move to the next level, and the view that will appear if the user has successfully passed all obstacles in all levels available in this game.

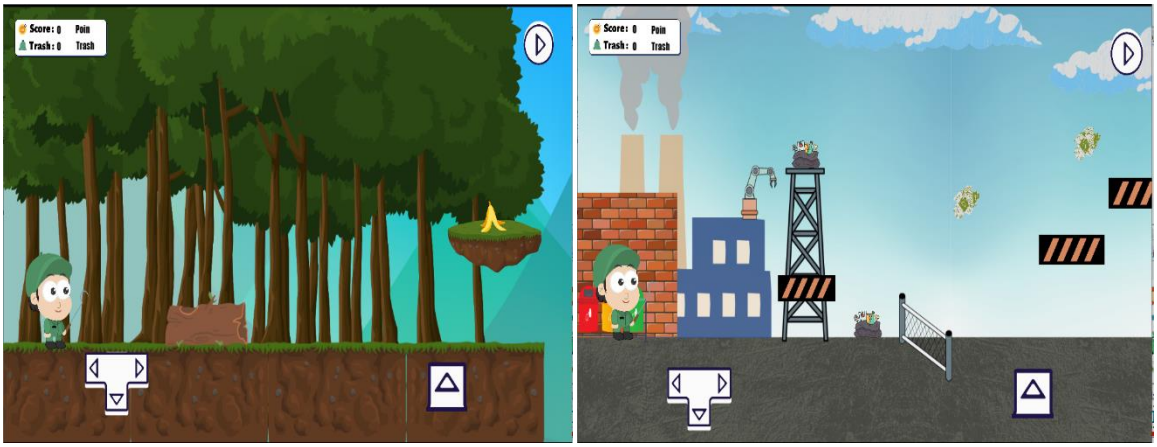

Figure 12. The Process of Creating Instagram Filters uses Spark AR

Figure 12 is a display of each level in the game. At level 1, there is a forest background where users collect organic waste, such as banana waste, apples, and dry leaves. Level 2 in this game is set in an industrial factory at level 2 where users will collect some inorganic and hazardous waste such as candy wrappers, bottles, and poison. Level 3 is set in an industrial factory. At level 3, the user will collect organic, inorganic, and hazardous waste, such as bananas, apples, dried leaves, candy wrappers, bottles, and poison. Whenever you collect trash, information about the garbage you get will appear. Score and trash will also automatically increase when the user collects the garbage.

Tasting

In making applications, testing is needed to determine the success of application functions (usability). The use of measuring instruments in this usability test is adjusted to usability components based on effectiveness, efficiency, and user satisfaction (Nurhadryani et al., 2013). In this testing process or testing, the author sees, ensures, checks, or finds whether there are bugs, errors, or errors while playing this 'Cleantopia' educational game. This testing was conducted by the author Mekarsari Cileunyi Elementary School on December 12, 2022, to 26 grade 4 students in Table 4. Testing is done by taking turns trying the 'Cleantopia' educational game and then being directed to fill out the Google form provided by the author. The distributed Google form contains assessments using a Likert scale of 1-5, which can measure the feasibility, checking, and evaluation of educational games from the student's point of view after trying to play this educational game. The author divides this test into three aspects to be assessed: the programming in Table 1, content in Table 2, and appearance in Table 3. These three aspects will be a reference for the author to determine whether this educational game is feasible enough to be disseminated to the public or requires improvement. In this process, the author can also see that students, after playing this educational game, become aware of the cleanliness of the garbage around them, and students become familiar with it, as shown by the instructions in Table 5 and the results in Table 6.

Table 1. Programming Aspect Test Statement

No.	Statement
1	Easy-to-use Game
2	Ease of Selecting the Settings Menu
3	Ease of Selecting the Info Menu
4	Ease of Selecting the Play Game Menu
5	Ease of Selecting the Level Menu
6	Ease of using the Buttons
7	Ease of using the Game's Exit, Login, and Replay Buttons

No.	Statement
8	Each menu button can function correctly.
9	No Bugs in the Game

Table 2. Content Aspect Test Statement

No.	Statement
1	The Language used is Easy to Understand
2	The Language used is Intriguing
3	It takes a Little Time to Understand how to use the Game
4	The Information Conveyed in the Game can be Received Quickly.

Table 3. Display Aspect Test Statement

No.	Statement
1	Balanced Placement of the Text And Images
2	Background Selection with the Game Theme is Appropriate
3	The Colors Match the Game Theme
4	The interface in this Educational Game is Easy to Understand and Straightforward.

Table 4. Calculation and Result of Application Testing on Respondent

No.	Respondent	Programming Aspect	Content Aspect	Display Aspect	Total
1	Respondent 1	40	19	20	79
2	Respondent 2	45	20	20	85
3	Respondent 3	41	20	18	79
4	Respondent 4	43	19	20	82
5	Respondent 5	39	19	20	78
6	Respondent 6	44	19	20.	83
7	Respondent 7	44	19	19	82
8	Respondent 8	45	18	20	83
9	Respondent 9	45	19	20	84
10	Respondent 10	45	20	20	85
11	Respondent 11	45	19	20	84
12	Respondent 12	45	19	20	84
13	Respondent 13	42	20	20	82
14	Respondent 14	45	19	20	84
15	Respondent 15	41	19	20	80
16	Respondent 16	44	18	20	82
17	Respondent 17	41	18	19	78
18	Respondent 18	45	20	20	85
19	Respondent 19	41	19	19	83
20	Respondent 20	44	20	20	84
21	Respondent 21	44	17	20	81
22	Respondent 22	43	17	19	79
23	Respondent 23	41	20	20	81
24	Respondent 24	45	20	20	85
25	Respondent 25	39	17	19	75
26	Respondent 26	45	20	19	84
Total		**1.121**	**494**	**512**	**2.131**
Maximum Score		**1.170**	**520**	**520**	**2.210**
Percentage (%)		**95.81%**	**95%**	**98.46%**	**96.43%**

$$\text{Formula overall percentage} = \frac{The\ number\ of\ scores\ that\ can\ be}{The\ maximum\ number\ of\ scores} \times 100\% \quad (1)$$

$$\text{Overall percentage} = \frac{2.131}{2.210} \times 100\% = 96.43\%$$

Table 5. Interview Questions

No.	Question	Assessment				
		5	4	3	2	1
1	Have you been able to Distinguish the Types of Waste?					
2	Have you Put your Trash in the Right Place?					
3	Do you Dispose of Garbage According to the bins based on the Types?					
4	Do you Realize Littering is Wrong?					
5	Do you Realize Environmental Hygiene is Important?					

The following answers were obtained based on interviews conducted with sample students of class 4A Mekarsari Elementary School, where the author worked through direct interviews on December 12, 2022.

Table 6. Calculation and Result of Application Testing on Respondent

No.	Respondent	Interview Result
1	Respondent 1	25
2	Respondent 2	25
3	Respondent 3	23
4	Respondent 4	25
5	Respondent 5	25
6	Respondent 6	24
7	Respondent 7	23
8	Respondent 8	23
9	Respondent 9	20
10	Respondent 10	25
11	Respondent 11	25
12	Respondent 12	25
13	Respondent 13	19
14	Respondent 14	19
15	Respondent 15	25
16	Respondent 16	25
17	Respondent 17	25
18	Respondent 18	25
19	Respondent 19	25
20	Respondent 20	25
21	Respondent 21	25
22	Respondent 22	25
23	Respondent 23	25
24	Respondent 24	25
25	Respondent 25	25
26	Respondent 26	25
Total		**626**
Maximum Score		**650**
Percentage (%)		**96.30%**

Overall percentage $= \frac{626}{650} \times 100\% = 96.30\%$

Discussion

This educational game 'Cleantopia' was developed in 5 stages: concept, design, material collection, manufacture, testing, and Distribution. At the conceptualization stage, brainstorming is carried out to put forward ideas until One idea is selected as the material for making applications, namely educational game applications regarding the introduction of waste with the target of primary-level students; at this stage, a navigation structure Is also produced, which is the flow of the program. The design stage begins with creating a storyboard to explain the game flow further and as an illustration of how the game will look.

After the concept and design have been completed, the next step is to collect materials for product needs, such as logos, animations, and other assets. In this stage, the creation uses Adobe Illustrator software. Entering the manufacturing stage, using Construct software, all the assets made are organized into an educational game that can be run. The testing stage is carried out to ensure that all the features in the game are running well. Testing was conducted on 26 students of class 4A Mekarsari Elementary School. The test results obtained 96.43%, and the results of testing with the direct interview method resulted in a percentage of 96.30%. After testing is carried out and produced at a reasonable rate, the next stage is distributing the application to students and teachers as educational material while playing.

CONCLUSION

Based on the research results in the form of observations and calculations of student response results to the 'Cleantopia' educational game application, it can be concluded that the game that has been designed is effective in increasing student awareness of environmental cleanliness at Mekarsari Elementary School Cileunyi and can be a companion or complement to teacher teaching materials. The results of tests conducted by the author on a sample of class 4A students of Mekarsari Elementary School Cileunyi based on aspects of programming, content, and game appearance have run well and attracted students' attention. After making an environmental hygiene educational game for elementary school children, the author recommends that evaluative research be carried out to assess the impact and effectiveness of the game on concept understanding, children's involvement, and potential changes in behavior related to environmental hygiene in schools and surrounding areas.

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