Designing Educational Game of Logical Thinking Based Unity 3D for Understanding Science Concept Students As a Part of Holistic Thinking

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Abstract. *The development of the digital world should have a big impact on Indonesian education. However, based on the education quality survey reported by PISA, Indonesia is ranked 72 out of 77 countries in the world. One of the causes is the low understanding of basic knowledge po ssessed by students. Subsequent research has shown that there is a positive correlation between logical thinking and understanding students of science concept. Based on this background, this paper discussed the designing application logical thinking game based unity 3D for understanding students of science concept as a part of holistic thinking. The application was developed based on Android using C# language and Unity 3D game engine. The system development method that is done is the waterfall model. The steps are taken requirements analysis, design, coding, system testing, and maintenance. Based on the system testing that has been done, this educational game application can work well with 100% success. With this educational game application, it is hoped that it can improve students understanding of science concept holistically based on logical thinking.*

Keywords: *Educational Game, Logical thinking, Android, Unity 3D, Science Concept*

1. INTRODUCTION

Indonesia as a country with a population of 267,7 million people has a high frequency of expectations for good human resources. However, the potential for good human resources is hampered by various factors, one of them is the quality of education (Danny et al., 2020). In the education quality survey report released by PISA, Indonesia ranks 72th out of 77 countries. The report is based on indicators of low levels of understanding of basic abilities, such as reading, math, and basic science skills (Argina et al., 2017). Then, other researcher has shown that logical thinking is positively correlated with the understanding of science concept, this is evidenced by the lower value of logical thinking for someone who has a low value for scientific concepts than for those who have a high value for scientific concepts (Sumirat, 2017).

To minimize the backwardness of education in the eyes of the world, the Indonesian government has designed a standard education process curriculum that utilizes information and communication technology. The goal is to obtain an effective and efficient learning process among educational people. An effective and efficient learning process can be carried out if messages and learning information are conveyed well to students (Sánchez & Martínez, 2020). One of the learning tools that can support the creation of good communication or information delivery is learning media such as multimedia (Sudarman et al., 2020).

Learning multimedia is a medium that presents text, animation, images, sound, and video simultaneously, and engages its users to interact and operate the media directly (Fajari et al., 2020). So far, the most widely used and developed multimedia by teachers as a learning medium is a power point. The results showed that most of the

teaching staff prepared standard power points which were delivered using the lecture method. This causes the teacher-centered learning process, so that students become less interested and the intellectual development of students is not optimal (Maesaroh et al., 2016).

One solution to overcome the problems above is to use multimedia that is able to attract students learning interest with an attractive user interface design, one of which is a digital educational game. Digital educational games are game applications designed to educate users in understanding the concept of certain material and knowledge (Sabirli & Coklar, 2020). The development and implementation of digital educational games has been widely reported from various levels of schools, from elementary to high school levels. At the elementary level, it was reported about the development of civics learning based on educational games on the joint decision award material for fifth class (Aryun Nailun Nasikhah, 2017). At the junior high school level, it has reported about the development of digital educational games to increase students' interest in learning in science subjects (Adita et al., 2018). At the high school level, the development of interactive multimedia based on educational games as a learning medium for respiratory system material for eleventh class has been done (Ganda et al., 2020). All of these report show the effectiveness of using educational games to improve understanding students in learning.

Based on the research described above, the development of educational game applications to improve students' understanding of basic abilities can be done. The research offered by the author is Designing Application of Logical Thinking Game Based on Unity 3D for Understanding of Science Concept As a Part of Holistic Thinking. Logical thinking is the basic ability to think correctly based on a set of premises available (xxx, 2020). With the application of logical thinking into educational game applications, it is hoped that it can foster students' critical reasoning power in understanding scientific concepts. Thus, the learning that is carried out can give birth to a comprehensive thinking ability that can realize an inclusive education.

2. LITERATURE REVIEW

2.1 Correlation Logical Thinking and Understanding of Science Concept

Logical thinking is the basic ability to think accurately based on a set of available premises. It is important to develop logical thinking for understanding of science concept. This is because logical thinking is part of the basic ability to think. With low logical thinking abilities, it will also have a low understanding of science concepts. This is evidenced in studies that examine the comparison of logical tests on students that have examination results in science. The result shows that the scores on Test of Logical Thinking (TOLT), there are only 23.3% of the students who have reached the concrete stage; 53.3% of the students who have reached the transitional stage; and 23.3% of the students who have reached the formal stage. This study also shows that there is a positive correlation between logical thinking and understanding of science concepts. The higher the student's logical thinking score, the higher the student's understanding of the concept of science (Sumirat, 2017)

2.2 Educational Games

Educational games are games that are designed for learning, but still offer play and fun. Educational games are a combination of educational content, learning principles, and application games. Educational games can be used as an educational medium that can be used as learning media. This type of game is commonly used to invite users to learn while playing. Through this learning process, users can gain knowledge, so that educational games are a new breakthrough used in the world of education. Apart from the fact that this type of game combines learning and playing sides, this type of game can also be used to attract children's attention to learning (Amalia et al., 2020).

2.3 Android Smartphone

Android is an operating system for Linux-based mobile devices that includes an operating system, middleware, and applications. At this time, most smartphone vendors have produced smartphones based on Android, including HTC, Motorola, Samsung, LG, Sony Ericsson, Acer, Nexus, Nexian, IMO, and many other smartphone vendors in the world that produce android. This is because Android is an open source operating system so it is free to be distributed and used by any vendor. The rapid growth of android besides the factors mentioned earlier is because Android itself is a very complete platform both for its operating system, applications and Development Tools, Android application market and very high support from the open source community in the world, so that Android continues to grow rapidly both in terms technology and in terms of the number of devices in the world (Karnadi & Sitohang, 2020).

2.4 Unity 3D

Unity 3D is a program for creating games that are designed to be easy for beginners to use. The development environment for Unity 3D runs on Microsoft Windows and Mac Os X, and applications created by Unity 3D can run on Windows, Mac, Xbox 360, Playstation 3, Wii, iPad, iPhone and not lagging behind on the Android platform. Unity can also create browser-based games using the Unity web player plugin, which works on Mac and Windows, but not Linux.This program is very popular and is the choice of more than 800,000 game creators from all over the world because Unity 3D provides all the core functionality needed to create great games. Unity 3D provides various programming language options for developing games, including JavaScript, C#, and BooScript. Even though three programming languages are available, most developers use JavaScript and C# as the language used to develop games (Nurym et al., 2020).

3. RESEARCH METHODS/METHODOLOGY

The method used in the development of this paper is the waterfall method. The reason for using this method is because the waterfall method approaches systematically and sequentially in building a system so that it fits perfectly with the theme of this paper. The waterfall method process is the work of a system carried out in sequence. The resulting system will be of good quality, due to its gradual implementation so that it is not focused on certain stages. The stages of the waterfall method are as following figure:

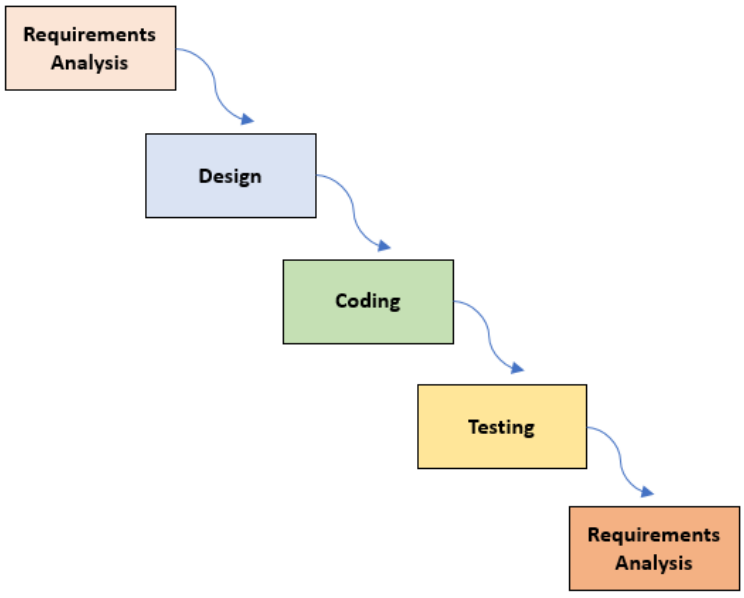

Figure 1. Waterfall Method Steps

3.1 Requirements Analysis

The requirements analysis iis carried out by analyzing user requirements, analyzing software and hardware needed in system development and other needs. The making of this game uses a PC TOSHIBA SATELITE P755 with Intel Core 3 processor specifications, 4 GB of memory. The smartphones used for testing were Xiaomi Redmi 3, Android 7.1.2 N2G47H (Nougat) with 2GB RAM.

3.2 Design

The purpose of this step is to provide an overview of what to do and a graphical user interface. This step fulfills all user requirements according to the analyzed results such as the development game display design and helps define the overall system architecture. The documentation generated from this system design stage includes the design of the Application Flow Diagram, Use Case Diagrams, and user interface design.

3.3 Coding

Writing program code is translating system weaknesses that have been made in the form of commands that use a computer using a programming language. This stage is a real stage in a system. The programming language systems used are Javascript and C # with the help of the Unity 3D game engine (Zhang & Chen, 2020).

3.4 Testing

Testing is used to ensure that the software is made according to the design and all functions can be used properly without failure. This study uses the Blackbox Testing method. Blackbox Testing is a software testing technique that focuses on the functional specifications of the software (Yulianton et al., 2020). Blackbox testing works by ignoring the control structure so that attention is focused on domain information. Blackbox testing allows software developers to create a set of input conditions that will exercise all the functional requirements of a program. The advantages of using the Blackbox Testing method are: (1) Examiners do not need to have knowledge of a particular programming language; (2) Testing is carried out from the user's perspective, this helps reveal ambiguities or inconsistencies in the requirements specification; (3) Programmers and examiners are both dependent on each other (Viglianisi et al., 2020).

3.5 Maintenance

The final step of system development in the Waterfall model is maintenance which includes the process of installing and repairing the system. Maintenance in accordance with the wishes of the user or in accordance with the contract of work.

4. RESULTS AND DISCUSSION

The game design must first draw the flowchart of the overall system so that the game system is made clearer and more structured. A flow chart is a diagram that shows the logical flow in a program or system procedure. Flowcharts are mainly used for communication and documentation aids. The flowchart used is a type of Flowchart System, which is a chart that shows the workflow or what is being done in the system as a whole and explains the sequence of procedures that exist in the system.. The game flowchart is shown in figure 2 below:

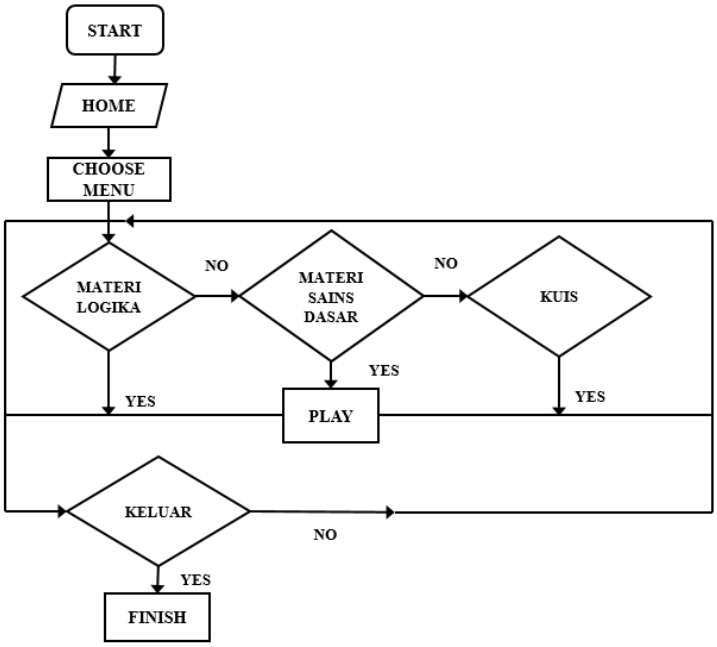

Figure 2. Flowchart of the Game

The flow of game use can be found through the Use Case Diagram. Use Case Diagrams describe the interaction between one or more actors with the information system to be created. The following is the design of the processes contained in the logical thinking educational game to understand the concept of stundet science, illustrated with a Use Case Diagram which can be seen in Figure 3 below.:

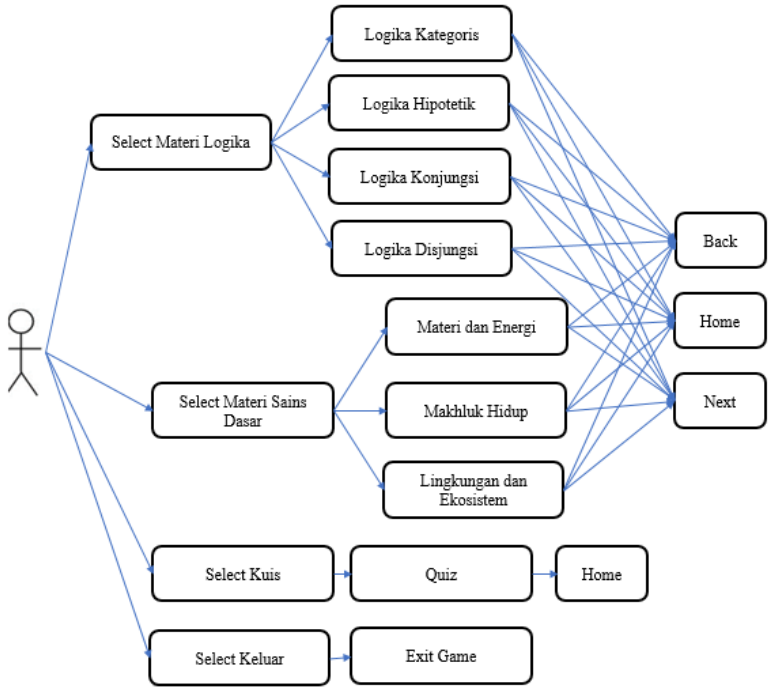

Figure 3. Use Case Diagram

4.1 Designing User Interface

As a design product, educational games adapt general design principles which include: the principle of proportion, the principle of emphasis, the principle of balance, the principle of rhythm, the principle of harmony, and the principle of unity (Adita et al.,

2018). A good educational game must fulfill these design principles in user interface design. The user interface is considered good if it can function properly, not only considering aesthetic aspects (Capece et al., 2020). In other words, in determining the form of an interface design (user interface), not only visual aesthetic aspects are needed, but also must pay attention to the functional aspects of the elements in the interface design. In making the user interface for this educational game using the Draw I / O application which can be accessed offline by installing the application and online via the website. The design prioritizes learning media that is clear and easy to understand. The following is an educational game user interface design of logical thinking for understanding science concept students in figure 4 to figure 7:

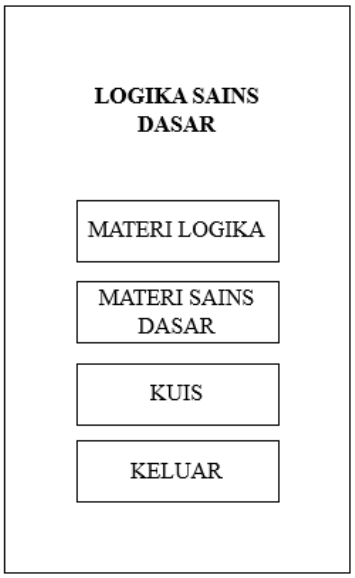

Figure 4. Design Interface of Main Menu Page

The earliest menu is the main menu or home menu which consists of 3 menus and 1 button exit, namely MATERI LOGIKA (Logic lessons), MATERI SAINS DASAR (Basic science lessons), KUIS (Quiz), and KELUAR (exit button).

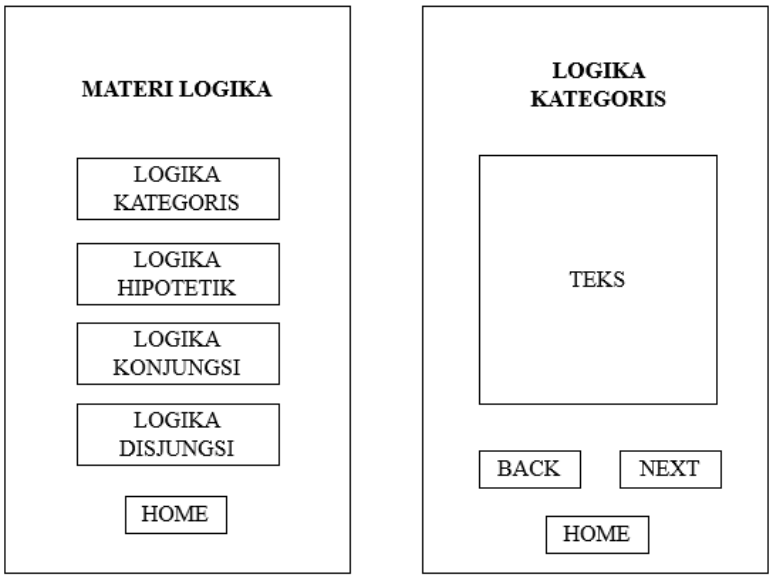

Figure 5. Design Interface of Materi Logika Menu

The MATERI LOGIKA menu consists of 4 basic logic lessons which include LOGIKA KATEGORIS, LOGIKA HIPOTETIK, LOGIKA KONJUNGSI, LOGIKA DISJUNGSI, and HOME to return to the previous menu. All kinds of MATERI LOGIKA in this section are the basic materials of logic lessons. When a menu of MATERI LOGIKA is selected, a display will appear that provides a description of each type of MATERI LOGIKA. There is a BACK menu to return to the previous page, and a NEXT menu is available for further explanation of the selected logic lesson, and HOME to return to the previous.

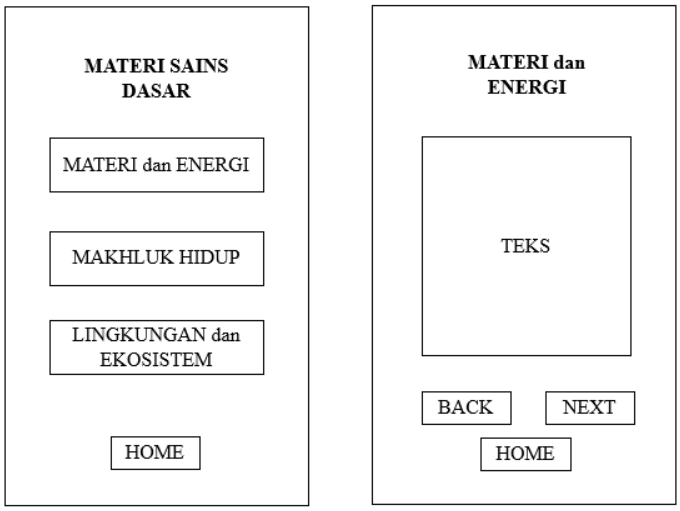

Figure 6. Design Interface of Materi Sains Dasar Menu

The MATERI SAINS DASAR menu consists of 3 basic science lessons, including MATERI dan ENERGI, MAKHLUK HIDUP, LINGKUNGAN dan EKOSISTEM, and HOME to return to the main menu. All kinds of MATERI SAINS DASAR in this section are the basic materials of basic science. When a menu of MATERI SAINS DASAR is selected, a display will appear that provides a description of each type of MATERI SAINS DASAR. There is a BACK menu to return to the previous menu, NEXT menu is available for further explanation of the selected logic lesson, and HOME to return to the main menu.

The last menu is the KUIS menu. The KUIS menu created to test user understanding after using this application. KUIS made by multiple choice with 4 choices. This is because students prefer to answer multiple-choice questions rather than essay questions. The page is accompanied by a time limit answering each question which is 30 seconds. Questions are also accompanied by a home button to return to the main menu:

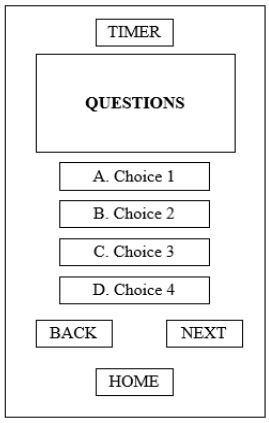

Figure 7. Design Interface of Kuis menu

4.2 Design of Game Display

The game display is made using the Adobe Illustrator CC 2018 application with reference to the previously designed user interface. Making the game display using the main color brown. In the rules of human and computer interaction, the colors used must not be more than 5 colors. In addition, the symbols used must comply with the rules for using symbols so that users can more easily understand the elements in the game. Data display on the educational game user interface includes the use of color, typography, illustrations, and layout / composition. Typography analysis is carried out by checking the type and size of the letters used, font arrangement / arrangement, giving effects, and the final result on the readability of the text (Pratama et al., 2020). Below are the results of the game interface display designin figure 8 to figure 11:

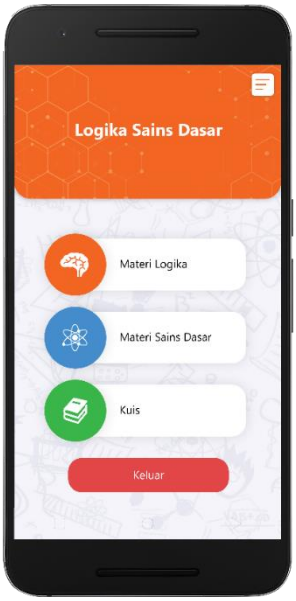

Figure 8. Display of Main Menu Page

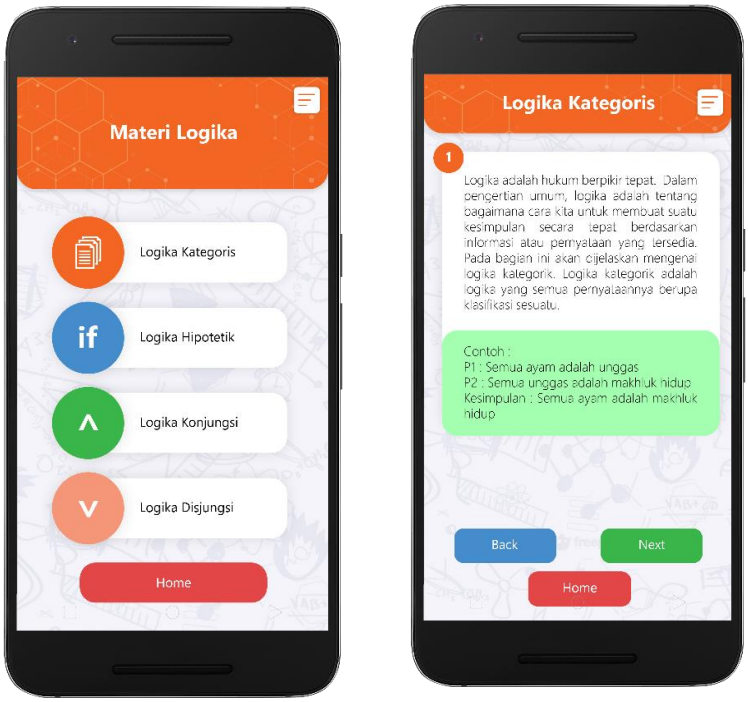

Figure 9. Display of Materi Logika Menu

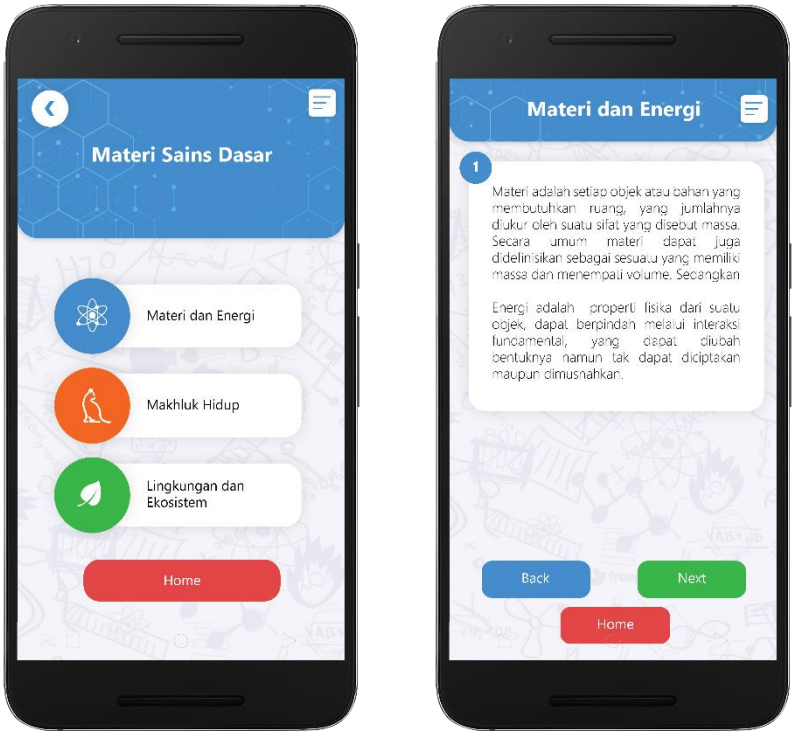

Figure 10. Display of Materi Sains Dasar Menu

Figure 11. Display of Kuis Menu

4.3 Game Testing

Testing this game uses the Blackbox Testing technique, a software testing technique that focuses on the functional specifications of the software. Each element of the game is tested for function and recorded whether it meets the expectations of the developer. The trial results are illustrated with the following information:

1. Success. Means the function or work element in accordance with expectations.
2. Fail. This means an error occurs or the function does not run according to expectations.

The test results are displayed in table 1 to table 6 below:

BUTTON	FUNCTION	RESULT
Materi Logika	Go to the Materi Logika page	Succes
Materi Sains Dasar	Go to the Materi Sains Dasar page	Succes
Kuis	Go to the Kuis page	Succes
Keluar	Exit from the game	Succes

Table 1. Main Menu Testing

BUTTON	FUNCTION	RESULT
Logika Kategoris	Go to the Logika Kategoris page	Succes
Logika Hipotetik	Go to the Logika Hipotetik page	Succes
Logika Konjungsi	Go to the Logika Konjungsi page	Succes
Logika Disjungsi	Go to the Logika Disjungsi page	Succes
Home	Bacak to the main menu	Succes

Table 2. Materi Logika Menu Testing

BUTTON	FUNCTION	RESULT
Back	Go to the back page	Succes
Next	Go to the next page	Succes
Home	Back to the main menu	Succes

Table 3. All Type Materi Logika Page Testing

BUTTON	FUNCTION	RESULT
Materi dan Energi	Go to the Materi dan Energi page	Succes
Makhluk Hidup	Go to the Makhluk Hidup page	Succes
Lingkungan dan Ekosistem	Go to the Lingkungan dan Ekosistem page	Succes
Home	Bacak to the main menu	Succes

Table 4. Materi Sains Dasar Menu Testing

BUTTON	FUNCTION	RESULT
Back	Go to the back page	Succes
Next	Go to the next page	Succes
Home	Back to the main menu	Succes

Table 5. All Type Materi Sains Dasar Page Testing

BUTTON	FUNCTION	RESULT
Question	Go to the Materi dan Energi page	Succes
Multiple Choice	Go to the Makhluk Hidup page	Succes
Timer	Go to the Lingkungan dan Ekosistem page	Succes
Home	Bacak to the main menu	Succes
True/Wrong Sign	It comes with a tick/ cross based on the answer	Succes

Table 6. Kuis Menu Testing

CONCLUSION

Test results show that educational game of logical thinking based unity 3D for understanding science concept students as a part of holistic thinking that have been made functional is running well with the presentation of the test 100% successful and is considered feasible to use. But the appearance, function, material, and animation still have to be developed to be more leverage when used and effectively provide knowledge. Suggestions for further research are to make the quiz menu design more varied, which is to combine and combine multiple questions and choices with text, images, and sound. In addition, you should also test the display and material to the user.

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