Educational Games For Disaster Of Earthquake Mitigation Based Android Using Unity

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Abstract

Earthquake is one of the natural disasters that occur due to shifting of tectonic plates that produce waves that have an effect on the earth's surface and have the potential to cause a tsunami. Based on the geographical, indonesian is one of the countries that has the earthquake risk and potential causes of tsunami disaster. Badan Penanggulangan Bencana Daerah (BPBD) conducted an information about earthquake mitigation by publishing a book entitled "Buku Saku Tanggap Tangkas Tangguh Menghadapi Bencana" containing the causes of earthquake disaster, recognize signs of the earthquake disaster, and earthquake safety tips. In the fact, There are still many people who do not know about the book that has published by BPBD. To resolve these issues, this study aims to reduce the risk of earthquake impact from "Buku Saku Tanggap Tangkas Tangguh Menghadapi Bencana" using educational games that built to help the people know about earthquake mitigation to become easier. Unity used to develop the educational game with genre is simulation. The Agile Model of System Development Life Cycle (SDLC) is the research that applied throughout the development of this education. The software will be testing uses "Blackbox" testing , it is focuses on output of input and execution with ignore the internal mechanism system. In the meanwhile, The System Usability System (SUS) used to evaluate the usability of prudct and to mesure the level of targets acceptance of various technology models. Based on the SUS testing, this research is accaptable by the public with a grade scale is "C" category, the adjactive rating is "GOOD" and the percentil rank is 73,29 SUS score on "C" grade.

Keyword : *Agile, Android, Earthquake, Educational,Unity*

1. INTRODUCTION

An earthquake is an event that vibrates the earth due to the sudden release of energy in the earth, marked by a fault in the rock layers in the earth's crust. The energy produced is emitted in all directions in the form of earthquake waves, causing effects on the earth's surface. Indonesia is one of the countries that are prone to earthquake risk, this is based on the geographical location of Indonesia which is at themeeting point of 3 plates, namely the Indo-Australian Plate, the Eurasian Plate and the Pacific Plate. (BMKG, 2022). The path of the meeting of the 3 plates is one of the causes of regional

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tectonic earthquakes and causes very severe damage in the Indonesian Archipelago region, which has the potential to cause a tsunami disaster. (Hardiansyah, 2010).

Based on Badan Meteorologi, Klimatologi dan Geofisika (BMKG) press, the BMKG provided an information on an earthquake that had a destructive impact, among others, in Lebak (Banten) on January 23, 2018, with an earthquake with a magnitude of 6.1. This left one person dead, several people injured and more than 1,200 houses damaged (CNN INDONESIA, 2019) .

Badan Nasional Penanggulangan Bencana (BNPB) conducted outreach to the community by publishing a book entitled "Buku Saku Tanggap Tangkas Tangguh Menghadapi Bencana". The counseling aims to add insight to the community regarding actions when an earthquake occurs. These efforts are needed to reduce the risk/impact of natural disasters, including casualties, losses, and environmental damage (Istiqomah & Sudarmilah, 2019). According (Rahardian, 2019) The counseling conducted by BNPB received less attention from the public, this was evidenced by distributing as many as 20 questionnaires to the public containing knowledge about books published by BNPB. One of the reasons is that people only read a definite action that must be taken during an earthquake, either before a disaster occurs, when a disaster occurs, or after a disaster occurs. Based on this, it is very necessary to create educational media about earthquake disaster mitigation to find out what to do before an earthquake occurs, when an earthquake occurs, and after an earthquake occurs along with information about earthquakes.

The Educational games are games that are used as entertainment media and learning media (Nuqisari & Sudarmilah, 2019). It can be used for teaching and learning activities (Muhajarah & Rachmawati, 2019) and can provide opportunities for someone to develop skills and knowledge (A. Setiawan et al., 2019). Based on statement by (Rahardhian,2019), according to (Ch Opi & RUA Sompie, 2022; Istiqomah & Sudarmilah, 2019) education media aims to teach how to take on the disaster thourgh anymedium and one of it is educational game.

Unity is an development game platform to creating a game based android, desktop, web, console, and other platform (Kristianto, 2021). It can handle the creation of game with high variety of features on 2D and 3D graphic (Khaerudin et al., 2021).

Previous research will be shown on below Table 1.

Table 1.

No	Author	Title
1	Rahardian	Game Edukasi Siaga Bencana GempaBumi
2	Istiqomah, E. Sudarmilah	Game Edukasi Mitigasi Bencana GempaBumi Berbasis Android
3	Indra Ch. Opi , Sherwin R.U.A Sompie	Rancang Bangun Game Edukasi Tanggap Bencana Gempa Dan Tsunami

The author developed an educational game as a final project. The game is "Educational Game For Disaster of Earthquake Mitigation Based Android Using Unity". The diference of previous research on top is these game built using Unity as the source code and game design. This game is single player and consists of 5 areas, namely: House, Building, Highway, Beach, and in the train. This game is a decision-making and simulation genre with 3D graphics that is specifically for ages 10 years and over.

The purpose of designing the game is to create a media in the form of an educational game for earthquake disaster mitigation and to find out what to do before a disaster occurs, when a disaster occurs, and after a disaster occurs. The benefit of the game design by the author is to provide an education to the public about the actions that must be taken when an earthquake occurs.

2. METHODE

The method used in designing this educational game is SDLC (*System Development Cycle Life*) with Agile models. Agile methodology is a process framework that used in software development to create iterative approach, collaboration and adaptability of the life cycle project (Azmee, 1901). According to (Martin, 2002) on (Altameem, 2015), Agile modeling techniques are for improvement that depend on iteration in a short time and very fast product development. The advantages of using the agile model are very profitable to create a small project, the ability to change the progress of a project in a short time (Balaji, 2012). Therefore, the author uses the agile model to make it easier to create the product directly. The following are the stages of the Agile model :
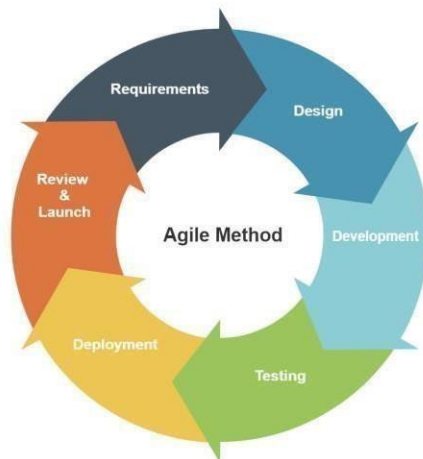
Figure 1. Agile Method

2.1 Requirements

The requirements is an proccess with goals to identify, analysize, and validate requirements for a software system (Paetsch & Maurer, 2003). This stage is carried out to analyze the needs that is used in designing educational games for earthquake natural disaster mitigation, starting with determining a game theme, game title and platform to be used. On requirements typically differentiate two types of requirements such as functionalrequirements which specify the system feature shall do in application, and non functional requirements which specify the quality of performance and usability in application (Becker et al., 2019).

2.1.1 Functional Requirements

The system provides an information and simulation of earthquake mitigationcanbe used byuser.

2.1.2 Non Functional Requirements

The tools used, such as hardware and software, consist of:

Table 2. Tools and Material

Hardware	Software
1. ASUS X441NA Laptop Intel Celeron - N3350 CPU @1.10GHz, RAM DDR3 4GB 2. Samsung A12 Android Version 11.0, CPUOcta-core 2.3GHz Cortex-A53, RAM 4GB	1. Unity version 2021.3.16 2. Java SDK and NDK 3. Notepad++

2.2 Design

The design is producing design with specified result is to be achieved include what tools are to be used, what action are to be performed and how the task should be decomposed (*Open Research Online*, 2017). It should be shown an use case diagram, storyline, storyboard and asset to create a design of the game.

2.2.1 Use Case Diagram

Use Case Diagram is the functional of system that can interact with actor to achive actor needs (Kurniawan, 2018). According to Sommerville(2001), actor can be actor, equipment, person, or other system that interacts with system is building. The use case describe the functional of system or equipment that the system interact from user's point of view (Nasution & Harahap, 2022).
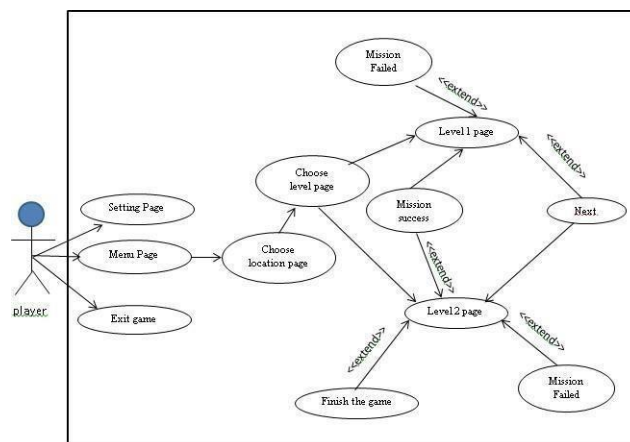

Figure 2. Use Case Diagram

2.2.2 Activity Diagram

The Activity Diagram is a workflow or activity of all system where itdraws the activity of system not activity of actor (Pitrawati & Sanjaya, 2021).
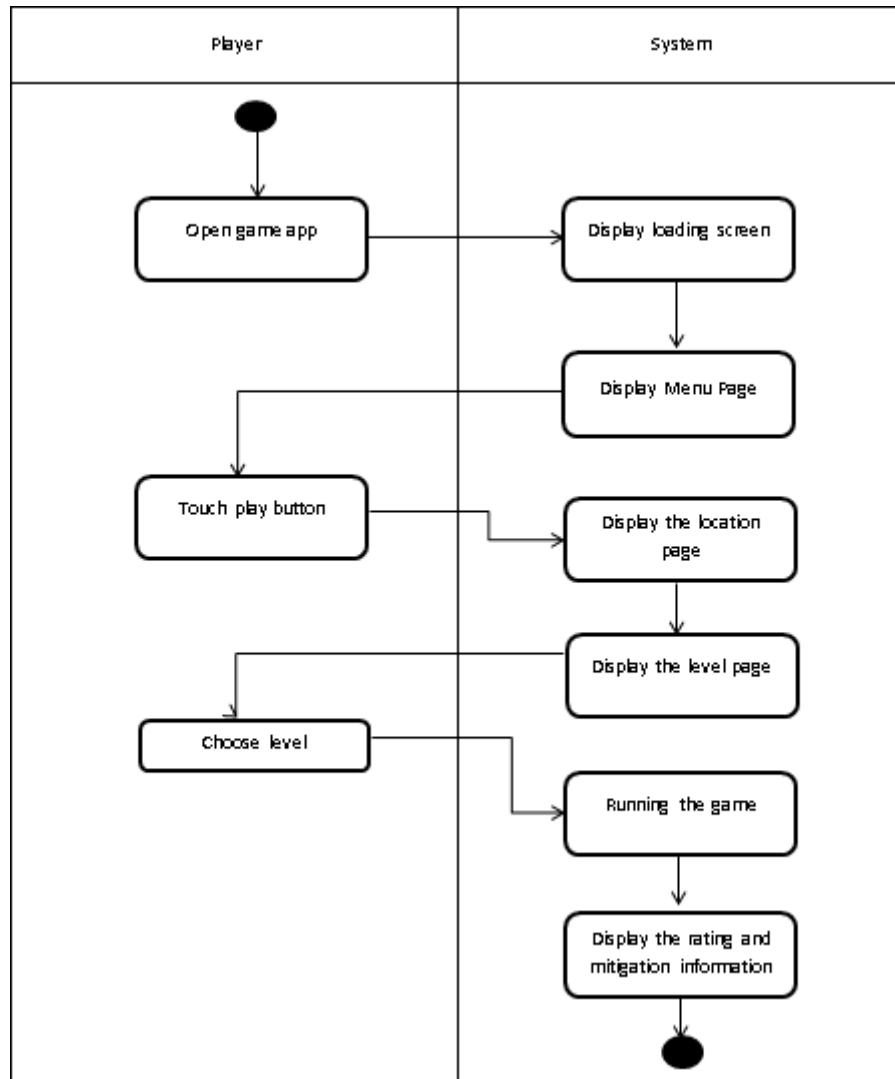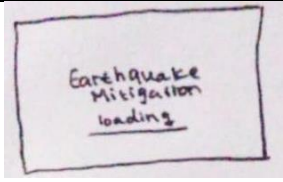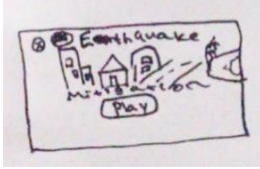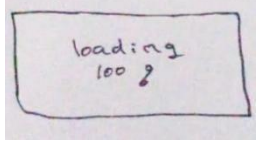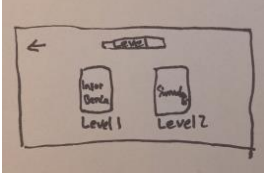

Figure 3. Activity Diagram

a. Create Storyline
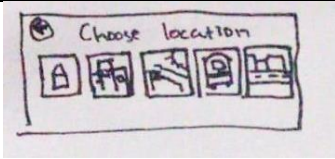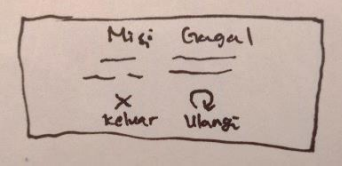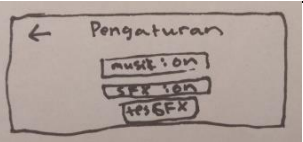
The storyline is a fictive world and character in a story which they develop themselves (Mitchell, 2016). It is a plot that tells the first of the game and the purpose of the end (Nurchasanah & Sudarmilah, 2016) . This educational game tells the story of how a person saves himself from an earthquake disaster. This educational game aims to determine the mitigationof natural disasters and contains simulations when an earthquake occurs, such as information about earthquakes and how to save yourself from an earthquake. In this educational game, you are asked to complete different missions and challenges at each level. If the player has completed the mission at each level, they will be given a reward in the form of an information about earthquakes.

b. Create Storyboard

Storyboard is deliver naraative through visual to create conceptual idea of the information, location, meaning, and appearance (Hafour, 2020).
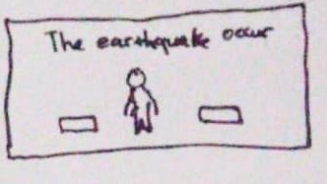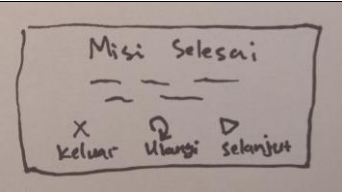
Table 3. Design Of Storyboard

No	Images	Description
1		Display loading before entering themenu page.
2		The main menu display consists of the play button, about button, setting button, and exit button.
3		Display Loading to the play page.

4		The level select page will appear when the play button is clicked, and there is a back button to the main menu page.
5		Display the location page of the earthquake simulation consist of the location button and back button.
6		Level 1 page view, the system will providing the information of earthquake and earthquake safety tips .
7		Level 2 page view, players save themselves during an earthquake occurs based on the selected game location by clicking on a clickable object.
8		Display the complete levels pop up, players successfully complete missions and challenges. There is a back-to menu, restart, and next button.
9		Display the failed pop up to complete the level; the player did not successfully complete the mission and challenges. There is a back to menu button, and restart.
10		Display the Setting page

c. Prepare The Asset

- Character and background assets are taken from the source https://assetstore.unity.com/ , https://mixamo.com .
- Sound assets are taken from several sources such as https://www.fesliyanstudios.com/ , https://www.zapsplat.com/ , and https://www.soundjay.com/ .

2.3 Development

After the design has been built, the next is process of development. The development is a process of building the design specification that has been built into physical form.(Richey et al., 2005) . At the development, it focuses to translating concept art, game design, and other elements. After that the games built based on game storylines, game storyboards, and assets that match the game theme consisting of characters, audio/sound, and background. This game is developed for android Operating System (OS) with minimum version is android version 5.0 and maximum version is android version 11.0 .

2.4 Testing

The testing is a phase to identify design or implementation issues that might prevent users from interacting with the product (Moreno-ger et al., 2012). It is useful to determine whether the system has met the expected results and make it easier to find out product defects (Ristian & Anggoro, 2021). This stage is a process to test the quality of the game system carried out by the author and supervisor to find out whether the game mechanism is running well. To test the game, the author runs the game using "Samsung A12 Android Version 11.0, CPUOcta-core 2.3GHz Cortex-A53, RAM 4GB" and the author runs Blackbox test on several application system including graphical interfaces, sounds, and controls, to see if they are same with the specified function. The Blackbox test is a type of test that ignores the internal mechanism of a system and focuses on the outputs in response to select input andexecution conditions (Bhasin, 2014).

2.5   Deployment

The deployment is a process for product to deploy by any media to implement the product itself that can be consumed and supported (Paleyes et al., 2022). this stage is to implement the game has been built and to deploy to environment. The author will use the System Usability Scale (SUS) test as verify that the solution in the system is suiteable for user. The SUS test is a evaluation method that used see the usability of prudct and to mesure the level of targets acceptance of various technology models (D. Setiawan & Wicaksono, 2020). this test will be conducted using quetioner with 30 response option from "Strongly Agree" to "Strongly Disaggree" . This stage aims to ascertain whether the game that has been provided can meet the desires of the environment or become an input for making changes to mechanisms or assets, and to find out whether game can run without any errors and black box testing. The target of deployemnt is adolscent and adults.

2.6   Review and Launch

The Review is a type of research that are conducted to identify and retrieve the evidence that relevant with particular question and to apraise the result of the search to inform that to ensure the result are both reliable and meaningful (Munn et al., 2018). At this stage, the author will review the result of the quetioner that using the SUS test to find out whether the game can run without any errors in the mechanism and Blackbox testing. This is not part of the development cycle, but the result is to develop or fix some of the game content component.After that the game will be launch.

3.   RESULT AND DISCUSSION

The author has provided to develop an education game with simulation genre about the disaster of earthquake mitigation for 10 years above. This game aims to increase their knowledge and basic in fundamental of earthquake mitigation. The discussion of this game,,s development disclosed as follows :.

3.1   The result of the game display

3.1.1 First loading page

This is the first layout displayed in game.

Figure 4. First Loading Page

3.1.2 Main Menu

This is a layout where a player can be interact at first layout. This layout has a buttons as "Play Button", "Exit Button", "Setting Button", and "About Button". If player click "About" button, it will display pop up of "about". If player click "play button", it will move to location page. if a player click "Setting" button, it will move to "Setting" page.

Figure 5. Menu page

Figure 6. "About" pop up

3.1.3 Selection location menu

After a player push "Play" Button on Main Menu, this is a layout that displaysanoptions to choose a game location that will be played.

Figure 7. Selection location page.

3.1.4 Selection level menu

This is a layout that displays level on location after a player has choosen the location. On level 1 button is a layout about an information of earthquake mitigation before earthquake disaster happen. If a player has finished level 1, it will next to level 2. On level 2 button is a gameplay layout. if a player has finished on level 1, the system willbe next to level 2 automatically.

Figure 8. a)Selection level page

3.1.5 Gameplay page

On Figure.7 is a gameplay layout on level 1, it is an information about short explanation of earthquake and mitigate or actions that must be taken during an earthquake. While On Figure.8 is a gameplay layout on level 2, it is a simulation page where a player must take an action during earthquake occurs. There is a "Petunjuk" button that has a function to display an information of actions that must be taken when earthquake occurs and "pause" button that has a function to pause the game then display a pop up where it can reset the gameplay, exit from gameplay and play the gameplay.

(a) (b)

(c) (d)

(e)
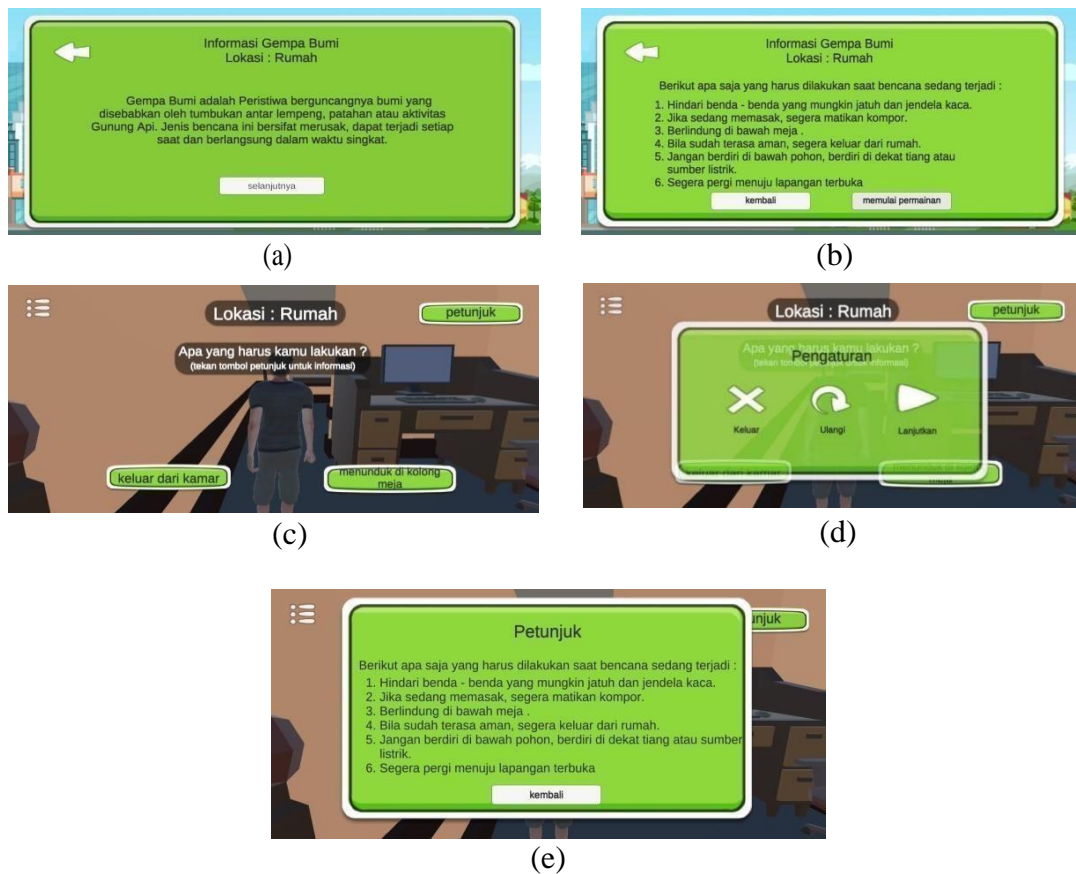
Figure 9. a & b) Gameplay Level 1, Figure 10. c, d, & e) Gameplay Level 2

3.1.6 Finish page

This is a layout where a player has finished the gameplay. It has 2 layouts of popup are "success" and "failed". On "Successed" layout, a player has finished the gameplay correctly based on information of earthquake mitigation. While "Failed" layout, a player failed to finish the gameplay based on information of earthquake mitigation.

(a)   (b)

Figure 11. a) Finish pop up, b) Failed pop up

3.1.7 Setting page

This layout is a setting page.there is a "musik" button, "SFX" button, and "SFX test". If player click the "musik" button, the system will stop thebackground music. If player click the "SFX" button, the sound effect will be stopped, if the player click "SFXtest" button, it will check the sfx sound is turn on or turn off.

Figure 12. Setting page

3.2 Blackbox Testing

This blackbox is aimed to evaluate the functional specification of the game app (software). The result of the software testing shows that Educational Games Of The Disaster Of Earthquake Mitigation Based Android Using Unity for public is running properly in Android Devices.

Table 4. Blackbox Test Result

No	Layout	Button	Expected Result	Status
1	Display Loading	-	Go to "Main Menu" layout	Valid
2	Main Menu	Play	Go to "Selection Location" layout	Valid
		Setting	Go to "Setting" layout	Valid
		About	Go to "About" layout	Valid
		Exit button	Show a pop-up information abouthow to close the game	Valid
3		Music Switch	Turning the game music on/off	Valid
		SFX Switch	Turning the game sFX on/off	Valid
		SFX Test Button	Tessting the sFX sound	Valid
		Back	Go back to "Main Menu" layout	Valid
4	About	Back	Go back to "Main Menu" layout	
5	Selection Location	"Home" Image	Go to "Selection level" layout	Valid
		"Build ing" Image	Go to "Selection Level" layout	Valid
		"High way" Image	Go to "Selection level" layout	Valid

		"Beach" Image	Go to "Selection level" layout	Valid
		"Train Station" Image	Go to "Selection level" layout	Valid
		Back	Go back to "Main Menu" layout	Valid
.6	Selection Level	"Level 1 – Information" Button	Go to "level 1" layout	Valid
		"Level 2 - Simulation" Button	Go to "level 2" layout	Valid
		Back	Go back to "Selection Location"layout	Valid
7	Level 1	"Selanjutnya" Button	Show a pop up about next mitigateinformation	Valid
		"Memulai permainan" Button	Go to "Level 2" layout	Valid
		Back	Go back to "Selection Level" layout.	Valid
	Level 2	"Petunjuk" Button	Show a pop up about information"what should player to do"..	Valid

		Answer Choices	Correct answer : the character willmove, then move to the next question. If the all of answer is correct then show a pop up "Success". Wrong answer : The character willmove, then show a pop up "failed".	Valid
		Back	Go to "Selection Level" layout.	Valid

This blackbox test is the reliability in which produces the button outputs and function thatis in accordance to the concepts and designs that had been arranged bythe author.

3.3 System Usability Scale (SUS) testing.

The System Usability Scale (SUS) provides a "quick and dirty". reliable tool for measuring the usability. It consist of a 10 item questionaire with five response option for respondents from "Strongly Agree" to "Strongly Disagree". When a SUS is used, participants are asked to score the following 10 items with one of five responses.

Table 5. SUS Test Statements

Statement Code	Statement
P1	I think that I would like to use this game system frequently.
P2	I think the interfaces is intresting
P3	I thought the game was easy to play/use.
P4	I think that I would need the support of a technical person to be able touse/play this game.
P5	I found the various functions in this game were well integrated.

P6	I thought there was too much inconsistency in this game.
P7	I would imagine that most people would learn to use/play this game veryquickly.
P8	I found the game very cumbersome to use.
P9	I felt veryconfident playing the game (I feel like there aren't manyobstacles in playing this game).
P10	I needed to learn a lot of things before I could get going with this system.

In the System Usability Scale(SUS) test for Educational Games For Disaster Of Earthquake Mitigation Based Android Using Unity, the respondents consisted of 60 people (in the test result will be coded as R1, R2, R3 and so on until R60) from several adult and adolcents.

The computation for the SUS test score is done by removing one point from each respondent"s answer to the odd - coded question (P1, P3, P5, P7, P9) and five points from each respondent"s answer to the even - coded question (P2, P4, P6, P8, P10). Values from question 1 to 10 (P1 - P10) are then being put together to be multipled by 2.5. if the system has average of more than 70, it is considered "acceptable". The test result of the SUS test will be shown in Table 4.

Table 6. SUS Test Result

Responde nt	SUS Raw Score	SUS Final Score (Raw Scroe * 2.5)
R1	32	80
R2	30	75
R3	31	77.5
R4	28	70
R5	28	70

R6	25	62.5
R7	28	70
R8	27	67.5
R9	29	72.5
R10	28	70
R11	32	80
R12	29	72.5
R13	24	60
R14	30	75
R15	28	70
R16	30	75
R17	29	72.5
R18	30	75
R19	28	70
R20	28	70
R21	26	65
R22	28	70
R23	25	62.5
R24	29	72.5
R25	27	67.5
R26	28	70
R27	29	72.5
R28	26	65
R29	30	75
R30	28	70
R31	31	77.5
R32	29	72.5
R33	30	75
R34	29	72.5
R35	28	70
R36	30	75

R37	27	67.5
R38	28	70
R39	27	67.5
R40	28	70
R41	27	67.5
R42	29	72.5
R43	29	72.5
R44	30	75
R45	26	65
R46	31	77.5
R47	28	70
R48	30	75
R49	32	80
R50	30	75
R51	28	70
R52	28	70
R53	27	67.5
R54	31	77.5
R55	29	72.5
R56	30	75
R57	30	75
R58	32	80
R59	28	70
R60	29	72.5
Total		4397.5
Avarge		73.29

Based on the usability result of 60 respondents is obtained total score of SUS final score is 4397,5 with the average result is 73,29. After getting the final result of respondents, next step is determine the grade of usability result using 2 method. The first is using Acceptability, Graden Scale, and Adjective Rating, The

second is using percentile range (SUS Score) that has an usability as "A, B, C, D, E, and F".

To obtain the result of user perspective of Game Edukasi Mitigasi Bencana Gempa Bumi, it should obtain based on Acceptability, Grade Scale, and Adjective Rating. The result of Acceptability, Grade Scale, and Adjective Rating will be shown on below figure 10.
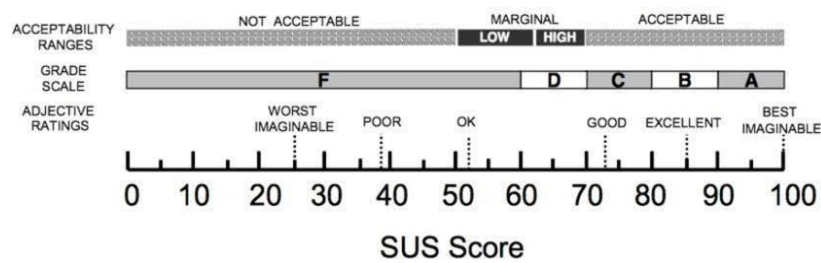

Figure 10. The result of Usability using Acceptability, Grade Scale, and Adjective Rating (Made etal., 2020).

Based on the result of analysis of the recapulation result on Acceptability, Grade Scale and Adjective Rating is 1) The rating of Acceptability range player of "Game Edukasi Mitigasi Bencana Gempa Bumi" is on "Acceptable", 2) The rating of Grade Scale player is on" C" category, 3) Adjective Rating player is on "GOOD" category. Based on the result of SUS test Percentil Rank on "Game Edukasi Bencana Gempa Bumi" is 73,29 SUS Score on "C" Grade. The "Game Edukasi Mitigasi Bencana Gempa Bumi" is acceptabled on environment and needs to be evaluated and to developed again so that it is more optimal for its use.

4. CLOSING

Based on the Test that has been conducted by blackbox test, this game can be played very well on Android mobile as function and button. Based on The SUS test result display that 25% of adults respondents know about "Buku Saku Tanggap Tangkas Tangguh Menghadapi Bencana" from BPBD, 10% of adolcents respoendents, and 65% of adults and adolcents who do not know about "Buku Saku Tanggap Tangkas Tangguh Menghadapi Bencana" from BPBD, and based on the result of analysis of the recapulation result on Acceptability, Grade Scale and Adjective Rating is obtained the grade of Acceptability is "Acceptable", the rating of Grade Scale is "C" category, the result of Adjective Rating is "GOOD" and SUS test Percentil Rank is 73,29 SUS Score

on "C" Grade. Therefore, The "Game Edukasi Mitigasi Bencana Gempa Bumi" can be accapteable environment and needs to be evaluated and to develop again, especially in the in the interface display.

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