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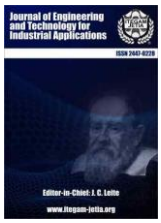

RESEARCH ARTICLE OPEN ACCESS

RPG BASED EDUCATIONAL GAME ON BASIC ARITHMETIC USING THE MDLC METHOD

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ABSTRACT

This study aims to build an educational game on basic arithmetic operations (addition, subtraction, multiplication and division) for elementary school students. This educational game application was created using the Multimedia Development Life Cycle (MDLC) development method developed by Luther-Sutopo, with 6 development phases including concept, design, material collection, assembly, testing and distribution. The use of RPG Maker MV to make an educational game called Hero of Mathematics is more interactive and interesting. The results of the material and multimedia test related to the feasibility of the game got a score of 4,025 and 4.4 which are included in the strong interpretation. Meanwhile, in the attractiveness test, the game got a score of 3.8 which is included in the very interesting criteria. Thus, this Pahlawan Matematika (Mathematics Hero) educational game can be said to be feasible to be used as a medium for learning mathematics, especially basic arithmetic operations material for 1st grade elementary school students.

I. INTRODUCTION

Games are now very easily accessible to the public via mobile devices, smartphones, PCs and internet cafes. Different types of games like RPG (Role Playing Game), FPS (First Person Shooter), MMO (Massively Multiplayer Online), RTS (Real Time Strategy) and others. Today's game industry is not only entertainment-oriented, but also can be used as a medium for children to learn, so that children become more interested in a subject. RPG is a game in which players take on the role of imaginary characters and work together on adventures to create a story together [1],[2]. Players choose their character's based on the character's characteristics, and the success of their actions depends on a predetermined system of game rules. Game-based learning is an educational approach that integrates multiple academic themes into a single learning activity, can facilitate learning by contextualizing new information within existing knowledge and personal experience, and can encourage active participation and responsibility [3]. Educational role play is a way to master problems by developing students' imagination and appreciation [4],[5].

Educational games are a type of games that support the learning process in a more fun and creative way, and serve to provide material or user knowledge with interactive support [6]. The use of game elements in the educational field is having positive consequences on the learning process, and motivation in students [7]. Educational games are games meant to teach certain themes, broaden concepts, boost development, comprehend a historical or cultural event, or aid in learning while playing [8],[9]. Educational games are games with educational features that may be utilized as alternative medium to transmit subject matter in an engaging manner. An educational game, often known as an edugame, is a game that is used to aid in the learning process, training, and knowledge enrichment [10]. Most countries have a high need for instructional games before children even enter school. Early childhood learning games are the most popular mobile educational games in most nations. A game learning media is a game that employs media in its operation and has rules and difficulties that must be completed or the mission to be completed or the objective to be attained [11],[12].

II. THEORETICAL REFERENCE

II.1 GAME-BASED LEARNING

Game-based learning is a learning phase in which games are used as an alternative to attaining learning goals [13]. Game-based learning is learning emphasizes achieving a goal in determining the type of game, providing clear directions for learning objectives, providing other learning stimuli and improving the abilities of users that are used in everyday life. Game-based learning is an innovative method that offers benefits to improve the training process and facilitate motivation to learn. Game-based learning increases logical-mathematical ability to think [14]. Effective game-based learning can improve students' attitudes towards mathematics and produce better learning outcomes. Game-based learning is an effective learning strategy to strengthen understanding and improve learning performance through challenges and in-game content. Therefore, further innovation in game-based learning needs to be ensured. One is with comic book games [15].

Games are privileged environments of motivation and commitment. It is only natural that some researchers have devoted some of their efforts to studying ways to import their main features into tools to support learning (serious games), improving not only student knowledge but also the development of fundamental mathematical skills such as problem solving, mathematical reasoning, and mathematical communication [16]. One of the factors causing low mathematics achievement is currently due to the lack of varied learning media fun for students. As a result, the availability of learning media that allow children to discover fundamental mathematics while having fun in the form of a digital game is required [17]. In every mathematics learning, students can have a confident sense of attachment to complicated mathematical assignments chosen by the teacher, while the teacher should assist students in creating, refining, and exploring conjectures in such a way that they can persuade themselves of the conjecture's veracity [18]. Students prefer to play dynamic games compared to listen to teacher explanations through web meeting applications or just doing tasks that tend to be monotonous and boring. These facts make the teaching staff look for alternative learning components, one of which is by developing learning media that can increase students' learning motivation. Education games are one type of media that may be created to enhance online learning activities [19],[20].

One of the reasons pupils are unable to answer mathematical problems correctly is a lack of understanding of mathematical ideas. The difficulty of understanding mathematical concepts is due to the lack of student interest in learning about mathematics. Students that are uninterested in learning will be inattentive when engaged in learning, which will hinder student success [21]. The low learning achievement of students in mathematics, occurs in most of the material being taught. One of them is material on number. The low achievement of students' mathematics learning, especially on the number material, is a very important problem to be overcome. This is due to the urgency of the material as one of the prerequisite materials for other subjects in mathematics. Although this material is a prerequisite material for other materials, in general, some students are less interested in the lessons delivered by the teacher. This condition indicates that learning mathematics in class is less attractive. Problems related to students' poor understanding of mathematical concepts can be overcome by creating learning media that piques students' interest in learning and improves their understanding of mathematical concepts. Students can learn independently about learning materials at school using the multimedia learning method without having to wait to ask a teacher when they are having difficulties. The use of multimedia in learning can provide a stimulus to students to be more enthusiastic and focus their attention on the teaching materials being taught [22]. As a result, the creation of learning media is required to motivate kids to learn [23].

II.2 MATHEMATICS LEARNING

Most individuals find mathematics tough to learn since it is the most difficult and a plague in learning. Mathematics is not only for science but also a very important tool for people that we use to solve the problems in our daily lives [24]. It is critical to understand the four basic operations in a balanced manner if this is to aid studying mathematics. The basic mathematical operations required to study mathematics are addition, subtraction, multiplication, and division. E.A Bilgin's research “A Mobile Educational Game Design for Eliminating Math Anxiety of Middle School Students” indicates that one of the reasons students struggle with the topic of four operations known as arithmetic operations is that they misunderstand the principles of addition, subtraction, multiplication, and division or learn these rules incorrectly [25].

According to another research, the aggregate of these improved indices shows that objectives were reached while making mathematics an engaging, motivating, and entertaining topic, making VLE a valuable tool to supplement traditional teaching ways [26].

Another study, In-Game Activities to Promote Game-Based Math Learning Engagement discovered that refugee allocation and material trading actions boosted student content engagement while in-game development tools and learning assistance increased cognitive engagement. This study also discovered that students' learning engagement was related to their mathematical thinking growth in the setting of GBL [27].

A previous study by Arifah et al. recommended the development of the "Bilomatics" game, which is an educational game including Numbers information for grade 1 elementary school kids and may be utilized as a medium in learning activities. The R&D approach was employed in this investigation, together with the Waterfall development paradigm [28]. The limitation of this research is that it has not illustrated the material in the form of an adventure game, which is currently favored by many children, so it needs to be developed with other methods.

According to another study, this Android-Based Mathematical Educational Game With Children's Arithmetic Concepts intends to create a game application that may educate children or students to learn to count quickly and entertainingly so that children do not become tired of boring learning techniques. Designed in a mobile format, it is intended to be portable. Because of the appealing design of this game, players may learn to count or do mathematics more enjoyably [29],[30]. The limitation of this research is that the material presented is not varied, the new material is limited to addition and subtraction operations.

Based on prior research, the author attempts to create an educational gaming application for children in the first grade by employing more dynamic and intriguing approaches and models. Making the application with RPG Maker MV utilizes the notion of a role-playing game, such that the educational game contains components of enjoyable learning and active learning with problem-solving-based content [31]. Users will be invited to adventure and solve various mathematical problems related to

basic mathematical operations in order to continue the stages of the game.

The MDLC method is used to develop an educational game called Heroes of Mathematics, from concept to distribution, so that the advantages and disadvantages of the educational game application can be identified to achieve its goal as an alternative learning media to improve children's understanding of learning and liking mathematics.

III. MATERIALS AND METHODS

In this study, the application is utilized as an alternative learning media to generate multimedia teaching materials at the primary school level utilizing the MDLC (Multimedia Development Life Cycle) paradigm. MDLC is a technique that includes the following steps: idea, design, material collecting, assembly, testing, and distribution [32],[33]. According to Luther [34],[35] there are 6 stages in MDLC: Concept, Design, Material Collection, Manufacturing, Testing and Distribution [36],[37].

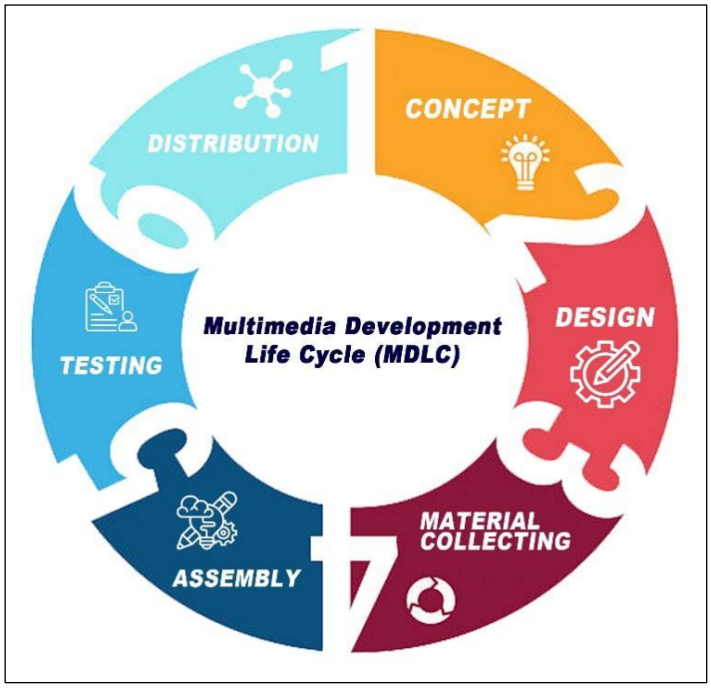

Figure 1: Multimedia Development Life Cycle (MDLC) Method. Source: Luther's Model, (1994).

1. Concept

The concept of this application as a medium for learning basic mathematical operations in the form of addition, subtraction, multiplication and division for children. This application is named "Pahlawan Matematika" which is packaged in a game that is interactive, fun, and easy to use. This application is also accompanied by examples of exercises that challenge and test the child's ability to apply arithmetic operations.

2. Design

The design of this application consists of a story board design and an interface design.

a. Story Board, to visualize the idea of the application to be built, so that it can describe the storyline of the application, the author makes it in the form of a story board consisting of Main Menu, Intro, Bolang's House, Narration1, Pak RT's House, Narration 2, Dungeon.

3. Material Collection

Material collection is carried out as needed. Such as clipart, photos, graphics, sound and others. This stage can be done by dividing the operation into several levels (parallel) and developed together (assembly).

4. Assembly

At this assembly stage, all multimedia objects and materials are created and developed based on the design stage. By completing each section then all of them are combined into a single unit.

5. Testing

After the assembly phase is complete, testing will be carried out by running the application. This stage is also known as the testing stage. Where will be checked in the application, to find out whether there is an error or not. These checks will be carried out by the creators.

6. Distribution

This stage is done to save the application into an adequate storage media. Such as floppy disks, CD-ROOMs, tapes and others. If the storage media is insufficient to accommodate the application, a compilation stage will be performed on it.

IV. RESULTS AND DISCUSSIONS

System Requirements Analysis is used to ease system analysts to determine the whole that will be used for making the system. System requirements in this study consist of functional requirements and non-functional requirements.

a. Functional Needs

Functional is a type of requirement that contains any processes that will be carried out by the system. Functional requirements also contain what information must exist and be generated by the system.

The following are the functional requirements of the game to be made:

1. The game displays a *splash screen*.
2. In the menu display there are options consisting of:
   a. *New Game*, to start a *new game* or start the game from the beginning.
   b. *Continue*, to continue the game that has been saved (save).
   c. *Options*, as a sound or sound settings.
3. While playing (in game) there are also several options, consisting of:
   a. *Item*, to see what items the player has.
   b. *Skill*, to see the knowledge and magic of the character being played.
   c. *Equip*, to see the weapon or armor used by the player's character.
   d. *Status*, to see the status of the character played by the player.
   e. *Options*, serves as a sound or sound settings.
   f. *Save*, to save the game session.

Game End, to return to the main menu

b. Non-Functional Needs

Analysis of non-functional requirements is an analysis that contains what properties are used to support the creation of the system. In making this game requires a series of equipment to support the smoothness of the creation and testing of the game " Pahlawan Matematika (Mathematics Heroes)" including the following:

1. Software

The software needed in making the learning application game " Mathematics Heroes " is as follows:

a. Microsoft Windows 7 (64bit)

b. RPG Maker MV

c. Other programs that support the completion of this game application.

2. Hardware

a. Computer

Hardware specification needed to create game application "Pahlawan Matematika" is as follows:

1. *Processor: Intel(R) Celeron(R) CPU N2920 @1.86GHz 1.86GHz*
2. *Memory*: 4GB
3. *HDD*: 500GB
4. *VGA: Intel(R) HD Graphics*

b. *Windows Device*

The specifications of the Windows device used to run this game are as follows:

1. Laptop: *OS Windows.*
2. *OS: OS Windows* 32/64 bit (*XP, VISTA, 7, 8,* and *Windows* 10)
3. *Browser*: *Mozilla Firefox 54.0.1*

c. Interface

In building an educational game application that suits the needs and conditions for children, of course an analysis of the interface model that will be applied is needed. The interface design in Pahlawan Matematika educational game consists of:

- Splash Screen Display

This display appears a few seconds before entering the main menu.

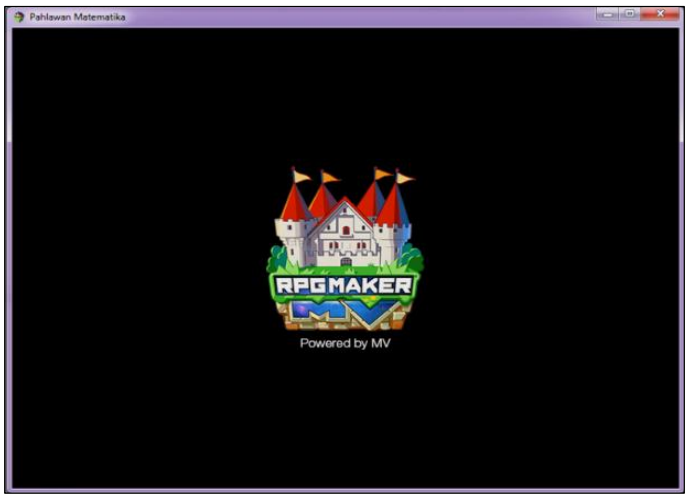

Figure 2: Splash Screen Display.
Source: Authors, (2024).

- Main Menu Display

This display contains the title of the application, the New Game button to start a new game, the Continue button to continue the saved game session, and the Options button for sound settings.

Figure 3: Main Menu Display.
Source: Authors, (2024).

- Menu (*ingame*) Display

This display contains character information, items, skills, equip, save, end game, status, options.

Figure 4: Menu (ingame) Display.
Source: Authors, (2024).

- Item Display

This view contains items owned by the character/player.

Figure 5: Item Display.
Source: Authors, (2024).

- Skill Display
  This skill display contains skills or moves that characters can use during battle.

Figure 6: Skill Display.
Source: Authors, (2024).

- Equip Display
  This display shows the status of weapons and clothes that can be used by the character/player

Figure 7: Equip Display.
Source: Authors, (2024).

- Status Display
  This view contains information about the character and the clothes or weapons used

Figure 8: Status Display.
Source: Authors, (2024)

- Save Display
  This view contains saved game sessions

Figure 9: Save Display.
Source: Authors, (2024)

- Options Display
  This display is useful for game sound settings, etc.

Figure 10: Options Display.
Source: Authors, (2024)

- Bolang's House Display
  In this display, the player cannot control the character, the character will wake up followed by a narration.

Figure 11: Bolang's House Display.
Source: Authors, (2024).

- Dungeon Display
  This display is where the character must defeat 4 bosses to complete this game.

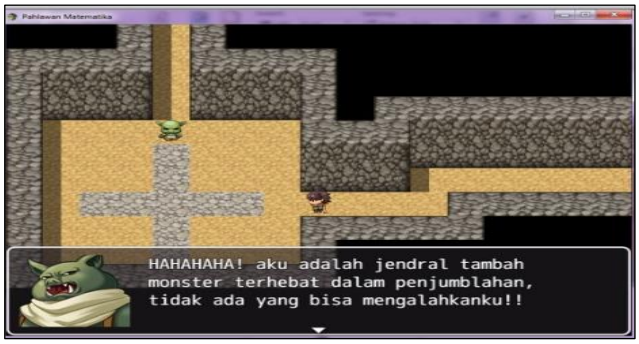

Figure 12: Dungeon Display.
Source: Authors, (2024).

- 12. Battle Display
  This display shows the battle between the character and the enemy.

Figure 13: Battle A Display.
Source: Authors, (2024).

Figure 14: Battle B Display.
Source: Authors, (2024).

Testing the Unit

1. Blackbox Testing
Testing of the program made using blackbox testing which focuses on the process of input and output of the program.

Table 1. Event Blackbox testing

Event	Condition	Reaction	Testing Result
Intro	When starting “New Game” (autorun) Players will be given an intro of narration	Show intro of narration	In accordance
Bolang’s House	After the intro (autorun)	Show narration, Game take over character and leave home	In accordance
Narration 1	When players leave the restaurant, they will be given narration 1	Show narration 1	In accordance
Practice	When in front of Mr. RT press the "Enter" button	Pak RT Show narration, and give exercises	In accordance
Narration 2	After practicing with Mr. RT this narrative will come out	Show narration 2	In accordance
Boss 1	Walk towards boss1 and touch him (Player Touch)	Battle with boss1	In accordance
Boss 2	Walk towards boss2 and touch him (Player Touch)	Battle with boss2	In accordance
Boss 3	Walk towards boss3 and touch him (Player Touch)	Battle with boss3	In accordance
Boss 4	Walk towards boss4 and touch him (Player Touch)	Battle with boss4	In accordance

Source: Authors, (2024).

Export Project

a. RPG Maker MV page
On the RPG Maker MV Page select Deployment.

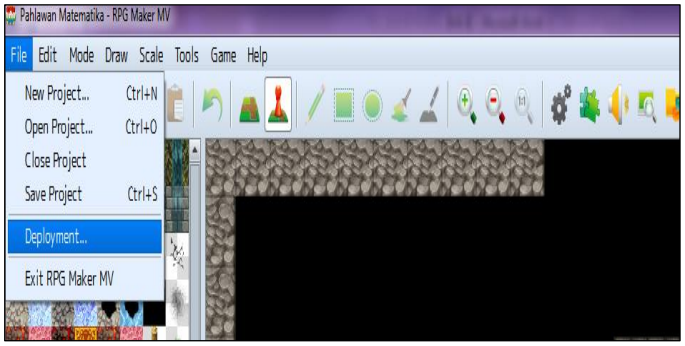

Figure 15: File Page RPG Maker MV Display.
Source: Author, (2024).

After selecting the deployment, select the platform you want to use and then specify the location of the game.

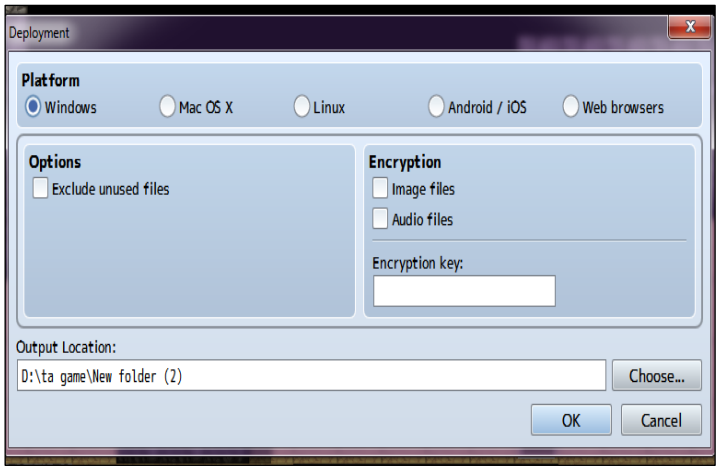

Figure 16: Deployment Display.
Source: Authors, (2024).

After that click "OK" and the game will be exported.

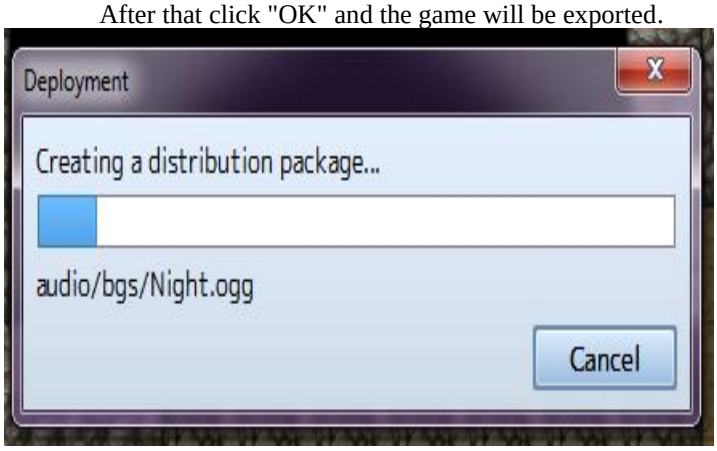

Figure 17: Process Export Display.
Source: Authors, (2024).

b. Export Results Page

After doing all the steps above, the game files and launcher can be found in the selected/defined folder

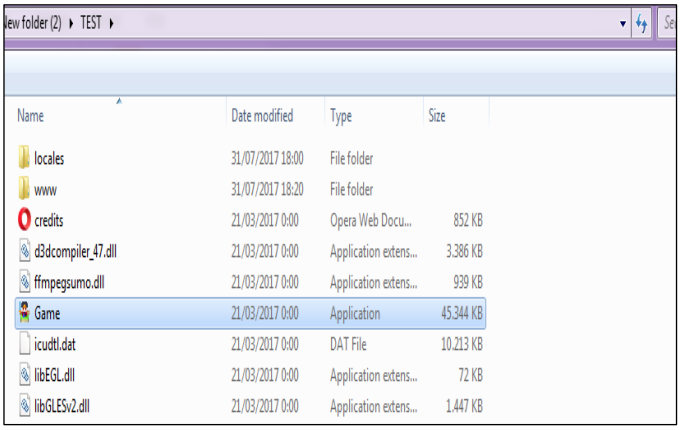

Figure 18: Folder of Export Result Display.
Source: Authors, (2024).

Testing the User Acceptance Test

This test is done by distributing questionnaires to 10 respondents as users of the application that has been made. The scoring for the results of the questionnaire is described in the table.

Table 2. Answer Options and Scoring UAT Testing

Code	Answer	Score
A	Very Easy/Good/Appropriate/Clear	5
B	Easy/Good/Appropriate/Clear	4
C	Neutral	3
D	Fairly Difficult/Good/Appropriate/Clear	2
E	Very Difficult/Bad/Inappropriate/Unclear	1

Source: Authors, (2024).

The details of the questions asked in the UAT test in this study can be seen in the following table:

Table 3. Testing questionnaire format

Code	Question	A	B	C	D	E
P1	Is the appearance of this game interesting?	?	?	?	?	?
P2	Are menu features easy to understand?	?	?	?	?	?
P3	Are the game instructions easy to understand?	?	?	?	?	?
P4	Can game materials help in understanding basic arithmetic operations?	?	?	?	?	?
P5	Does the evaluation (quiz menu) help in measuring understanding of the material?	?	?	?	?	?
P6	Does the card guessing game on this media provide its own challenges for the user?	?	?	?	?	?
P7	Is the card guessing game level good enough to sharpen user's brain?	?	?	?	?	?
P8	Does the puzzle game in this media provide its own challenges for user?	?	?	?	?	?
P9	Is the puzzle game level good enough to sharpen user's brain?	?	?	?	?	?
P10	Can this learning media be used as a learning aid?	?	?	?	?	?
P11	Is this learning media good enough?	?	?	?	?	?

Source: Authors, (2024).

User Acceptance Testing Calculation Results

UAT testing in this study was conducted by distributing question questionnaires to users/respondents. The number of respondents was taken as many as 10 respondents with a total of 11 questions.

Table 4. Questionnaire Answer Data for ICT Educational Games

Code	Answer					Percentage (%)				
	A	B	C	D	E	A	B	C	D	E
P1	7	3	0	0	0	70	30	0	0	0
P2	3	5	0	2	0	30	50	0	20	0
P3	3	6	0	1	0	30	60	0	10	0
P4	3	6	0	0	1	30	60	0	0	10
P5	2	8	0	0	0	20	80	0	0	0
P6	4	5	0	1	0	40	50	0	10	0
P7	7	2	0	1	0	70	20	0	10	0
P8	2	8	0	0	0	20	80	0	0	0
P9	7	2	0	1	0	70	20	0	10	0
P10	8	2	0	0	0	80	20	0	0	0
P11	6	4	0	0	0	60	40	0	0	0

Source: Authors, (2024).

The data obtained is processed by multiplying each answer point with a predetermined score in accordance with the answer value score table. From the calculation results by multiplying each answer with a predetermined score, the following results are obtained:

Table 5. Questionnaire Data after processing

Code	Value (Amount * Grade)					Total	Total / User	%	Final Score
	A	B	C	D	E				
	*5	*4	*3	*2	*1				
P1	35	12	0	0	0	47	4,7	94	9,4
P2	15	20	0	4	0	39	3,9	78	7,8
P3	15	24	0	2	0	41	4,1	82	8,2
P4	15	24	0	0	1	40	4	80	8
P5	10	32	0	0	0	42	4,2	84	8,4
P6	20	20	0	2	0	42	4,2	84	8,4
P7	35	8	0	2	0	45	4,5	90	9
P8	10	32	0	0	0	42	4,2	84	8,4
P9	35	8	0	2	0	45	4,5	90	9
P10	40	8	0	0	0	48	4,8	96	9,6
P11	30	16	0	0	0	46	4,6	92	9,2

Source: Authors, (2024).

Discussion

The final score (average) of the User Acceptance Testing test is the number of % divided by 10. The range of values used are:

- Value % >= 90% then the value A is included in the Very Good category
- 80 <= % <= 89.99 then the value B is included in the Good category
- 70 <= % <= 79.99 then the value C is categorized as Good Enough
- 60 <= % <= 69.99 then the value of D is included in the Less category
- 50 <= % <= 59.99 then the value of E is included in the Very Poor category.

From the results of the User Acceptance Testing that was carried out seen from the average results, with an average value of 9, it can be concluded that this Information & Communication Technology Educational Game is Interesting, easy to understand, easy to operate, supports policies, helps / makes it easy, this application is good, good documentation, advanced application technology, error free and needs to be implemented.

V. CONCLUSIONS

More gaming research is required since teaching and curriculum creation should be evidence-based, particularly studies on the efficacy of how effectively programming games may be utilized to improve comprehension of scientific models in mathematics. There are clear impediments to the creation and innovation of instructional games. Small, scattered, and unambitious development programs are one of the issues. To have a large impact, the goods, whether they be instructional techniques games, or programming platforms, should be scalable. Common issues include a lack of investment in learning technology: even if there are good learning games, teacher competency and the availability of appropriate equipment may limit the use of computer games in schools.

VI. AUTHOR'S CONTRIBUTION

Conceptualization: Dedi Saputra.
Methodology: Dedi Saputra, Haryani.
Investigation: Dedi Saputra, Eva Meilinda.
Discussion of results: Dedi Saputra, Haryani, Eva Meilinda.
Writing – Original Draft: Dedi Saputra, Juniato Sidauruk.
Writing – Review and Editing: Dedi Saputra, Juniato Sidauruk.
Resources: Dedi Saputra.
Supervision: Haryani, Eva Meilinda.
Approval of the final text: Dedi Saputra, Haryani, Eva Meilinda, Juniato Sidauruk.

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