Development of an Adventure-Based Learning Game on the Topic of Temperature and Heat for Junior High School Students

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Abstract. It has successfully developed an adventure-based learning game on temperature and heat material for junior high schools that is valid and interesting. This research uses the Rowntree development model, which consists of a planning stage, development stage, and evaluation stage. The evaluation stage uses Tessmer's formative evaluation, namely self-evaluation, expert review, one-to-one evaluation, and small group evaluation. Data collection techniques used are walkthroughs and student responses questionnaire sheets. The results of the expert review obtained an average value of 95% with very valid criteria. The results of the one-to-one evaluation stage, students' responses to the use of game learning obtained an average value of 90% with very interesting criteria. Meanwhile, in the small group evaluation stage, students' responses to the use of game learning obtained an average value of 100% with very interesting criteria. Based on the results of these studies, it can be concluded that the adventure-based learning game on temperature and heat material for SMP that was developed is included in very valid and very interesting criteria.

Keywords: Game learning, adventure, temperature and heat

INTRODUCTION

Physics is part one of the natural sciences (science) that studies natural phenomena or events (Neizhela, 2015). Physics has a very important role in the development of science and technological progress (Sari, et al., 2013). Studying physics can be interpreted as an attempt to find reasons why and how events can occur (Mutmainnah, et al., 2017). Physics learning aims to form students' reasoning abilities which can be seen through the ability to think logically, systematically, and objectively to solve a problem (Neizhela, 2015). Several elements must be considered in learning physics, including curiosity, scientific methods, facts,

theories, and their applications (Mutmainnah, et al., 2017). Physics learning requires a material that can connect learning outcomes and previous student experiences to improve the learning process (Cardinot, 2019).

One of the basic materials in physics lessons is the material of temperature and heat. Temperature and heat are physical concepts that are often found in everyday life. This material learns about temperature, thermometer, expansion, change of state, heat and specific heat, and heat transfer. The material of temperature and heat has a fairly important role and is the basis for studying thermodynamics. However, the concept of heat is quite difficult for students to understand so they consider

physics lessons to be less interesting and boring. This is also caused by abstract physics concepts, invisible objects, and quite heavy mathematical concepts (Setiawan, 2019) and (Lestari, et al., 2014). In addition, the implementation of physics learning which is still carried out using conventional methods (lectures) causes a lack of student participation in the learning process. Some students are also unable to apply the material that has been learned by using it in daily activities. So, an easy, creative, fun learning method is needed by current technological developments to improve physics teaching and learning so that students are more enthusiastic about learning (Neizhela, 2015) and (Deta, et al., 2020). The development of information technology and the world of entertainment is growing rapidly so that our children prefer to watch soap operas, and movies, play games, the internet will become their teacher rather than listen to the teacher's lessons in class. Therefore, today's teachers are required to create interesting and entertaining learning so that they are not inferior to the increasingly sophisticated information technology and entertainment world (Nurseto, 2011). The young generation born in the 21st century is the internet generation. Millennials in this era are also known as the game generation. Millions of people have become users of digital games for both entertainment and education. The increasing popularity of games among children and adolescents has caused many educators to switch to using digital games as learning media in their classrooms, this is done to involve students during the teaching and learning process (Setiawan, 2019). Teaching using game media is referred to as Game-based Learning (GBL) or game-based learning (Setiawan, 2019).

A game is an interactive game that serves as entertainment and has an important role in the development of the human brain, such as helping to improve concentration and being able to solve problems quickly and well. This can happen because in a game various challenges must be solved appropriately and quickly (Rahmawati, et al., 2020). Game-based learning in the classroom continues to increase. Educators use games as a medium for learning physics and support positive changes in school curricula. This game-based learning method has been proven to support social development and encourage teamwork skills. The application of game-based learning is not a new idea because researchers and educators have been discussing games for learning in formal education since the 1960s (Cardinot, 2019).

Game-based Learning (GBL) refers to the use of games to support teaching and learning activities using a student-focused approach by incorporating learning content into games or games. This can lead students to develop and practice various skills (Cardinot, 2019). The use of games in teaching and learning practices currently also does not have significant obstacles due to changes in students' environmental perceptions. Students are used to using digital devices, both for entertainment, television, advertising, and other areas of life (Liu et al., 2020).

Games can be used in the field of education because they have several advantages, namely, they can turn abstract concepts into reality, make learning more fun and easy to understand, increase learning motivation, and strengthen the memory of subject matter (Rahmawati, et al., 2020). Educational games play a role in realizing active learning because they contain interactive elements to make learning more fun and able to encourage student participation in learning (Selvi, et al., 2018). Games or games have various types of genres, one of which is adventure games. Adventure games are software programs that create mock environments in which players will interact to solve challenges or problems in the game (Marzuki). Adventure games can develop the character and behavior of players to be in harmony with their social environment and increase students' motivation to achieve goals (Kristiadi, et al., 2019). However, adventure game-based learning media is still rarely developed, especially on temperature and heat materials. Therefore, this shows that learning media in the form of games can increase students' interest, motivation, and involvement in the teaching and learning process, as well as practice problem-solving skills (Liu, et al., 2020) and (Naimah, et al., 2019).

METHOD

The research method used is the development research method (Putri, 2018). Research development is the process to develop a new product or improve an existing product. The main purpose of development research is not to formulate or test theories, but to develop the best products for use in schools (Iskandar et

al, 2016). The development model that the researcher uses in this research is the Rowntree development model. Rowntree's development model consists of 3 stages, namely the planning stage, the development stage, and the evaluation stage (Putri, 2018).

At the planning stage, which is the initial stage, the researcher conducts a needs analysis in the form of teacher and student interviews related to physics learning, makes a storyline, and makes a design of learning materials. . In the development stage, researchers make flowcharts, character designs, initial menus, final menus, lose game designs, place designs, mini-game designs, game products export games to android and windows. The evaluation stage is the last stage, where the researcher evaluates the final product. At this stage, the researcher used Tessmer's formative evaluation which consisted of self-evaluation, expert review, one-to-one evaluation, and small group evaluation.

RESULTS AND DISCUSSION

Result

Result of the Planning stage
a. Needs Analysis

At this stage, a needs analysis of students is carried out on game learning on the topic of temperature and heat. Based on the needs analysis that has been carried out on physics teachers and several seventh-grade students of SMPN 15 Palembang with informal interview methods, the results show that it is necessary to develop creative and interactive learning media that is adapted to the times and technological advances that can increase students' interest in learning. . This is obtained from several statements by students who assume that physics subjects are less desirable because they are boring, this is because the physics concepts taught are abstract, many formulas and symbols are difficult to understand. Therefore, learning media is needed that is creative, interesting, easy to use, and can interpret a physics concept easily to understand. In addition, learning media that can be reached regardless of place and time are needed in today's era. This then encourages researchers to develop learning media based on game learning physics on the topic of temperature and heat for junior high school students. Based on the results

of an analysis of the 2013 curriculum at the education unit level and an analysis of the science syllabus for grade VII SMP, it was found that the appropriate competencies to be developed into game learning-based learning media were the topics of temperature and heat. The topic was chosen because the concept can be explained in various forms, such as verbal, visual, graphic, and mathematical. In addition, the topic is related to activities that are often carried out by the community. Temperature and heat are also materials that contain abstract concepts so that they can be presented in-game learning. Then the researcher finds out about the material to be discussed, arranges questions, and designs a storyline that fits the temperature and heat material**.**

According to the results of the needs analysis above, it can be concluded that there is a need for learning media that are creative, interactive, easy to use, and by the development of the times and the latest technology. This is the basis for researchers in developing adventure-based learning games on temperature and heat materials.

b. Storyline

The storyline in this learning game is that there is a boy where the child who is born with strange events such as all the planets in the solar system align, extreme weather, and heavy rain, then the child is named Ojan. Time has passed, and now Ojan has become a good junior high school student, devoted to his parents and happy to help others. The story begins when Ojan goes to school, but suddenly he is sent to a fantasy world by a mysterious person. This fantasy world is a land of education where there are monsters everywhere. Ojan's journey in the land of education begins by walking down the road to the palace of the land of education to meet the king of education so that he can be returned to his original world. In the middle of the journey, Ojan will meet monsters that block the road and he must answer the questions that the monsters ask to be able to pass the road to the palace of the country of education. After arriving at the palace, Ojan spoke to the king to immediately return to the world where Ojan came from, but the king made a condition for Ojan to help the education country where monsters appeared. The king asked Ojan to find the legendary book of physics that had been lost. The king gave three bodyguards who would accompany Ojan on his journey. The adventure

of the Ojan continues to find the legendary book of physics. The story ends.

c. Learning materials

Temperature material in the form of:

Figure 1. Difficulty Level 1 Material Temperature

This picture of the level 1 difficulty level of temperature material explains the basic temperature concept, namely, when your hand touches an ice cube what you feel, the answer is that your hand feels cold.

Figure 2. Difficulty Level 2 Material Temperature

Picture the level of difficulty level 2 of this temperature material to find out the various temperature scales, the answer to the question is Celsius.

Figure 3. Difficulty Level 3 Material Temperature

Picture the level 3 difficulty level of this temperature material to find out the various temperature scales, the answer to the question is Fahrenheit.

Figure 4. Difficulty Level 4 Material Temperature

Picture the level 4 difficulty level of this temperature material to find out the various temperature scales, the answer to the question is Kelvin**.**

Figure 5. Difficulty Level 5 Material Temperature

Picture the level of difficulty level 5 this temperature material to find out the various temperature scales, the answer to this question is Reaumur**.**

Figure 6. Difficulty Level 6 Material

TemperatureDraw the level 6 difficulty level of this temperature material to calculate the different temperature scales, the answer to the question is 250C.

Heat material in the form of:

Figure 7. Difficulty Level 7 Material Calorie

Picture the level of difficulty level 1 of this heated material to find out 1 cal (calories) how many joules, the answer is 4.2 joules.

Figure 8. Difficulty Level 8 Calorie Material

Draw the level 3 difficulty level of this heated material to calculate how much heat is needed to melt 400-gram ice with 80 cal/gram latent heat, the answer is obtained by the formula Q = m×L, Q = 400×80 = 32,000.
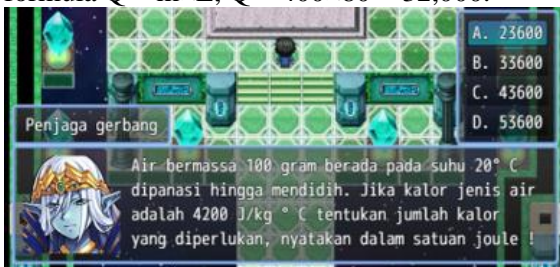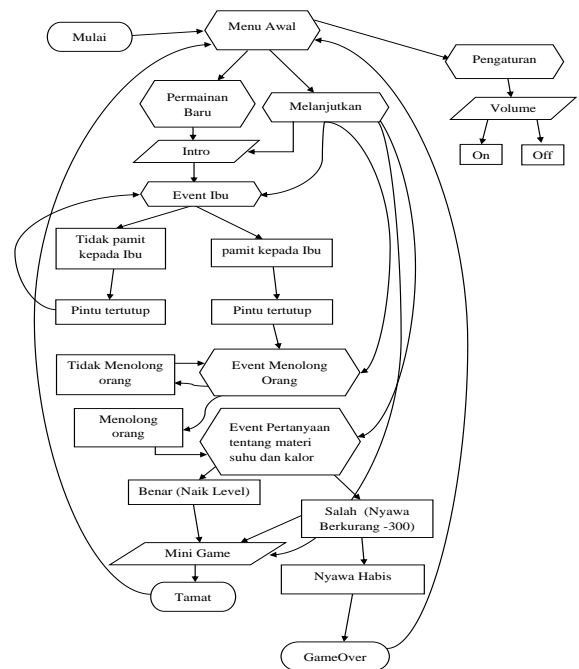

Figure 9. Difficulty Level 9 Material Calorie

Picture the difficulty level 3 of this heated material to calculate the amount of heat when water boils from water with a mass of 100 grams at a temperature of 20°C with a specific heat of 4200 J/kg, the answer is obtained using the formula Q = m×c×ΔT, Q = 100× 4,200×80 = 33,600.

Development Stage Results
Flowchart

A flowchart is a chart that shows the program flow or procedure steps in solving a problem (Jannah et al 2015). Here's the Flowchart for the adventure game Si Ojan:

Character Design

Game Character	Description
Figure10.Main Character	Figure 10 is the main character in this game. This character is a junior high school student who has an adventure in the land of education and must defeat many monsters and help others. The main character is named Ojan, this

	character will be used by players while playing in this game.

Figure 11.Supporting Figures 1

Figure 11 is the one supporting character in this game who acts as Ojan's mother and gives an event to open the door of the house.
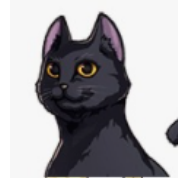

Figure 12. Supporting Figures 2

Figure 12 is the second supporting character in this game named Lili a little girl who lost her cat. The character gives an event to find the lost cat, Lili.
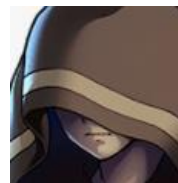

Figure 13. Supporting Figures 3

Figure 13 is the third supporting character in this game named Rachel, a junior high school student who is Ojan's friend. This character tells Ojan

	about where the cat Lili is.

Figure 14. Supporting Figures 4

Figure 14 is the fourth supporting character in this game named Meong who plays the role of a lost cat.

Figure 15. Supporting Figures 5

Figure 15 is a supporting character for five in this game. This character is very mysterious and this character is in charge of sending Ojan to a fantasy world, namely the land of education.

Figure 16. Supporting Figures 6

Figure 16 is a supporting character for six in this game whose name is Cio's grandmother who told Ojan to ask about the country of

education the owner of the food stall.

Figure 17. Supporting Figures 7

Figure 17 is a supporting character for the seven in this game, namely a food stall owner. The character tells Ojan everything about the state of education and the location of the palace of the state of education.

Figure 18. Supporting Figures 8

Figure 18 is a supporting figure of eight in this game whose name is Cio's grandfather. The character tells Ojan about the many monsters and the grave of the founder of the temperature in the land of education.

Figure 19. Supporting Figures 9

Figure 19 is a supporting character for nine in this game who acts like a monster named Kroco. The character gave an event to Ojan in the form of questions about the basic concepts of temperature and various kinds of temperature scales.
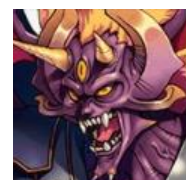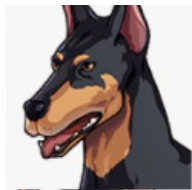

Figure 20. Supporting Figures 10

Figure 20 is a supporting character of ten in this game who acts like a monster who has the title of founding general of temperature. The character gave an event to Ojan in the form of a question about calculating the temperature scale to a different temperature scale.

boils.

**Figure 21.
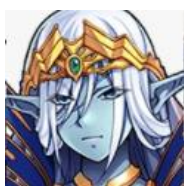Supporting
Figures 11**

Figure 21 is the eleven supporting characters in this game who act as stray dogs.

**F igure 22.
Supporting
Figures 12**

Figure 22 is the twelve supporting characters in this game who act as fire dragon race monsters. The character gives an event to Ojan in the form of a question about the heat of fusion of ice.

**Figure 23.
Supporting
Figures 13**

Figure 23 is the thirteen supporting characters in this game who act as gatekeepers to the land of education. The character gives an event to Ojan in the form of a question about calculating the amount of heat when water

**Figure 24.
Supporting
Figures 14**

Figure 24 is a supporting character for the fourteen in this game who acts as the king of the country of education. The character asks for Ojan's help to save the country of education by getting the legendary lost physics book.

**Figure 25.
Supporting
Figures 15**

Figure 25 is a supporting character of fifteen in this game whose name is Joko and likes to fight. The character acts as Ojan's companion to get the legendary book of physics.

Figure 26. Supporting Figures 16

Figure 26 is sixteen support characters in this game named Sakura and a high-level magician. The character acts as a companion for Ojan to get the legendary book of physics.

Figure 27. Supporting Figures 17

Figure 27 is a supporting character for the seventeen in this game, namely a little fairy who acts as a companion for Ojan to get the legendary book of physics.

c. Home Menu

Design Figure 28. Home Menu

The start menu is the game page that appears first. On the start menu, there are game titles, new game menus, resume menus, and settings menus. The title of the game is useful as information about the game to be played to the player. The new game menu is used by players to start a new game. The resume menu is used by players when they want to continue a game that has been previously played and saved. The settings menu is used to make settings regarding the game being played.
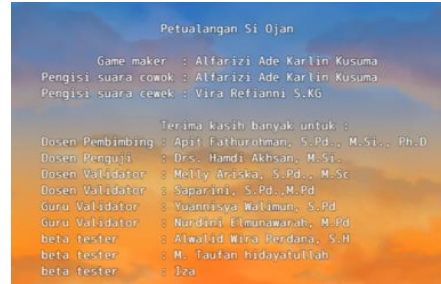
d. Final Menu Design

Figure 29. Final Menu

The final menu is the game page that appears when you have completed the entire series of Ojan's adventure games. In the final menu load the thank you display and the player will automatically return to the start menu.

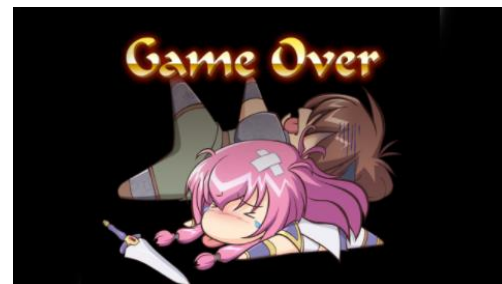**e. Design Lose in Game**

Figure 30. Display of Losing Game

The display of losing or game over will appear if the player cannot answer the question correctly, thus running out of life/energy in the game and ultimately losing.

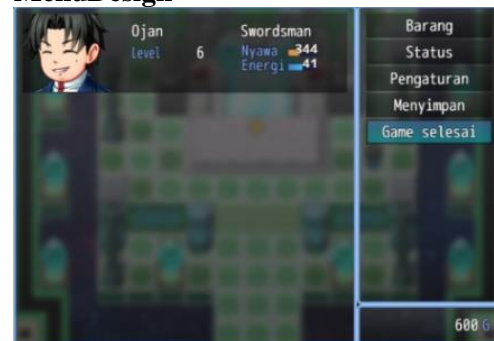**f. Player Information MenuDesign**

Figure 31. Display of Player Information

This player information menu serves to find out information related to life, level,

energy, items, status, settings, storage, and the game finished/start menu.

g. Place Design

The following are the designs of places in the adventure game Si Ojan:

Figure 32. Home and School Design

The design of the house uses various design assets such as bedrooms, kitchens, living rooms, and living rooms. The characters in the house design are Ojan and Ojan's mother.

The school design uses various design assets such as school buildings, school parks, vehicle parking lots, and roads. The characters in the school's design are Lili, a cat, a mysterious person, and Rachel.

Figure 33. Market Design

The market design uses various assets such as fruit markets, and tents. The character in the house design is Cio's grandmother.

Figure 34. Restaurant Design

The design of the restaurant uses various assets such as a place to eat and a piano. The character in the design of the house is the owner of the restaurant, Cio's grandfather.

Figure 35. Forest Design

Forest design uses various assets such as trees, rivers, and bridges. The characters contained in the design of the house are four monsters, Kroco monsters.

Figure 36. Palace Design

The design of the palace uses various assets such as the king's room, and the royal palace of education. The characters in the palace design are palace guards, kings, Jaka, Sakura, and fairies.

h. Mini Game Design

Figure 37. Moving Puzzle Challenge

The design of this mini-game is a small game where you have to move the ground ball that is blocking the road in the following way:
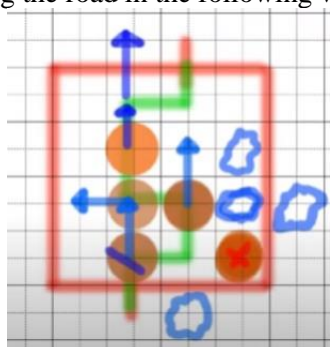

Figure 38. Puzzle System Calculation

The puzzle game calculation system uses a method by takes into account the ground balls that have been placed so that players can pass the event.

i. Export Game to Android and Windows

Export games to android using the android studio application using the c/c++ programming language as shown below:
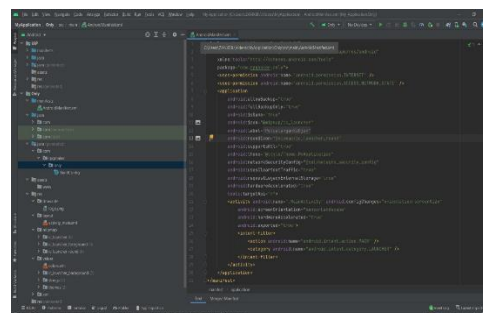

Figure 39 Android Studio Program

Meanwhile, export to windows has been provided by RPG maker mz itself.

Discussion

a. Expert review

Expert review is the evaluation or assessment stage by the validator and aims to assess the validity of the games that have been made. In this expert review stage, the assessment was carried out using a Likert scale, and suggestions were collected on aspects of content, learning, and media from three Physics Education lecturers, FKIP UNSRI, and two teachers at SMPN 15 Palembang. The results of the assessment of the game can be seen in the table 1.

Table 1. Results of the Validation of Si Ojan's Adventure Game at the Expert Review Stage.

Aspect	Indicator	Amount Score
Content	The material presented is in accordance with the curriculum	24
	The material presented is in accordance with competency standards	25
	The material presented is in accordance with the abilities of students	25
	Material depth	21
	Clarity of the content of the material presented	23
	HVA Percentage 94%	94 %
Learning	Clarity of study instructions (use of media)	24
	Ease of understanding material	23
	The carrying capacity of the media to help learning	25
	HVA percentage	94 %
Media	The arrangement of pictures and illustrations as an example	24
	Interesting illustrations and pictures	25
	Illustrations and communicative images	23
	The unity of conformity between the image and the material	22
	Use of font or letter type	25
	Font size	25
	Font color selection	25
	Background color selection	24
	language used	25
	The level of ease of use of games	24
	HVA percentage	97 %

Table 2. Recapitulation of Validation Results of SiOjan'sAdventureGame

Aspect	HVA Percentage	Category
Content	94%	Highly Valid
Learning	96%	Highly Valid
Media	97%	Highly Valid
Mean Score	95%	Highly Valid

Based on the results of the expert assessment from the table, it was found that the percentage using the HVA formula at the expert review stage for the content aspect was 94%, the learning aspect was 96%, and the media aspect was 97% with an average of 95%, so the result was very valid. The assessment is also accompanied by comments and suggestions aimed at improving the game's shortcomings.

b.One-to-One Evaluation

This stage is the evaluation or assessment stage which aims to assess the attractiveness of the learning game that has been made. In the one-to-one evaluation stage, the assessment was carried out by three seventh-grade students from SMPN 15 Palembang who had studied temperature and heat. It aims to obtain positive assessments from students of the adventure-based learning games that have been played.

Before students give an assessment, the researcher first provides game learning applications to students. After the students finished the game, the researcher gave a questionnaire sheet to the students directly to get the students' opinions on the games they had played. The results of the student's assessment of the game at this stage can be seen in the table 3.

Table 3. Student Responses in the One-to-One Evaluation Stage

Respondents	Y.S	A	A.A	Score
Are you interested in learning physics after playing this game?	1	1	1	3
Were the questions in the game easy?	1	0	1	2
Did you enjoy learning about temperature and heat using this game?	1	1	0	2
Would you be interested in playing this game again?	1	1	1	3
Did you understand the story presented in the game?	1	1	1	3
Is this game suitable for teaching temperature and heat?	1	1	0	2
Was the graphic quality of the game good?	1	1	1	3
After completing the final level of the game, can you say that physics is not scary?	1	1	1	3
Did your interest in learning physics increase after playing this game?	1	1	1	3
If there is a sequel to this adventure game, would you want to play it?	1	1	1	3
Total Questionnaire Score	10	9	8	27
Maximum Questionnaire Score				30
HEOS Percentage				90%
Category				Very Interesting

According to the assessment of the students at this stage, it was obtained that the percentage obtained using the HEOS formula was 90% and was categorized as very interesting. Furthermore, the game will be tested at the small group evaluation stage.

d) Small Group Evaluation

This stage is the final assessment or evaluation stage of the game that has been previously tested at the expert review and one-to-one evaluation stages. At this stage, the game was piloted in a group consisting of 9 grade VII junior high school students. The researcher directs each student to try out game learning. After playing the learning game, students were given a questionnaire sheet for student responses by the researcher directly aimed at obtaining student responses to the learning game that had been played. The following are the results of student assessments shown in the table 4.

Table 4. Student Responses at the Small Group Evaluation Stage

Question	Respondent									Amount score
	A,G	D	I.R	T.Y	E.S	A.R	S	D.R	C.E	
1	1	1	1	1	1	1	1	1	1	9
2	1	1	1	1	1	1	1	1	1	9
3	1	1	1	1	1	1	1	1	1	9
4	1	1	1	1	1	1	1	1	1	9
5	1	1	1	1	1	1	1	1	1	9
6	1	1	1	1	1	1	1	1	1	9
7	1	1	1	1	1	1	1	1	1	9
8	1	1	1	1	1	1	1	1	1	9
9	1	1	1	1	1	1	1	1	1	9
10	1	1	1	1	1	1	1	1	1	9
The total score of the questionnaire assessment										90
The maximum total score of the questionnaire is										90
HEOS Percentage										100 %
Very category										Very Interesting

Based on the assessments of the students shown in the table, it was found that the percentage using the HEOS formula at this stage is 100% and if it is converted it can be categorized that adventure-based game learning on the topic of temperature and heat is included in very interesting criteria so that the resulting product is very valid and interesting.

Product Advantages and Disadvantages

Based on the description of the results of the research discussion, game learning-based learning media on the topic of temperature and heat for junior high school students has several advantages and disadvantages, as follows: a) Advantages: (1) Learning media based on game learning can increase students' interest in learning because the material is packaged interestingly; (2). Game learning-based learning media is more efficient because it can be accessed online anywhere and anytime so that students can also learn independently; (3) . Learning using learning media based on game learning has its unique side because it is still quite rarely used in teaching and learning so that it can attract more students' interest in learning. b) Disadvantages: (1). Requires subject teacher skills to create learning media based on this learning game and requires a computer with a minimum of Intel core 4 and 8GB RAM to run the RPG maker MZ application; (2) Students need a minimum mobile phone with Snapdragon 636 specifications, 3GB RAM, and an Android 5.0 or lollipop system.

CONCLUSIONS AND SUGGESTIONS

The research on the development of game learning-based learning media for junior high school students has yielded significant results. Firstly, it can be concluded that the learning media based on game learning on the topic of temperature and heat is very valid, based on the expert review results on aspects of content, learning, and media with an average value of 95%. Additionally, this game learning media on the topic of temperature and heat has been found to be very interesting based on the responses from students in using this learning media at the one-to-one evaluation stage and the small group evaluation with the percentage values of 90% and 100%, respectively.

Based on these findings, it is recommended that further research is conducted on the development of game learning using the same or different themes. This will allow for a wider range of topics to be explored and for the effectiveness of game-based learning to be further evaluated. Additionally, research on different types of games, such as simulations, sports games, action games, etc. should be conducted to assess the effectiveness of these different game types in facilitating learning.

Finally, it is recommended that further research be conducted at the field test stage to assess the effectiveness of the learning media in a real-world setting. This will provide a more accurate assessment of the effectiveness of the learning media and allow for any necessary modifications to be made. Overall, the findings

of this research suggest that game-based learning can be a very effective approach to learning and that further research in this area is warranted.

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