Southeast Asian Journal of Islamic Education
Volume 05, No. 01, December 2022
E-ISSN: 2621-5861, P-ISSN: 2621-5845
https://doi.org/10.21093/sajie.v4i2.5512

Development of Educational Game-Based Learning Media in Natural Science Subjects at Madrasah Ibtidaiyah Jayapura

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Article History:

Received: December 29th, 2022 *Accepted: January 23rd, 2023* *Published: January 25th, 2023*

Abstract

This research aimed to address the issue of educational technology in madrasah ibtidaiyah by producing an educational game-based learning media in the field of natural science in MI in Jayapura, Papua. The development method used in this research was the modified 4D Thiagarajan model. This research consisted of three stages: Define, Design, and Develop. The educational game-based learning media, named GALAKSI Application, was evaluated by validators to determine the feasibility of the learning media to be used in MI. The instrument used was a checklist questionnaire. The data obtained was qualitative data that was converted into quantitative data and then tabulated and analyzed descriptively to determine the quality of the developed product. The research results show that the educational game-based learning media GALAKSI for natural science subjects has been developed based on the assessment of validators. The assessment results show that the aspect of display quality obtained a percentage of 85%, the aspect of software engineering got a percentage of 81%, the aspect of curriculum obtained a percentage of 82%, the aspect of the material presentation got a percentage of 95%, the aspect of implementation obtained a percentage of 97%, the aspect of evaluation obtained a percentage of 93%, and the aspect of language obtained a percentage of 92%. Based on these data, it is classified as very good (SB). The results show that the GALAKSI Application educational game-based learning media can be used for self-learning by students.

Keywords: educational game, learning media, Madrasah Ibtidaiyah, natural science subject

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Citation: Mukti, F. D. (2022). Development of Educational Game-Based Learning Media in Natural Science Subjects at Madrasah Ibtidaiyah Jayapura. *Southeast Asian Journal of Islamic Education*, *5*(1), 81-94. https://doi.org/10.21093/sajie.v4i2.5512

A. Introduction

During the pandemic, there needs to be distinctive and effective activities in education so that the role of technology can be an alternative to enhance learning activities. Technology in Indonesia, based on its development level in the world according to the International Telecommunication Union (ITU), has an ICT Development Index (IDI) ranking of 108 out of 167 countries in the world (Sanou, B., 2015). Based on the Kominfo research in 2018, technology is used for E-learning 2.8% and playing games 24.5%. The complexity of access problems during the Covid-19 pandemic, clear boundaries of space and distance in physical spaces such as education in Papua instantly switches to a space that no longer recognizes space and distance or even time limitations. Social, moral, intellectual, and technological habits become essential points of active roles in responding to the transformation in education. Challenges will become opportunities if this situation catalyzes educators' creativity (Wandik et al., 2021).

Based on the data above, education dynamics in Papua are still highly complex. Therefore, the pandemic requires educators to be more creative in using technology, and learning needs to be integrated with the culture that can be accessed flexibly in online learning. This follows government recommendations that during the pandemic, the teaching and learning process is conducted at home through online or distance learning to give meaningful experiences for students (Dewi, 2020).

If learning is done ineffectively and online learning is done continuously, it will cause boredom. Repeated boredom will have an impact on fatigue. One of the things that cause this condition is online content being theoretical and not allowing students to practice and learn effectively (Dhawan, 2020; Saxena et al., 2021). This will result in the material absorbed by students not being optimal, in addition to the abilities of the teacher and students in using the internet, which still needs to be improved. Because of this, online learning will not be effective if done continuously (Dewantara & Nurgiansah, 2020; Heryan, 2021; Khowim & Rahmawati, 2022; Nursafitri et al., 2022; Patrama & Nugroho, n.d.; Ramopoly & Baka, 2021; Rara et al., 2021; S. Wulandari et al., 2021).

Based on the explanation above, educational game-based technology is greatly needed to be developed because, in Papua, it is still relatively difficult to obtain relevant learning media. Elementary school/madrasah ibtidaiyah students quickly get bored with online learning and have a high interest in games, so this technology is expected to be a practical alternative in enhancing their understanding of natural science subjects in elementary school/madrasah ibtidaiyah. In addition to the above problems, there are other problems, such as a lack of human resources who are experts in educational technology in madrasah ibtidaiyah in Papua and a lack of funding for the development of educational technology in madrasah ibtidaiyah in Papua. This can cause less effectiveness and efficiency in applying technology in learning, so it needs more practical technology to facilitate learning (Sumule et al., 2022; Yusuf & Widyaningsih, 2020). The benefits of visualization and interaction that can be optimized in the world of education are greatly needed to enhance students' understanding of learning (Bahar, Y., N., 2014). Based on that understanding, the research focused on the development of Educational Game-Based Learning Media in Natural Science Subjects at Madrasah Ibtidaiyah Jayapura.

B. Literature Review

This research aimed to avoid duplication by reviewing relevant previous studies and focusing on the research undertaken. Nila Sari and Indri Anugraheni carried out research on "Development of Android-based Learning Media in Theme-based Learning in Class IV, Theme 6, Subtheme 1 in Elementary School". This research was carried out to find out the feasibility and stages of designing android-based learning media in theme-based learning in class IV, theme 6, and subtheme 1 in elementary school. The research employed Research and Development (R&D). The data were collected using an instrument sheet to validate material and media by two material experts and two media experts. The data were analyzed using descriptive qualitative and percentages, with the results as follows: the validation results of content experts got a percentage of 96.4% with a very high interval, and the assessment results of media experts got a percentage of 91.7% with a very high interval. Based on the validation results of material and media experts, the development of android-based learning media in theme-based learning in class IV, theme 6, and subtheme 1 in elementary school are declared valid and suitable for implementation. (Donna et al., 2021; Nila Sari, 2021; Prabawa & Restami, 2020; Safitri, 2020).

The similarity of this research is the learning conducted in elementary school or equivalent to madrasah ibtidaiyah and a science subject. The difference in this research is that the operating system used is still a simple game, such as sorting objects. Still, in the development of this research, it is an adventure-based system that provides a complete interaction in learning. The difference is also seen in the focus of the grade, class IV, while in this research, it is in class V. The interface of the research application is also straightforward, but the development interface designed this time is designed uniquely, so the learning concept is playful and interactive.

Fahrur Rozi and Ayunda Kristari conducted development research at State Senior High School 1 Tulungagung to describe the steps of designing an android-based educational game application and the feasibility level of the android-based educational game application developed. This development research was made using the Prototype model, namely Listening to customers, Designing and creating a Prototype, and Testing the Prototype. The subjects in this research were students of class XI in the Natural Sciences at State Senior High School 1 Tulungagung. The data were collected using observation, interview, and questionnaire techniques. The instrument for testing this product was based on four testing stages based on functional suitability, portability, usability, and performance efficiency aspects by ISO 25010. The study results showed that the percentage of the feasibility of the average value in media expert testing was 100% which was included in the very feasible category, and material expert was 98%, which was included in the very feasible category. In the portability testing, the developed educational game application can be installed and uninstalled on various OS versions. In usability testing, it received 81%, which was included in the very feasible category. In performance efficiency testing, this physics game application does not consume large memory and CPU, so it does not disturb the performance of other applications (Rozi & Kristari, 2020).

The similarity of this research is education-based game learning. The difference from this research is that the operating system is still a simple game, yet to implement a zone system. Still, the development of research conducted by the researcher is an adventure that provides a complete interaction in learning and has

several different zones so that children do not get bored. The difference is also at the high school level, while this research is at the madrasah ibtidaiyah level. The interface on the research application is also very simple, but the development interface done this time is designed uniquely, so the concept of learning is playing while learning.

Dian Wulandari conducted research to develop a game-based learning media, specifically a "Wheel of Fortune" game, to improve students' understanding of thematic learning in grade 4 of State Islamic Elementary School 4 in Muaro Jambi, to determine the validity and effectiveness of the media, and to identify the difference in students' understanding before and after using the media. The research result was a learning media product in the form of a game of chance wheel developed to improve students' understanding through the concept of learning while playing. The research showed that the game of chance wheel learning media developed using the Borg and Gall model was valid. The level of validity of the game of chance wheel as a learning media based on the assessment: (1) thematic learning experts obtained a score percentage of 89.23% with the criteria of very valid, (2) media and design experts obtained a percentage of 90.76% with the criteria of very valid, (3) material experts obtained a percentage of 92.85% with the criteria of very valid. The media's validity assessment by a small group of students obtained a percentage of 96.33% with the criteria of very valid, and the field test obtained a percentage of 96.2% and had an effective level of 93.33% (Diartha et al., 2019; Firdaus & Yermiandhoko, 2020; Jihan et al., 2019; D. Wulandari, 2019).

The similarity of this research is education-based game learning. The difference in this research is that the educational game developed is outside the form of an application and is only manual. Still, in the research development conducted by the researcher, it is an education-based game on the Windows operating system that provides complete interaction in learning and has several different zones to prevent boredom. The difference is also seen in the focus on the MI level of the fourth grade, while in this research, it is at the MI level of the fifth grade. The media game appearance in the previous study is also very simple. Still, the development interface conducted this time is designed uniquely so that the concept of learning is playing while learning.

According to the research of I Kadek Wisnu Nata, the learning process of Science has yet to be carried out well. This is due to students needing help understanding the material. The research aimed to develop interactive multimedia learning media for Science subjects in primary schools. The teaching material expert assessment scored 94.6%, with a very good category. The expert assessment of learning design scored 87.5%, with a good category. The learning media expert assessment scored 94.0%, with a very good category. The individual evaluation scored 91.03%, with a very good category. The small group assessment scored 88.68%, with a good category. Based on the scores obtained, the interactive multimedia learning media in the Science subject with the DDD-E model is very good. This research implies that interactive multimedia learning media can help students understand Science independently (Nata & Putra, 2021).

The similarity of this research is the learning done on science subjects in elementary school. The difference from this research is that the operating system used is still in the form of material and questions. Still, in the development of the research conducted by the researcher, it is an educational adventure game that provides a complete interaction in learning and has several different zones so that

children do not get bored. The difference is also seen in the interface of the research application is very simple. Still, the development interface done in this research is designed uniquely so that the concept of learning is learning while playing.

Based on the previous research above, developing educational game-based learning media in the science subject in Madrasah Ibtidaiyah in Jayapura is critical. The product produced can present interactive activities and has a unique game design concept, thus making it possible to have different results from the previous research. Developing educational game-based learning media in the science subject in Madrasah Ibtidaiyah in Jayapura still needs further research with more effective products. The research above is relevant to this research because the results of the research above can provide information and an overview to the researcher about the products used and the ways of making and applying them as a learning media.

C. Method

This research was Research and Development (R&D). The purpose of this research was to produce a product or improve it, then follow up by testing the feasibility of a product (Sugiyono, 2009). In this research, the researcher developed an Educational Game-Based Learning Media for Science subjects in Madrasah Ibtidaiyah in Jayapura. The development model in this research is procedural, consisting of descriptive procedures and following applicable syntaxes, resulting in a product (Tim Puslitjaknov, 2008). The development used in this research follows the 4-D model (Define, Design, Develop, and Disseminate) (Trianto, 2013), However, the level is limited to the Develop stage in the limited trial. The development scheme can be seen in the following figure.

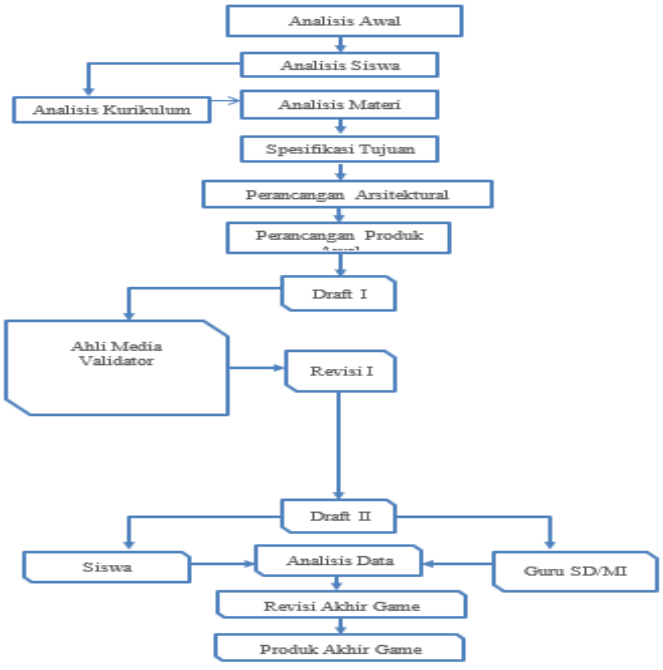

Figure 1. Media Development Design

1. Define Stage: This Stage begins with analyzing various aspects, including:
   a. Initial-end analysis serves in viewing the fundamental problems.
   b. Student character analysis aims to see the knowledge and utilization in learning.

c. Curriculum analysis seeks to determine the appropriateness of the curriculum used and then adjust it in a structured format of indicators.
d. The material analysis aims to adjust the media that will be developed

2. Design Stage Activities in this Stage include designing media and then validating the product created.
3. Develop Stage in the Development Stage, the media's feasibility is evaluated. Media feasibility is reviewed through evaluations by peer reviewers and validators, and then a limited trial is conducted.

The data analysis technique used in this development is as follows. The analysis used was quantitative and qualitative descriptive. The obtained qualitative and quantitative data were used to improve the media. The data analysis technique for developing educational game-based learning media in Science subjects at Madrasah Ibtidaiyah in Jayapura city was conducted as follows. Quantitative data as product feasibility data, were obtained from questionnaires (assessment from experts and reviewers).

1. Changing the assessment of experts and reviewers from a qualitative form to a quantitative form by following scoring rules.

Table 1. Scoring provisions (Widoyoko, E., P., 2009)

Category	Score
VG (Very Good)	5
G (Good)	4
A (Adequate)	3
L (Less)	2
VL (Very Less)	1

2. Calculating the average score of each aspect obtained by the formula (Mundir, 2013):

$$\tilde{\chi} = \frac{\sum \chi}{n}$$

Explanation:

$\tilde{\chi}$ = Average - the calculation of the average that is sought
$\sum \chi$ = Total score
n = The number of subjects

3. Changing the average score of the quantitative assessment aspect obtained into a qualitative value according to the following assessment criteria (Prastyo, S., 2017)

Table 2. Score Conversion Based on the Ideal Criteria Formula

NO	Score Range (i)	Category
1	$X > M_i + 1.80\ SBi$	Excellent
2	$M\ i + 0.60\ SB\ i < X \leq M\ i + 1.80\ SB_i$	Good
3	$M\ i - 0.60\ SB\ i < X \leq M\ i + 0.60\ SB_i$	Enough
4	$M\ i - 1.80\ SB\ i < X \leq M\ i - 0.60\ SB_i$	Less
5	$X \leq M_i - 1.80\ SBi$	Very Less

Explanation:
M_i = Ideal average
M_i = $\frac{1}{2}$ x (Maximum score + ideal minimum score)
SB_i = Ideal standard deviation
M_i = ($\frac{1}{2}$) x ($\frac{1}{3}$) x (Maximum score + ideal minimum score)
X = Maximum score

The formula in table 2 explains the guidelines for converting quantitative values reaching five categories into qualitative categories as a basis for concluding the feasibility of learning media. If Mi and SBi values are substituted in the formula in table 3, then the conversion guidelines will be obtained as follows:

Table 3. Convert the Actual Score to a Scale of Five (Widoyoko, E., P., 2009)

NO	Score Range (i)	Category
1	X > 4,2	4,21- 5,00
2	3,4 < X ≤ M_i + 4,2	3,41- 4,20
3	2,6 < X ≤ 3,4	2,61 – 3,40
4	1,8 < X ≤ 2,6	1,81 – 2,60
5	X ≤ 1,8	0 – 1,80

Explanation:
X = Current score
M_i = Ideal average
= $\frac{1}{2}$ (Maximum score + ideal minimum score)
= $\frac{1}{2}$ x (5 + 1)
SB_i = Ideal standard deviation
= $\frac{1}{6}$ (Maximum score - ideal minimum score)
= $\frac{1}{6}$ + (5-1)
= 0,67

4. Calculating the percentage of eligibility for the Acquisition Score

$$\text{Percentage of eligibility (\%)} = \frac{The\ total\ score\ obtained}{Maximum\ score\ amount} \text{ x } 100\%$$

Percentage results provide answers for the feasibility of the aspects being studied. This scale considers the range of percentage numbers. The expected maximum value is 100%, and the minimum is 0%. The content of media feasibility categories is as follows (Arikunto, S., 2013).

Table 4. Eligibility Category

NO	Percentage (%)	Category
1	< 21%	Very Unworthy
2	21% - 40%	Unworthy
3	41% - 60%	Adequate
4	61% - 80%	Worthy
5	81% - 100%	Extremely Worthy

D. Findings and Discussion

This research is a Research and Development (R&D), which is research used to produce a specific product or to improve an existing product and continue to test its effectiveness (Dwiqi et al., 2020; Ilsa et al., 2021; Mashuri, 2020; Ramdani et al., 2020; Wahyugi & Fatmariza, 2021). The product developed is an Educational Game Media for Science Subjects for Fifth Grade Students in MI Jayapura. The development model used was procedural and descriptive and showed the steps that must be followed to produce a product. The development procedure used was to follow the 4-D model Define, Design, Develop, and Disseminate, but the stages were limited only to the Develop stage in the limited test.

The Define stage consisted of the initial-end analysis stage, student character analysis, curriculum analysis, and material analysis. The preliminary analysis aimed to identify the fundamental problems that cause the need to develop learning tools. The fundamental problem that needs to be solved is the limitations of science learning media in terms of flexibility, the profitability of the devices used, the rapid development of Windows OS technology, and the low grades of class V in the science subjects at MI Jayapura. The next stage was the analysis of student characteristics, which aimed to determine students' cognitive development level. According to Piaget's theory, SD/MI students are at the stage of concrete operational development. Children think based on real/concrete experiences. However, the ability to add, subtract, shrink, and classify has evolved with simple multiplication and division. The ability to think a little abstractly must always be preceded by concrete experience. Elementary-aged children still really need concrete objects to help develop their intellectual abilities.

At the cognitive development stage of elementary school-age children, children can think logically (Hyun et al., 2020; Mifroh, 2020; Nabila, 2021; Nainggolan & Daeli, 2021; Nuryati & Darsinah, 2021), understand conversational concepts, organize objects into classifications, and remember, understand and solve concrete problems. Children at this stage like to make shaped objects (Herliana & Anugraheni, 2020), manipulate objects and make mechanical devices, think more dynamically, and think backward in a structure or context. At the end of this stage, children give deductive and inductive reasoning. However, many still view successive examples of a general principle as unrelated, for example, in the sequential steps of proving mathematical induction.

The analysis phase of student characteristics provides information that is then used to prepare the teaching material. Curriculum analysis was carried out to provide teaching materials developed in educational game-based learning media because it is possible that not all teaching materials are suitable to be developed in the form of game-based learning media. Another factor that was taken into consideration was the results of the percentage of student's mastery of science materials, then based on consideration of the lack of media in the science field and also based on recommendations by the teacher concerned.

The design stage was the design stage of the GALAKSI Application prototype. At this stage, the devices needed in the design were as follows:

1. Hardware requirements meet in building the system
    a. Laptop Aspire E1-410 with Processor Intel(R) Celeron(R) CPU N2820 @ 2.13GHz (2 CPUs), ~2.1GHz
    b. RAM capacity of 2048 MB
    c. Graphic Card (VGA) Intel(R) HD Graphics

2. Software requirements meet in building the system
   a. Windows Pro 10 Ultimate 64-bit Operating System
   b. Autodesk 3DS Max 2014 64 bit
   c. CorelDraw X5 64 bit
   d. Macromedia Flash
3. Minimum hardware and software requirements meet to run the system
   a. PC with the minimum operating system of Windows 8
   b. PC with 4 GB of RAM

After preparing the required equipment, the design phase included designing the application building, consisting of interface design and menu design for the GALAKSI application. The design carried out has criteria of being easy to operate by hand, attractive and straightforward design, and appropriate and consistent use. In the development stage, an assessment was carried out by a validator. A validator/class teacher carries out the evaluation. The validator has competency in their respective field, thus meeting the qualifications set by the developer, so the validator meets the requirements to assess the GALAKSI application learning media. This is because the GALAKSI application must have good quality and be accountable regarding appearance quality, software engineering, curriculum, material presentation, implementation, evaluation, and language. So, the results of the assessment showed that the aspect of appearance quality obtained a percentage of 85%, the aspect of software engineering obtained a percentage of 81%, the aspect of curriculum obtained a percentage of 82%, the aspect of the material presentation obtained a percentage of 95%, the aspect of implementation obtained a percentage of 97%, the aspect of evaluation obtained a percentage of 93%. The aspect of language obtained a percentage of 92%. Based on these data, it is classified as very good (SB). The evaluation can be seen in Table 5.

Table 5. GALAKSI Application Rating

NO	Aspects of Criteria	Indicators	Max Score	Ideal percentage (%)	quality
1	Display Quality Aspects	1,2,3,4,5	25	85%	SB
2	Software Engineering Aspects	6,7,8	15	81%	SB
3	Curriculum Aspects	9,10	10	82%	SB
4	Aspects of Material Presentation	11,12,13	15	95%	SB
5	Aspects of Execuliarity	14,15	10	97%	SB
6	Evaluation Aspects	16,17	10	93%	SB
7	Language Aspects	18,19	10	92%	SB

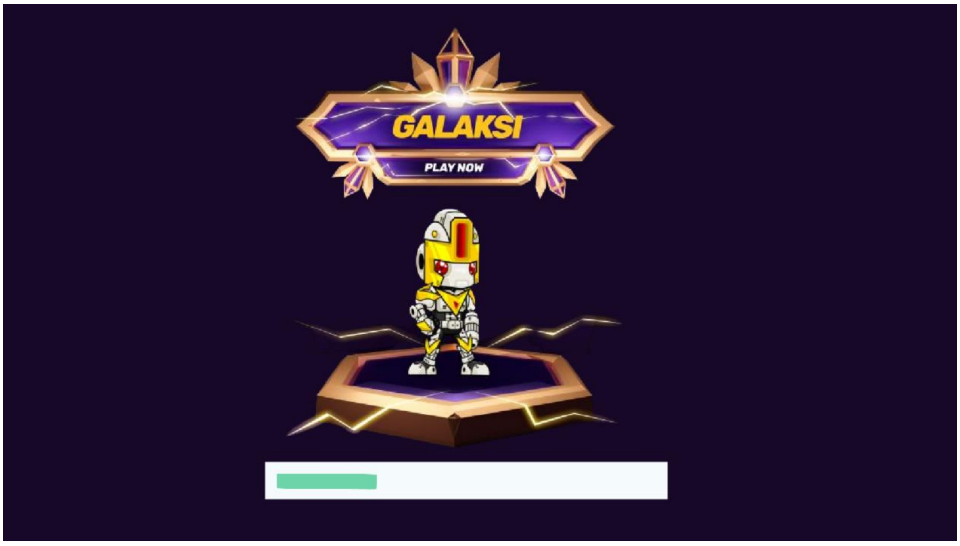

Figure 2. Display of Splash Screen

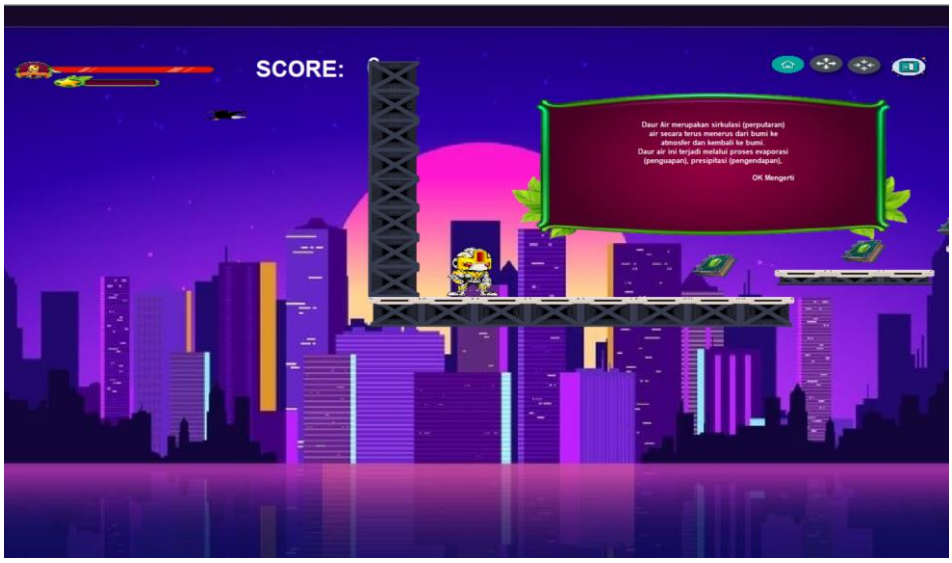

Figure 3. The appearance of materials in the game

Based on the discussion above, the result of the development of this learning media is the GALAKSI learning application media, which can be operated on a Windows OS Laptop device with a multi-platform game operating system, which is a combination of the arena concept. Here is how to use the game learning media:

1. Install the GALAKSI learning media application on a Windows OS laptop.
2. Run the application, then click on the play menu for the GALAKSI application.
3. Then, the GALAKSI application menu will appear.

Based on this research, game learning media has the following advantages and disadvantages:

1. Advantages of the GALAKSI Application
   a. Media can be used anytime and anywhere by students
   b. Presentation of the material allows students to learn independently
   c. This learning media motivates students to learn
   d. Learning is not monotonous

e. Learning is more interesting because it is adapted to the era in the form of educational games.
f. Accelerating student understanding
g. Allowing students to work together in learning.

2. Shortcomings of the GALAKSI Application
   a. It requires a Windows OS laptop device
   b. It requires IT skills to create the GALAKSI Application and understanding some programming languages
   c. This can lead to students' tendency to play on laptops continuously
   d. It limits students' activities for physical movement.

E. Conclusion

Based on the development research that has been conducted, it produces an educational game-based learning media called the Galaksi Application, GALAKSI continuously is an acronym for Science Technology Literacy Game. Employing the 4D model, the stages in this research are still limited only to the Develop stage in limited trials. The results showed that the GALAKSI application learning media for science subjects developed based on the validator's assessment of the results of the evaluation showed that the display quality aspect obtained a percentage of 85%, software engineering aspects obtained a percentage of 81%, curriculum aspects received a percentage of 82%, material presentation aspects obtained a percentage 95%, the implementation aspect has a percentage of 97%, the evaluation aspect has a percentage of 93%, and the language aspect has a percentage of 92%. Based on these data, it is classified as having a very good category (SB). Based on the results, the GALAKSI Application learning media can be used for independent student learning.

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