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Development of Interactive Learning Multimedia Using the Drill & Practice Model on Scientific Literacy of Junior High School Student

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Abstract. The purpose of this study was to develop interactive learning multimedia using the drill & practice model on the scientific literacy of junior high school students which had validity, practicality, and potential impact. This study used Frey and Sutton's development research model which combined formative evaluation from Tessmer. This study was tested on junior high school students. Data were obtained from interviews, documentation, walkthrough, questionnaires, and tests. Based on the expert reviews, this interactive learning multimedia was declared very valid with an average score of 0.99 (the maximum score is 1). In the one-to-one evaluation, it was declared very practical with an average score of 0.83 (the maximum score is 1). In the small group evaluation, it was declared very practical with an average score of 3.34 (the maximum score is 4). In the field test, the average classical test result was 62.18 with a good category. From the research data, it can be concluded that interactive learning multimedia using the drill & practice model on the scientific literacy of junior high school students was feasible to use in learning. The research results imply that students can understand science with the help of interactive multimedia learning which can have an impact on students' scientific literacy.

1. Introduction

PISA or Programme for International Student Assessment is conducted by the OECD aims to evaluate the 15-year-old student to know knowledge and skill [1]. This assessment is carried out every three years of sustainably. The focus of the assessment is reading literacy, mathematical literacy, and scientific literacy. The assessment in PISA reflects the fact that modern economies reward individuals not for what they know, but for what they can do with what they know in new situations [1]. PISA measures the knowledge and skills of students around the world.

Indonesia implements the 2013 Curriculum which is based on a scientific approach because of the importance of PISA results for students [2] [3]. By implementing this curriculum, it is hoped that it can increase the value of PISA. PISA results can become a basis for a country to determine certain policies. Policymakers use PISA result to assess student about the knowledge and skills compared with the other countries, establish benchmarks for improvements in the education, and understand the relative strengths



and weaknesses of education systems [1]. PISA is unique because of policy orientation, innovative concept of "literacy", relevance to lifelong learning, regularity, and breadth of coverage [4].

The quality of science education can be seen from the results of PISA [5]. As previously known, one of the domains measured in PISA is scientific literacy. Based on the 2015 PISA definition that scientific literacy is the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen [6]. PISA 2015 focuses on scientific literacy (main domain). However, PISA 2018, scientific literacy is a minor domain of assessment.

Indonesian students still get low scores for scientific literacy based on reports. This data represents the scores of Indonesian students on scientific literacy [4] [7] [8]:

Table 1. Indonesian Students' Scientific Literacy Scores

Year	Score	Rank
2000	393	38 (41 countries)
2003	395	38 (40 countries)
2006	393	50 (57 countries)
2009	393	60 (65 countries)
2012	383	64 (65 countries)
2015	403	62 (70 countries)
2018	396	70 (78 countries)

Many factors cause low scores for Indonesian students' scientific literacy. One of them is in the science learning process. Based on the information that the knowledge transfer process is provided without allowing students to build their knowledge so that students have difficulty applying science concepts in everyday life [5]. From observations at school, it was concluded that students only memorized to understand science [9]. Students have difficulty understanding the meaning and using science to solve problems [10]. Then, the process of managing science learning by teachers is very important to develop students' scientific literacy [11].

Indonesian students' scientific literacy can be built in the process of learning science in schools [12] [13]. One of the components of the learning system is the use of instructional media. The use of learning media can be maximally utilized in learning [14]. The process of learning will be better if it is supported by learning media. Learning media are also able to attract students' attention and provide information that can be visualized [15] [16]. With the existence of learning media that uses animation, some abstract material can be easier to understand [12] [17]. This is also supported by Edgar Dale's cone of experience theory where the influence of the media is very much dependent on the student's own learning experience [18] [19]. Students will remember 10% - 20% of the material by reading and listening (verbal), 30% by seeing (visual), 50% - 70% of discussion/presentation (engaging), and 90% by role-playing/simulating/doing things real (do)[20].

Based on the taxonomy of learning media, one of the media that can be used in process of learning is interactive learning multimedia. The use of multimedia provides great potential for educators in developing learning techniques [21]. Multimedia affects students' imagination and visualization in learning [16]. The results of the study stated that multimedia in science learning had an influence on students' cognitive levels [22]. In other studies, it is stated that interactive learning multimedia influences the learning process, especially to improve students' scientific literacy [12]. Besides, interactive multimedia can provide students with an easy understanding of science concepts [23]. Furthermore, interactive multimedia that has animation has a positive influence on learning [24].

Interactive learning multimedia is a type of computer-based learning. One of the computer-based learning models is the drill & practice model. The drill & practice model is a learning model by training students to instill habits in the form of practice questions [25]. The drill and practice model contains a series of questions to train users [26]. Research shows that interactive learning multimedia using the drill and practice model is significantly effective to improve students' understanding of scientific

concepts [27]. By using this model students are expected to be able to practice scientific literacy questions well and be able to construct scientific concepts that will improve students' scientific literacy.

Based on the description, the problem in this study are: (a) how to develop valid interactive learning multimedia using the drill & practice model on the scientific literacy of junior high school students? (b) How to develop practical interactive learning multimedia using the drill & practice model on the scientific literacy of junior high school students? (c) What is the potential impact of interactive learning multimedia using the drill & practice model on scientific literacy that has been developed on student test results in junior high school students?

The purpose of this study was to develop interactive learning multimedia using the drill & practice model on the scientific literacy of junior high school students which had validity, practicality, and potential impact. By using this multimedia in the learning process is expected to improve students' scientific literacy.

2. Method

This research is development research that uses the multimedia development model from Frey & Sutton which has been modified. This model is specially designed for product-oriented computer-based multimedia development. Figure 1 represents the stages of the multimedia development model [28].

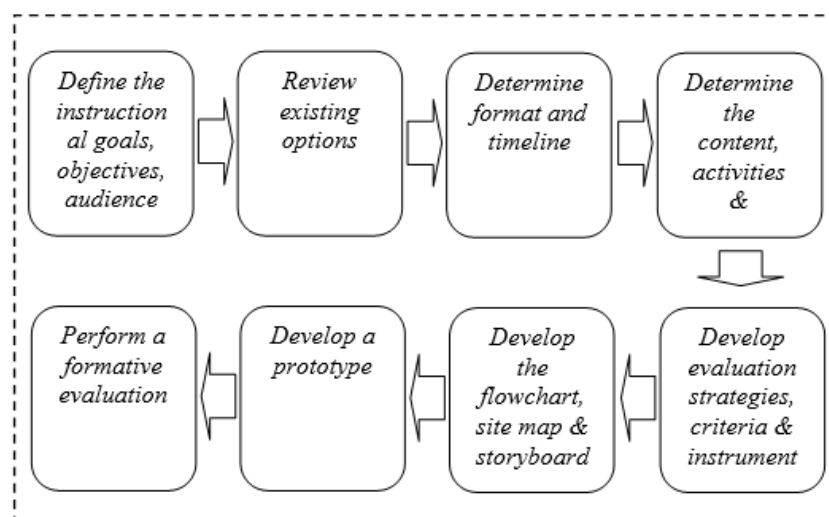


Figure 1. Multimedia Development Model

Based on Figure 1 above, the multimedia development model is carried out in 8 stages. In the stage to formative evaluation using formative evaluation from Tessmer which consists of five stages: self-evaluation, expert review, one to one, small group, and field test.

To obtain the data needed in this study, data collection was carried out through documentation, walkthrough, interviews, questionnaires, and tests. The documentation is intended to collect preliminary research data in the form of the PISA framework, PISA scientific literacy questions, syllabus of science, and data on previous exam scores. The walkthrough aims for checking or input purposes as a basis for revising the initial product involving several experts in content, design, media, and language at the expert review stage. Interviews were conducted with students at the one to one stage. The questionnaire was administered at the small group stage. The questionnaire was administered at the small group stage. The test is given to students who are research subjects at the field test stage. The subjects of this study were students of class IX in junior high school at LTI IGM Palembang. Students selected in the one to one evaluation are 3 students who represent low, medium, and high abilities. 10 students were in the small group stage. Then, proceed to the field test stage which uses one class.

3. Result and Discussion

3.1. Planning Stage

The planning stage consists of stages 1 to 5 of the multimedia development model from Frey & Sutton. Researchers analyzed the achievement of Indonesian students in PISA scientific literacy. From the analysis results obtained information, including (a) the attainment of Indonesian students' scientific literacy is still low [29] [30] [31]; (b) Indonesian students only have knowledge that is familiar with scientific phenomena because only 40% of students can reach level 2 and 60% below level 2 [4] [32].

The questions in this multimedia have used PISA scientific literacy sample questions which are grouped based on context aspects. This product development has been useful for students to solve PISA scientific literacy questions. The characteristics of students in this study were the average age of 15 years who were in class IX, has followed science subjects in grades 7 and 8, and able to operate computers.

3.2. Development Stage

This development stage consists of two parts, namely paper-based and computer-based. At the paper-based stage, researchers have created flowcharts and storyboards based on analysis of multimedia content. Furthermore, at the computer-based stage by referring to the flowcharts and storyboards that have been made, the researcher has developed an initial prototype assisted by the programmer.

3.3. Evaluation Stage

3.3.1. Validity Test Result by Expert Reviews

This stage aims to obtain a valid interactive learning multimedia product. This validation is focused on four aspects namely contents, design, media, and language. The following are the results obtained at the expert review stage.

Table 2. Expert Review Results

No	Expert	Average	Category
1	Contents (1)	0.98	Very valid
2	Contents (2)	0.98	Very valid
3	Design	1	Very valid
4	Media	1	Very valid
5	language	1	Very valid
Average		0.99	Very valid

Based on the table above, it can be seen that the results of the assessment of the four experts have an average of 0.99 with a very valid category. This data has shown that the interactive learning multimedia product developed deserves to be tested with revisions according to the suggestions and has been declared to have met the validity aspect. Even though the results of the first prototype have been declared valid, the validator still provides suggestions for improving the interactive multimedia that has been developed.

3.3.2. Practicality Test Result

This evaluation stage consists of a one-to-one evaluation stage and a small group evaluation. The practicality test results can be seen in Table 3 below:

Table 3. Practicality Test Results

No	Practicality Test	Average	Category
1	One to one	0.83	Very practical
2	Small group	3.34	Very practical

The one to one evaluation begins with selecting three students of class IX.B with criteria that have varying abilities from high, medium, and low learning outcomes. The product in this one to one evaluation is called prototype 1 which involves 3 students. Based on table 3 above, it can be seen that the results of the assessment of the three students have an average of 0.83 with the very practical category and have met the practical aspect. The suggestions given by students can be used as a basis for revising prototype 1 so that it becomes prototype 2 which is then used in the next stage namely the small group evaluation stage.

The small group evaluation stage was tried out on 10 students who represented the actual research subject, which did not include 3 students who had carried out a one to one evaluation. This stage also aims to see the practicality of using interactive learning multimedia products. Based on table 3 above, the results at the small group stage obtained a mean of 3.34 with the very practical category. The results of one to one and small group evaluations showed that these interactive learning multimedia was easy to use, easy to correct and students enjoy using this program.

Based on the results from expert reviews, one to one, and small groups obtained suggestions and comments which are used to improve interactive learning multimedia products called prototype 3. This product has been tested for validity and practicality so that it was ready for use at the next stage namely the field test stage to see the potential impact of the product.

3.3.3. Potential Impact Test Result

The field test used the third prototype. This stage aims to examine the potential impact of interactive learning multimedia developed on student test results. The research subjects at this field test stage were all X.A students, totaling 22 people. From the results of the field test, students obtained a classical average of 62.18 in the good category. The following is the percentage of field test results.

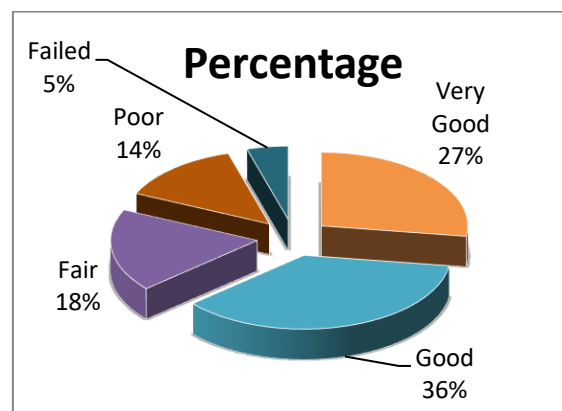


Figure 2. Percentage of Field Test Results

Based on figure 2 above was known that 27% of students in the very good category, 36% of students in the good category, 18% of students in the fair category, 14% of students in the poor category, and 5% of students in the failed category. From this data known that 63% of students can solve PISA scientific literacy questions well using interactive learning multimedia.

3.4. Discussion

The display of interactive learning multimedia using the drill & practice model on scientific literacy that has been developed can be seen in figure 3 below.

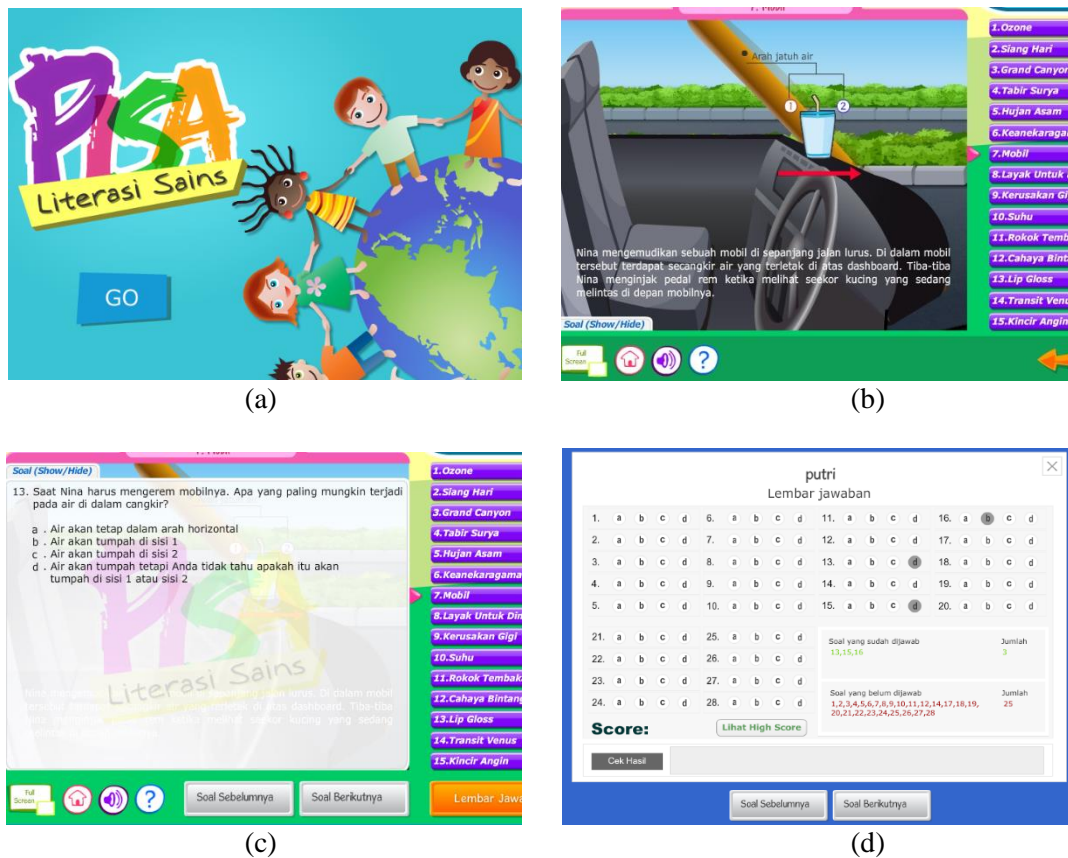


Figure 3. (a) Initial Display; (b) Animation Page and Menu; (c) Question Page; (d) Answer Sheet

Based on Figure 3 above, interactive learning multimedia using the drill & practice model has an animated start page and a "Go" button to enter the program. After that, the program provides a page to fill in the name and password to be able to continue on the question instructions page. Then, students will be given 15 topics on scientific literacy questions that have been grouped based on aspects of the context. Each aspect of the context has an introductory question in the form of animation and also a narrative in the program. Furthermore, students can see and fill in the questions that are considered the easiest. There are 28 questions available in the program. Some of the features available in the program such as the home button, voice button, next button, back button, help button, show/hide question button, exit button, and others. These features can help students run the program easily.

The interactive learning multimedia using the drill & practice model on scientific literacy had validity based on the validation results of expert reviews of contents, design, media, and language. Besides, this product had practicality because easy to understand, attract students' attention, and provide practice questions efficiently. Field test results showed that this interactive learning multimedia had a potential impact and can be used as an exercise program for PISA scientific literacy questions. Therefore, this product was declared valid, practical, and had a potential impact so the students can use the product well.

These findings support that interactive learning multimedia is effective for improving students' scientific literacy [12]. Multimedia in the learning process contains a combination of text, video, graphics, audio, and animation made the materials more detailed and enhancement the learning outcomes [15]. The use of multimedia in science learning affects cognitive enhancement [22]. Interactive display in multimedia makes students more interested and understands the material [21]. Other research shows that multimedia learning can improve student achievement, learning motivation, and remove learning barriers [33].

An interesting finding in this study is that students have been able to understand the questions through the animation available in the program based on field test data because each topic in this multimedia is equipped with an introduction to questions in the form of animation. Computer animation is very useful in learning [34]. The animation is also able to improve student understanding [16]. Other research suggests that visualization plays an important role in learning to be effective [35]. Visual media will provide opportunities for students to actively learn to solve problems [9]. Although animation in multimedia learning affects learning outcomes, student learning styles (visual & verbal) also influence learning outcomes [24].

Learning multimedia in theory is a combination of various media, namely text, images, video, audio, and animation [36]. In multimedia in this study, the content is also available. These interactive learning multimedia has interactions between students and computers. This interaction can be seen when students fill in their names and passwords, choose the questions that are considered the easiest to do according to the student's speed, play the animation available, choose answers from the questions, and the program also displays the scores of the results of the students' exercises. Also, this multimedia is equipped with an answer sheet that allows students to see the answers that have been filled in or not. Furthermore, the results of the training can be seen immediately after all the answers are filled in. Therefore, it can be said that this multimedia was easy to implement and easy to manage.

Based on the expert's opinion, the learning process will run optimally if accompanied by the selection of the right media [37]. Interactive multimedia can activate several senses in learning [19]. Multimedia can help explain scientific phenomena and abstract scientific concepts [38]. Besides, the delivery of concepts becomes more meaningful by using multimedia [39].

This interactive learning multimedia uses a drill & practice model. The drill & practice model is a computer-based learning model. This model was chosen because it can provide a concrete experience in the form of practice questions and test students' abilities according to their learning speed through the program [40].

Based on the explanation above, understanding the concept of science can be built by the students themselves. It can increase the scientific literacy of students in the learning process. Scientific literacy is very important because scientific literacy is an ability related to scientific problems related to scientific concepts, methods, and attitudes [41]. Students with scientific knowledge are expected to be ready for global challenges and problems that arise [3]. Another view explains that scientific literacy problems can not only be solved through the application of models/methods/strategies in the learning process but the environment, school infrastructure, human resources, organizations, and management also influence student learning outcomes [42] [43].

These interactive learning multimedia has several weaknesses. The questions provided are only multiple-choice questions which aim to make it easier to determine the test score results. Meanwhile, the types of PISA scientific literacy questions are also in the form of description questions. However, multiple-choice questions in multimedia can be used as an exercise program to answer PISA scientific literacy questions for students. This product can be a reference for other researchers who want to develop a program of practice exercises that are much better than before.

4. Conclusion

Based on the research, the data obtained consisted of: (a) interactive learning multimedia had a validity level with an average of 0.99 with a very valid category; (b) Interactive learning multimedia can be said to be practical to use because it had an average value of 0.83 (very practical category) at the one to one stage and 3.34 (very practical category) at the small group stage; (c) based on the results of field tests was obtained a classical average value of 62.18 with a good category. Thus, the developed interactive learning multimedia using the drill & practice model on scientific literacy can be said to have been valid, practical, and had a potential impact on student learning outcomes. The conclusion is this interactive multimedia learning is suitable for use in learning. Other multimedia learning can also be developed by other researchers by using various types of questions that can help students understand abstract science through animation so that it can have an impact on the achievement of scientific literacy.

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