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DEVELOPMENT OF MULTIMEDIA BASED TEACHING MATERIALS TO INCREASE COGNITIVE LEARNING OUTCOMES IN RESPIRATION SYSTEMS

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Abstract:
An important component in education is the teacher. 21st century teachers use technology in learning. The technology that is developing in education now is ICT, one of which is multimedia. Multimedia-based teaching material is an alternative teaching material that is good for students to improve cognitive learning outcomes in respiration system material. Research and development use the development model of Borg & Gall (1983) and referring to the instructional design model developed by Dick & Carey (2009). Furthermore the instructional materials developed are tested for effectiveness to determine whether or not there is an increase in cognitive learning outcomes in respiration system material. Based on the assessment of four aspects of material quality; aspects of curriculum, material presentation, evaluation, and language, obtain an average score of material quality assessment of 86.80%. Based on the assessment of seven aspects of media quality; aspects of display quality, software engineering, implementation, interface, reusable, maintainable, and compatibility, obtain an average score of material quality assessment, 85.15%. Multimedia-based teaching materials that are developed effectively improve students' cognitive learning outcomes in respiration system material.

Keywords: Teaching Materials; Multimedia; Respiration Systems; Research and Development.

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1. Introduction

Education is a major component in improving the quality of a nation. An important component in education is the teacher. With the existence of a teacher, it is expected that the learning objectives are obtained properly. 21st century teachers use technology in learning. The technology developed is expected to improve the quality of education by creating quality human resources (Ditama et al., 2015). The skills that must be approved by the teacher are being able to develop and use teaching materials so that material that is initially abstract becomes concrete.

Prepared teaching materials have an important role in learning (Nurjaya, 2012). Teaching materials commonly used by teachers in learning are books, modules, handouts, Student Worksheets, powerpoint and charta. Teaching materials that fit the needs and characteristics of students will

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make learning take place effectively and efficiently. Teaching materials should be developed independently by the teacher so they can be adapted to the needs and characteristics of the students. Teachers who develop teaching materials directly and use these teaching materials in learning, learning will be more interesting, and students will be easier to understand a material. Based on the results of questionnaire analysis of students' responses to teaching materials used in schools, it was revealed that as many as 57% of students thought that the teaching materials used in schools were less attractive, and as many as 53% thought that respiration material was difficult to understand.

Teaching materials that teachers can develop are in the form of multimedia. Multimedia is a teaching material consisting of a combination of various types of media displayed, to achieve learning goals (Wati, 2016). This merger is a unit which together displays information, messages, or content of the lesson. Multimedia is interactive, which means that multimedia has the ability to accommodate user responses. In the 4.0 industrial revolution, multimedia is the teaching material recommended in learning. Multimedia-based teaching material is an alternative teaching material that is good for students to improve cognitive learning outcomes in respiration system material.

Learning is a mental or psychological activity that takes place in active interactions with the environment. The learning process can involve cognitive, affective, and psychomotor aspects. Students who receive learning experiences can change all their abilities, both in terms of cognitive, affective, and psychomotor. Learning outcomes are used to determine the achievement of abilities possessed by students based on learning objectives. According to Wiersma & Jurs (1990), cognitive learning outcomes are behavioral changes that occur in the area of cognition. The learning process that involves cognition starts from storing and processing information to the stage of decision making.

This study aims to develop multimedia-based teaching materials in respiration system material, and to determine the effectiveness of multimedia-based teaching materials to improve cognitive learning outcomes in respiration system material.

2. Materials and Methods

The samples in this study were students of class XI MIA (Mathematics and Science) Senior High School consisting of 3 schools, 1 Babelan Senior High School, 2 Babelan Senior High School, and 3 Babelan Senior High School. This research is research and development with the development model of Borg & Gall (1983) and refers to the instructional design model developed by Dick & Carey (2009). This development research is limited to only five steps because of limited time and costs, while the steps for developing the product are as follows:

1) Research and Collecting Initial Information

Research and collecting initial information includes literature review, class observations, and preparation of initial reports. Preliminary research or needs analysis is very important to do to obtain initial information for development.

2) Planning

Planning is needed in developing a product so products that are developed as desired.
The planning phase includes:

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- Identifying General Learning Objectives (Identify Instructional Goals). The first step in the model is to determine what is expected of students, when completing learning.
- Doing Learning Analysis. After identifying general learning objectives, what steps will be taken to achieve these general learning objectives.
- Identifying Behavior and Characteristics of Learners (Analyze Learners and Contexts). To analyze general learning objectives, first analyze the characteristics of students who will be used as the model.
- Formulate Specific Learning Objectives (Write Performance Objectives). Based on the instructional analysis and students' initial knowledge, then formulate what specific statements students will be able to do when they complete learning.

3) Develop Preliminary Form of Product.

Develop of the preliminary form of product or preliminary draft includes:

- Developing Assessment Instruments. Based on specific learning objectives that have been formulated, an assessment will be developed in measuring the ability of students to show the extent to which achievement of specific learning objectives.
- Developing Learning Strategies. At this stage learning strategies will be developed that will be used in learning to achieve the final goal.
- Developing and Selecting Learning Materials. At this stage learning strategies will be used in accordance with the learning material.
- Designing and Conducting Evaluation (Design and Conduct Evaluation). This evaluation was carried out by collecting data used to identify the feasibility of the product being developed.

4) Preliminary Testing. The preliminary testing was carried out in a limited way to evaluate the products produced and product design validation. The results of the analysis from the initial trial are the input material for revising the initial product.

5) Preliminary Product Revision. The results of the initial trial obtained qualitative information about the product being developed.

Cognitive learning outcomes instruments in respiration system material are arranged as many as 40 items. The instrument was validated using Biserial Point with the help of Microsoft Excel 2010. Criteria for measuring validity: If rxy > r table means valid and rxy < r table means invalid. Instrument reliability is obtained by using the KR 20 formula. After the validity and reliability tests are carried out, the next stage is testing the effectiveness of teaching materials. The effectiveness test data is the result of the pretest and posttest cognitive learning outcomes in the respiration system material using multimedia-based teaching material as a treatment group and those who do not use multimedia-based teaching material as a control group. The results of the data were tested for differences using the t test at the 0,05 significance level. Prerequisite tests are carried out before the data are analyzed by conducting normality and homogeneity tests. The normality test uses the Kolmogorov-Smirnov test at $\alpha = 0,05$ and the homogeneity test uses the F test (Putrawan, 2017).

3. Results and Discussions

Collection of information is very necessary in the development of a product so that the product developed can be adjusted to the expected goals. Based on collection of information, it is known

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that the teaching materials used in the school are printed teaching materials such as textbooks and student worksheets, as well as computer-based teaching materials in the form of powerpoints. Other computer-based teaching materials need to be developed so that the teaching materials used by students in learning become varied, one of the teaching materials that uses computers is multimedia-based teaching material. This shows that research is needed to develop multimedia-based teaching material in respiration system material.

The displays of multimedia-based teaching materials in the respiration system material are:

Initial Display

The initial display consists of the name of the teaching material developed, the name of the developer, and the name of the supervisor. The menu in the initial display is a guide to use in multimedia-based teaching materials and entry is a menu to start learning using multimedia-based teaching materials.

Picture 1: Initial Display of Multimedia-Based Teaching Materials

Main Menu

The main menu of multimedia-based teaching materials (babermul) consists of 5 menus. The menus are competency menus, material menus, evaluation menus, profile menus, and bibliography menus

Picture 2: Display of Main Menu

Competency Menu

The competency menu contains Core Competencies, Basic Competencies, and Learning Objectives that students want to achieve after learning respiration system material through multimedia-based teaching materials.

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Picture 3: Display of Competency Menu

Material Summary Menu

The material summary on multimedia-based teaching material is a summary of the respiration system material in the form of a navigation button which when clicked on by students will display an explanation of the material.

Picture 4: Display of Material Summary Menu

Explanation of Material

Explanation of material on multimedia-based teaching material is equipped with related library resources. The material is also explained with pictures or videos so that students are easier to understand the material of the respiratory system. Images and videos are also complemented by information and sources.

Picture 5: Display of Material Explanation

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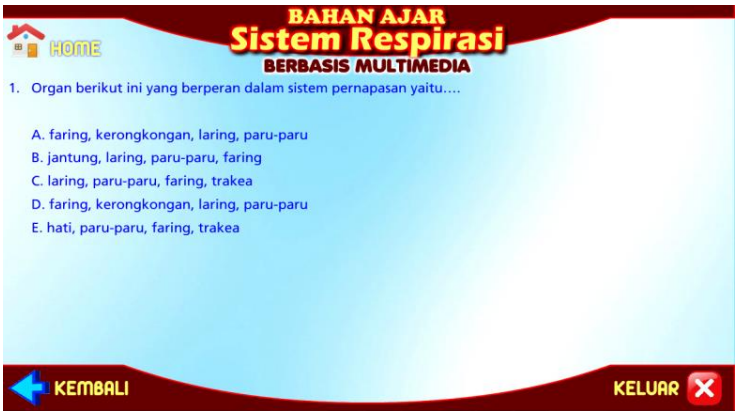
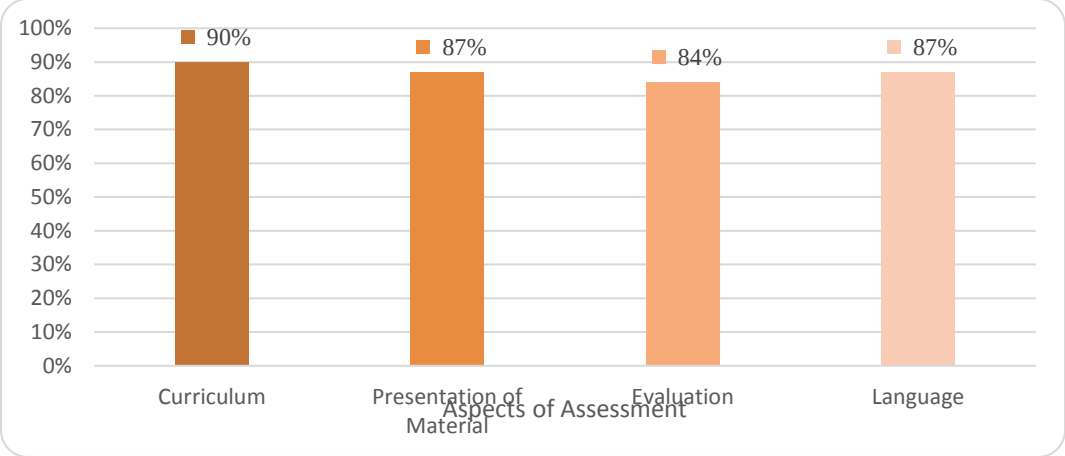
Evaluation

Evaluation on multimedia-based teaching material in the form of Multiple Choice with 5 options. Evaluation aims as a reference to the cognitive abilities of students. At the end of the evaluation there are scores based on the answers of the students.



Picture 6: Display of Evaluation

Teaching materials that have been developed are then evaluated. Evaluation is done to get input from the validator so that multimedia-based teaching materials on respiration system material are appropriate to use. Input from the validator is related to the material, and the media that is in multimedia-based teaching materials on respiration system material. Evaluation results related to material quality can be seen in the following diagram:



Picture 7: Average Score of Multimedia-Based Teaching Material

Based on the assessment of four aspects of material quality; aspects of curriculum, material presentation, evaluation, and language, the average score of material quality assessment was 86,80%. The results of evaluations conducted related to material quality indicate that multimedia-based teaching materials are developed by adjusting the characteristics of students, and specific learning objectives. This is in accordance with Rowntree's explanation (1995) that the content of teaching materials must be specific, designed in such a way as to achieve certain learning goals, the material is adapted to the characteristics of students who use it and the characteristics of the subject matter become effective teaching materials. Explanation of material is divided into parts

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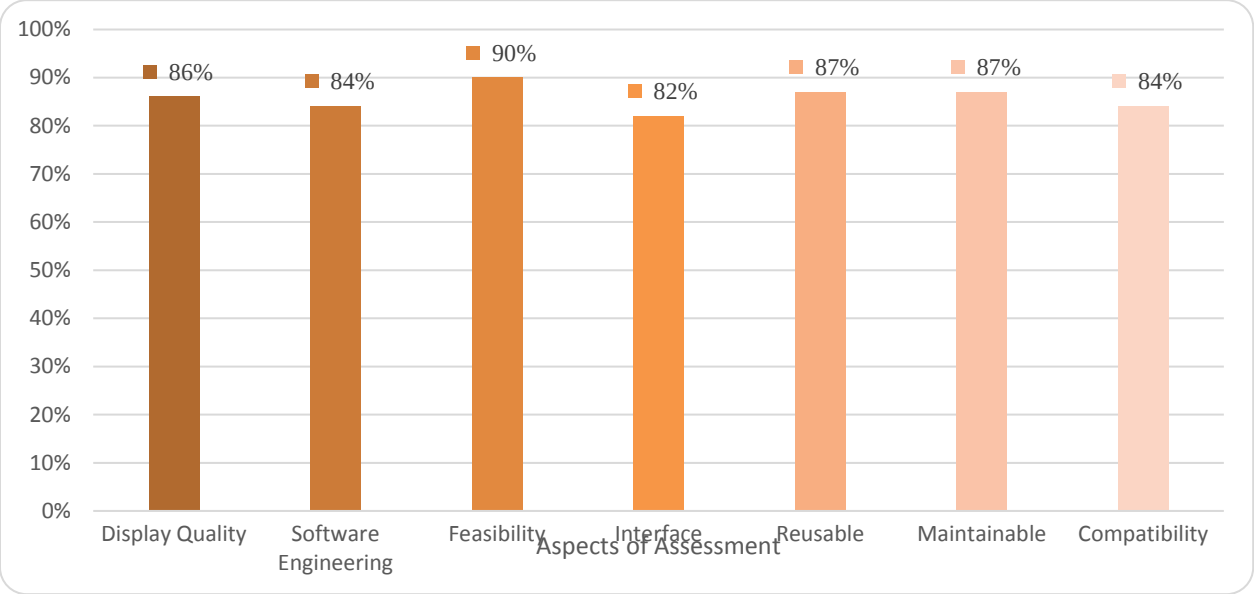
so that students focus on the concepts learned. A lot of material will burden the minds of students, to reduce it the explanation of the material is divided into several parts or segments (Mayer & Moreno, 2003). The evaluation menu is feedback because students can evaluate their cognitive learning outcomes. This was stated by Reiser & Dempsey (2007) that feedback is needed in teaching materials so that interaction between students and instructional materials is built.

The next step is to evaluate the quality of the media. The evaluation results related to media quality can be seen in the following diagram:



Picture 8: Average Score of Multimedia Based-Teaching Material Media Aspects

Based on the assessment of seven aspects of media quality; aspects of display quality, software engineering, implementation, interface, reusable, maintainable, and compatibility. The average score for the quality of the material is 85,15%. The evaluation results related to material quality show that multimedia-based teaching materials are easy to use anytime and anywhere because they are offline. This is in accordance with the explanation of Mukhopadhyay (2010) that multimedia that can be accessed offline will facilitate its use. The font size used is not too small and not too large, adjusted for the existing layout, so that it is easy to read. This is explained by Nakilcioğlu (2013) that letters are not symbols that represent sound, letters are cognitive communication tools that help explain the material, so that its existence needs attention. The images displayed on multimedia-based teaching material support the explanation of the material, not just displaying images. This is conveyed by Ngure et al., (2014) that images provide a real visual experience for students to introduce, develop, and enrich ideas. Video makes it easy for students to know how a process runs in the respiratory system. The use of video in teaching materials will make it easier for learners to see the process that is happening directly in a learning material (Kemp & Dayton, 1985).

The next stage is effectiveness test. The effectiveness test is carried out using the t test. Before the t test is carried out, a normality and homogeneity test is carried out first.

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1) Normality test

The normality test is carried out using the Kolmogorov Smirnov Test on the Microsoft Excel 2010 program. Population data is normally distributed if a max ≤ D table. Detailed normality tests can be seen in Table 1.

Table 1: The Result of Normality Test

Test Group	a max	D table	Test Result
Post test experimental group	0,15	0,23	Normal
Post test control group	0,22	0,23	Normal
Gain score experimental group	0,22	0,23	Normal
Gain score group	0,15	0,23	Normal

2) Homogeneity Test

The homogeneity test was carried out using the F test to find out the variance between the experimental and control groups. The program used for homogeneity testing is Microsoft Excel 2010. Based on homogeneity test calculations, it is known that the calculated F value is 0.58 and the F table value is 1.84 or F count < F table is 0,58 < 1,84. This shows that accept H_0 means homogeneous population data.

In this study four t tests were carried out;

a) t Test on Pre Test Score and Post Experimental Group Test on Cognitive Learning Results in Respiratory System Material

The purpose of the t test on the pre-test and post-test scores is to see whether there is an increase in scores in the experimental group. The results of the t test on the pre-test and post-test scores of the experimental group can be seen in Table 2.

Table 2: t Test Results on Pre Test Scores and Post Cognitive Learning Results Experimental Group Tests on Respiratory System Material

Test Group	Average	dk	Test Statistic		Explanation
			t count	t table (0,05)	
Pre Test Experimental	22,17	68	-37,27	1,995	Different
Post Test Experimental	31,86				

Based on Table 2, it is known that the average pre-test of the experimental group is 22,17, while the post-test of the experimental group is 31,86. This shows that there was an increase of 9,69. The results of the t test on the pre-test and post-test scores of the experimental group obtained t count of -37,27 and t table 1,995. Reject H_0 if t count <t table is -37,27 < 1,995, thus there is an increase in the score of the experimental group cognitive learning outcomes in respiration system material.

b) t Test on Pre Test and Post Scores of Cognitive Learning Outcomes Control Group Tests on Respiratory System Material

The purpose of the t test on the pre-test and post-test scores is to see whether there is an increase in the score in the control group. The results of the t test on the pre-test and post-test scores of the control group can be seen in Table 3.

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Table 3: t Test Results on Pre Test and Post Scores of Cognitive Learning Outcomes Control Group Tests on Respiratory System Material

Test Group	Average	dk	Test Statistic		Explanation
			t count	t table (0,05)	
Pre Test Control	22,18	68	-10,15	1,995	Different
Post Test Control	25,53				

Based on Table 3, it is known that the average pre-test of the control group is 22,18, while the control group post-test is 25,53. This shows that there is an increase of 3.35. The results of the t test on the pre-test and post-test scores of the control group obtained t count of -10,15 and t table 1,995. Reject H_0 if t count < t table is -10,15 < 1,995, thus there is an increase in the score of the control group cognitive learning outcomes in the respiration system material.

c) t test on Experimental Group Post Test Scores and Cognitive Learning Outcomes Control Group on Respiration System Material

t-test analysis on post-test scores aims to determine whether or not there are differences in post test scores in the experimental group and the control group. The results of the t test on the post test scores of the experimental group and the control group can be seen in Table 4.

Table 4: t Test Results on Experimental Group Post Tests Score and Cognitive Learning Outcomes Control Groups on Respiration System Material

Test Group	Average	dk	Test Statistic		Explanation
			t count	t table (0,05)	
Post Test Experimental	31,86	68	10,73	1,995	Different
Post Test Control	25,53				

Based on Table 4 it is known that the post test average of the control group is 31,86, while the control group post test is 25,53. The results of the t-test on the post-test scores of the experimental group and the post-test of the control group obtained t count of 10,73 and t table 1,995. Reject H_0 if t count > t table is 10,73 > 1,995, thus there is a significant difference in the scores of the post test results of the cognitive learning outcomes of the experimental group and the control group in respiration system material. Post-test scores of students using multimedia-based teaching materials were higher than post-test students who did not use multimedia-based teaching materials.

d) t Gain Test Scores for Experimental Groups and Cognitive Learning Outcomes Control Groups in Respiration System Material

The t gain test scores of the experimental group and the control group aim to determine the difference in pre-post test differences between the two groups. The results of the t gain test scores in the experimental group and the control group can be seen in Table 5.

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Table 5: t Gain Test Results of Experimental Group Scores and Cognitive Learning Outcomes Control Groups in Respiration System Material

Group Test	Average	dk	Test Statistic		Explanation
			t count	t table (0,05)	
Gain Score Experimental	9,69	68	15,12	1,995	Different
Gain Score Control	3,34				

Based on Table 5, it is known that the average of the control group gain score is 9,69, while the gain score of the control group is 3,34. The results of the t test gain score of the experimental group and the gain score of the control group obtained t count of 15,12 and t table 1,995. Reject H_0 if t count > t table is 15,12 > 1,995, thus there is a significant difference in the gain scores of the experimental group and the control group cognitive learning outcomes in the respiration system material. The score gain of students using multimedia-based teaching material is higher than the score gain of students who did not use multimedia-based teaching materials. Based on the t test conducted, it is known that multimedia-based teaching materials effectively improve students' cognitive learning outcomes in respiration system material.

4. Conclusions and Recommendations

Based on the results of research on the development of multimedia-based teaching material in respiration system material to improve cognitive learning outcomes it can be concluded that multimedia-based teaching material in respiration system material developed is appropriate to be used as teaching material in learning related to class XI respiration Senior High School and multimedia-based teaching materials that are developed effectively improve the cognitive learning outcomes of students in respiration system material.

The implication in this study is to contribute to teachers to use multimedia-based teaching materials to improve students' cognitive learning outcomes in respiration system material, multimedia-based teaching material developed can be used as a reference for educational institutions to improve education quality in school, and multimedia-based teaching materials developed can be used as a source of data and information for researchers to develop multimedia-based teaching materials in improving other factors such as understanding, motivation, and so on.

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