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Development of Interactive Multimedia Assisted by Virtual Laboratory for Critical and Creative Thinking Skills in Respiration and Excretion System Materials for Class XI High School Students

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ABSTRACT: The 21st century learning summarizes students' thinking skills in four competencies, namely critical thinking skills, creative thinking, collaboration, and good communication. Teaching materials in schools should be able to help students in practicing thinking skills. This study aims to produce interactive multimedia assisted by a virtual laboratory for respiratory and excretory system materials in humans that can improve the critical and creative thinking skills of class XI students that are valid, practical, and effective.

This type of research is development research with the Plomp modeldevelopment research which consists of three phases, namely the initial preliminary research phase, the development or prototyping phase, and the assessment phase. The research subjects are students of class XI SMAN 1 Sitiung Academic Year 2021-2022. The instrument in this study is a questionnaire of validity and practicality as well as a matter of effectiveness. The data analysis technique was validity, practicality using a Likert scale scoring and effectiveness using ANOVA using SPSS 21.

The results showed interactive multimedia assisted by a virtual laboratory obtained very valid criteria according to expert review with a value of 81.26%. The practicality of the teacher is very practical with a value of 96.66% and the student response criteria are very practical with a value of 95.71%. The effectiveness test of interactive multimedia assisted by a virtual laboratory is effective because the experimental class shows an increase in critical thinking skills. Based on these results, it can be concluded that the interactive multimedia assisted by a virtual laboratory on the respiratory and excretory system materials developed in humans is valid, practical and effective.

KEYWORDS: Critical and Creative, Interactive Multimedia, Virtual Laboratory.

1. BACKGROUND OF THE PROBLEM

21st century learning summarizes students' thinking skills in four competencies, namely critical thinking skills, creative thinking, collaboration, and good communication. Higher order thinking ability is an ability that includes three aspects, namely analysis, evaluation, and creation in accordance with the implementation of the 2013 curriculum (Anazalia, et al). Thinking skills that play a role are critical and creative thinking skills. Students who are able to face global competition in the 21st century world of work are creative and critical students (Agnafia, 2019).

Critical thinking skills should be owned by every student. Critical thinking skills are skills to train students in analyzing and identifying problems in depth to get brilliant new innovations. Critical thinking is important to develop because advances in information and global competition demand in analyzing phenomena or solving problems (Hayati, 2016).

Creative thinking skills are skills that train students to develop ideas, imagination and increase sensitivity to phenomena. Creative thinking skills of students are very important in the learning process, thinking can affect the ability, speed and effectiveness of students' learning (Widiawati: 2019) Creative thinking skills are one of the skills that important for students who are applied in learning to enrich their knowledge and skills. Students who think creatively tend to prefer to export new ideas to solve problems (Fuad, 2015).

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Critical and creative thinking skills are the key to learning and should be applied to the 2013 curriculum, especially in learning biology. Biology learning today requires thinking skills to analyze and understand phenomena or problems related to biology concepts in everyday life (Sofnidar, 2012). Critical and creative thinking skills are interrelated skills. Critical and creative thinking skills are significantly related because critical thinking skills contribute to creative thinking skills (Mayarni, 2020).

Based on the problem analysis conducted to the Biology teacher, students have difficulty understanding the learning material because the available teaching materials have not been able to maximize students' understanding of concepts and materials. Teaching materials in schools have not been able to visualize concepts and materials optimally. This problem has an impact on schools so that they do not maximize students' thinking skills which affect students' mindsets to be low (Sutama, 2014).

The limitations of existing learning tools in schools and those owned by teachers are one of the factors that can determine the quality of learning. The required teaching materials must contain activity based so that students can be active in the learning process and interesting teaching materials so that they can visualize the material densely and clearly so that they can encourage the improvement of their critical and creative thinking skills.

Based on the needs analysis at SMAN 1 Sitiung, students need media that can visualize the material briefly, densely and clearly so that it can help students to be active and assist in understanding learning. A total of 77.1% of students want the development of media, namely interactive multimedia assisted by the Virtual Laboratory (Appendix 6).

The developed media is Interactive Multimedia assisted by Virtual Laboratory. Interactive Multimedia assisted by Virtual Laboratory which was developed contains respiration and excretion material and is assisted by practicum on each material. Based on the results of observations on 70 students, 75% of students (Appendix 6) still consider the respiration and excretion material difficult to understand and if there is no practice in the laboratory, it will be more difficult to understand the material, as many as 80.1% of students stated that learning resources only from textbooks and powerpoints made independently by the teacher (Appendix 6), so that students cannot get visual examples of the respiratory system and excretory system in humans without the help of pictures and are less able to visualize the material clearly.

Based on the needs analysis, the media created by the teacher were sourced from textbooks and the internet. The developed media contains respiration and excretion material. The researcher chose the material for the respiratory system and the excretory system because this material is material that requires visual examples of the shape of the respiratory and excretory organs that must be shown to students so that they are easy to understand. There are many media made by teachers for KD 3.8 and KD 3.9 only. The concepts presented in the media made by the teacher have not facilitated and have not trained students' critical and creative thinking skills. Based on the questionnaire, it was found that 100% of the teachers stated that they had never measured or tested the thinking skills of students (Appendix 3), this was evidenced from the analysis test of students' thinking abilities with an average score of only 41,

In this case the researchers chose SMAN 1 Sitiung as a place for observation, research and data collection because at SMAN 1 Sitiung there was no media developed using interactive multimedia assisted by a virtual laboratory, andthe results of observations at SMAN 1 Sitiung, it was proven that previously there had been no development of interactive multimedia learning media assisted by a virtual laboratory. This has encouraged researchers to conduct research on the development of interactive learning media on respiration and excretion material for critical and creative thinking of students in class XI SMAN 1 Sitiung on biology subjects supported by virtual laboratories as teaching materials in order to improve students' understanding in learning and be able to improve critical and creative thinking skills.

2. RESEARCH METHOD

This type of research is design and development research. The development model used in the development of interactive multimedia assisted by a virtual laboratory is the Plomp development model. The Plomp development model consists of three stages, namely the preliminary research stage, the development or prototyping stage, and the assessment stage. The type of formative evaluation that will be used is described in the following details of the development and prototyping activities.

1. Prototype I

The design of Prototype I development starts from designing interactive multimedia storyboards. After that, it was continued by designing a systematic presentation of material and learning objectives to be achieved which were divided into

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several learning activities and guided by KD 3.9 and KD 3.10 in the 2013 Curriculum. Creating interactive multimedia products using the Adobe Animate CC program. Entering the Prototype I stage, it conducts self-evaluation activities and this stage is developed based on several components, such as the feasibility of content, language and graphics.

2. Prototype II

At this stage, consultation with experts or experts (expert review) is carried out to get interactive multimedia assisted by a valid virtual laboratory. Aspects assessed in the validity questionnaire are didactic, construct and technical.

3. Prototype III

The revised product will be assessed by the validator, and will be continued at the one to one evaluation stage. The one to one test was carried out by three students with different abilities, namely low, medium and high. Students provide suggestions in the form of input from aspects of content feasibility, language and graphics. Based on the comments given, students gave positive responses to the development of interactive multimedia assisted by a virtual laboratory.

4. Prototype IV

The development of prototype IV is the stage of conducting interactive multimedia practicality tests which were developed through small group evaluation activities. The small group evaluation was carried out by six students. Taking students based on the category of the ability level of students, namely low, medium and high, is known from interviews with teachers and students' scores. Each category consists of two students.

3. RESULTS AND DISCUSSION

3.1 Research Results

The results obtained from the preliminary research stage are used as guidelines for developing interactive multimedia assisted by a virtual laboratory on the respiratory system and excretory system material. This interactive multimedia assisted virtual laboratory was created using the Adobe Animate CC program. The activities carried out at this stage of development are as follows.

1) Development and Prototyping Stage

a. Prototype I . Development Results

The design for the development of Prototype I begins with designing an interactive multimedia storyboard (Appendix 13). After that, it was continued by designing a systematic presentation of material and learning objectives to be achieved which were divided into several learning activities and guided by KD 3.9 and KD 3.10 in the 2013 Curriculum. Creating interactive multimedia products using the Adobe Animate CC program. The development of interactive multimedia products can be seen at the following link:https://bit.ly/3PxEaAx

Entering the Prototype I stage, it conducts self-evaluation activities and this stage is developed based on several components, such as the feasibility of content, language and graphics. The design of prototype I includes the following things.

Figure 1. Interactive Multimedia Cover Display assisted by virtual laboratory

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b. Prototype II Development Results

The development of interactive multimedia in prototype II is carried out by an expert review of the validity of which aims to see the feasibility of interactive multimedia assisted by a virtual laboratory which was developed based on didactic aspects, construct aspects, and technical aspects. The interactive multimedia validation was carried out by three experts consisting of media, material and language experts.

Aspects assessed in the validity questionnaire are didactic, construct and technical. The didactic aspect includes the suitability of interactive multimedia developed with the 2013 revised 2017 curriculum and based on the learning needs of students. Aspects of the construct assessed for the suitability of interactive multimedia developed with criteria that must be met in the development of developed interactive multimedia, and the rules for using the Indonesian language. The technical aspects assessed were the suitability of writing, pictures, and graphics in the developed textbooks. The results of the validity of interactive multimedia can be seen in Table 11.

Table1. Results of Data Analysis Validation of Three Validators

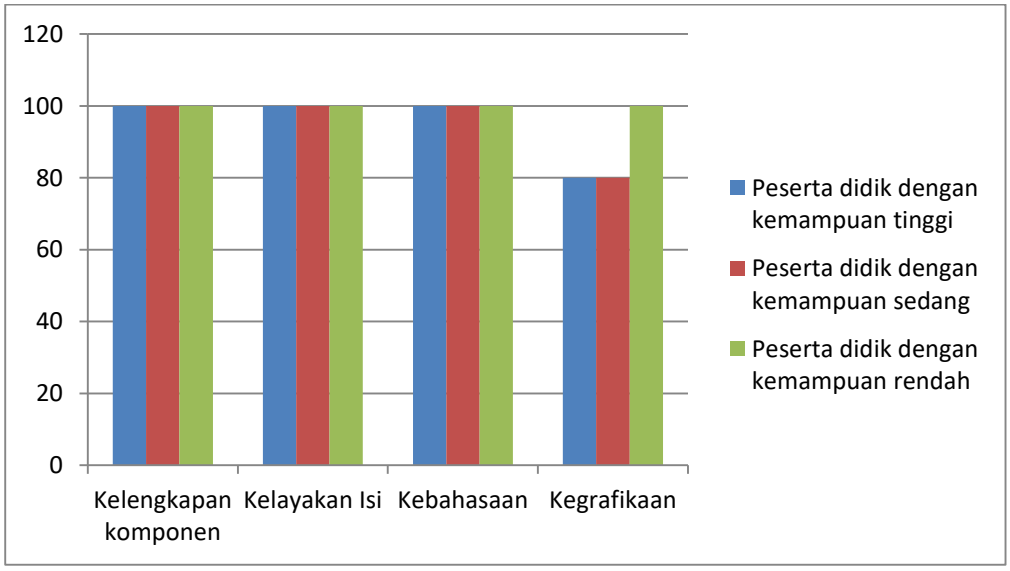
No	Aspect	Score (%)	Criteria
1	didactic	80.56	Valid
2	Construct	82.29	Very Valid
3	Technical	80.95	Valid
Average Vlidity Value		81.26	Very Valid

The results of the average validity value of 81.26% indicate that interactive multimedia assisted by a virtual laboratory on the respiratory system and excretory system materials developed in humans have very valid criteria based on aspects of the feasibility of content, language, presentation, and graphics.

c. Prototype III Development Results

The revised product will be assessed by the validator, and will be continued at the one to one evaluation stage. The one to one test was carried out by three students with different abilities, namely low, medium and high. Students provide suggestions in the form of input from aspects of content feasibility, language and graphics. Based on the comments given, students gave positive responses to the development of interactive multimedia assisted by a virtual laboratory.

The results of the accumulated One to One Evaluation Questionnaire on interactive multimedia that have been implemented can be seen in the image below:



Picture1. Questionnaire RatingOne To One

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The average value of the One To One Evaluation questionnaire that has been filled out by students is 96.66% (Appendix 18). Based on these results, it can be described that the assessment of the aspects of component completeness, Content Feasibility, and Language is appropriate. While in the graphic aspect, there are several suggestions from students for revisions such as the presence of several buttons that do not work and images that are not in accordance with the material.

d. Results of Development of Prototype IV

The development of prototype IV is the stage of conducting interactive multimedia practicality tests which were developed through small group evaluation activities. The small group evaluation was carried out by six students. Taking students based on the category of the ability level of students, namely low, medium and high, is known from interviews with teachers and students' scores. Each category consists of two students. The results of the small group evaluation obtained can be seen in Table 12.

Table2. Small Group Evaluation Results.

No.	Aspect	Score (%)	Criteria
1	Ease of Use	94.64	Very practical
2	Efficiency	92.86	Very practical
3	Attractiveness	100	Very practical
4	Easy to interpret	94.05	Very practical
5	Have Equivalence	100	Very practical
Average Practicality Score		**95.71**	**Very practical**

Based on the practicality test questionnaire, the results obtained were 95.71, it can be explained that interactive multimedia assisted by the virtual laboratory material for the respiratory system and excretory system in humans that was developed was considered very practical and could be used for class experiments and further tests. Students are also asked to provide suggestions for improving the developed multimedia.

2) Assessment Stage

The activities carried out at this stage of the assessment are multimedia assessments developed in actual conditions. Tests were carried out on two test classes, namely the experimental class and the control class. The purpose of the large group assessment is to determine the level of practicality and effectiveness of the developed multimedia.

1) The results of the Practicality Assessment by the Teacher

The practicality of computer-assisted interactive multimedia was also assessed by the teacher based on aspects of the use of multimedia in the classroom. The teacher who assesses is a Biology teacher who teaches in the experimental class for the 2021/2022 academic year. The teacher assesses the practicality of multimedia by filling out the questionnaire that has been provided. ResultsThe questionnaire filled out by the teacher is as follows.

Table3. Practical Assessment by Teacher

No.	Aspect	Score (%)	Criteria
1	Ease of Use	91.67	Very practical
2	Efficiency	100.00	Very practical
3	Attractiveness	100.00	Very practical
4	Easy to interpret	91.67	Very practical
5	Have Equivalence	100	Very practical
Average Practicality Score		**96.66**	**Very practical**

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Based on the table above, it is known that the average practicality value of interactive multimedia assisted by virtual laboratories filled by teachers is 96.66% (Appendix 20) with very practical criteria.

1) Results of Practicality Assessment by Students

Interactive multimedia assisted by a virtual laboratory that has been assessed as practical by small groups is revised and tested in the experimental class. Furthermore, at the end of the meeting, students provide an assessment of the interactive multimedia developed. The questionnaire given is a practical field test evaluation questionnaire. This test is called the large group test.

The results of the field test evaluation can be seen in the table below.

Table4. Results of Field Test Evaluation.

No.	Aspect	Score (%)	Criteria
1	Ease of Use	96.10	Very practical
2	Efficiency	92.49	Very practical
3	Attractiveness	92.49	Very practical
4	Easy to interpret	94.16	Very practical
5	Have Equivalence	89.99	Very practical
Average Practicality Score		94.57	**Very practical**

Based on the table above, it is known that the average practicality value of interactive multimedia assisted by virtual laboratories filled by experimental class students is 94.57% categorized as very practical to use (Appendix 24).

2) Effectiveness Test

The results of the effectiveness test obtained in the form of learning outcomes data. The learning outcomes include students' critical and creative thinking skills. Data on critical and creative thinking skills were obtained from the learning outcomes test at the end of the lesson. The learning process in the experimental class uses interactive multimedia assisted by a virtual laboratory. While the learning process in the control class uses teaching materials commonly used by teachers in schools. Learning outcomes data were obtained through learning outcomes tests conducted at the last meeting. The test is given in the form of essay questions. Data on the assessment of students' critical and creative thinking skills are presented in the table below.

Table5. Assessment of the Results of Students' Critical and Creative Thinking Skills

Thinking Skills	Class	N	Test Average
Critical	Experiment	35	82.69
	Control	32	59.5
Creative	Experiment	35	83.77
	Control	32	55.81

Based on the table above, it can be seen that the average critical and creative thinking skills of the experimental class students are higher than the control class average. The experimental class is a class that is given treatment in the form of interactive multimedia assisted by a virtual laboratory on the respiratory system material in humans, while the control class is a class without treatment. The average value of critical and creative thinking skills in the experimental class is 82.69 and 83.77 (Appendix 35). Meanwhile, the average value of critical and creative thinking skills in the control class is 59.5 and 55.81 (Appendix 36).

The next stage is hypothesis testing, but first the normality test and homogeneity test are carried out as prerequisites for data analysis. Prerequisite tests carried out are normality test and homogeneity test. Researchers conducted a normality test using the Kolmogorov-Smirnov test. The results of the normality test of the critical and creative thinking ability of the control and experimental classes resulted that all critical and creative values of the control class, experimental significance > 0.05, meaning that the data was normally distributed. Furthermore, the homogeneity of the data was tested using Levene's test. The results of the homogeneity test of the critical and creative values of the control and experimental classes showed that the critical and creative

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thinking ability data had a significance of > 0.05, which means that all data were homogeneous. Data that have been normal and homogeneous, then tested the hypothesis using ANOVA. The results of the hypothesis test of critical and creative thinking skills in the experimental and control classes can be seen in the table.

Table6. Results of ANOVA Calculation of Critical and Creative Thinking Skills.

Skills Think	**Class**	**Significance**	**Information**
Critical	Experiment	0.000	Hypothesis Received
	Control		
Creative	Experiment	0.000	Hypothesis Accepted
	Control		

Based on the table above, it is known that the significance value of students' critical thinking skills is 0.000 and creative thinking skills is 0.000. This indicates that the value of sig. < 0.05, which means that the hypothesis is accepted. Furthermore, further tests were carried out, namely the bonferoni test. Bonferoni further test results can be seen in

Table7. Bonferoni further test results

Group	**Group**	**Average Test Score ($\overline{X}$)**	**level Sig.**
Experimental Critical	Critical Control	71.09*	.000
	Creative Experiment	83.23*	.000
	Creative Control	69.25*	.000
Critical Control	Experimental Critical	71.09*	.000
	Creative Experiment	71.63*	.000
	Creative Control	57.65	.884
Creative Experiment	Experimental Critical	83.23*	.000
	Critical Control	71.63*	.000
	Creative Control	69.79*	.000
Creative Control	Experimental Critical	69.25*	.000
	Critical Control	57.65	.884
	Creative Experiment	69.79*	.000

Note: * = significant

Based on the Bonferroni further test, the experimental critical group was significantly different from the critical control group, the creative experimental group, and the creative control group. While the critical control group was not significantly different from the creative control. Thus, it is known that the use of interactive multimedia assisted by a virtual laboratory has an effect on improving the critical and creative thinking skills of class XI students of SMAN 1 Sitiung.

3.2. Relationship between Critical and Creative Thinking Skills

This study uses data regression analysis of variables X and Y, where variable X is critical thinking and variable Y is creative thinking. This was done in order to see whether there was a relationship between critical thinking skills and creative students in the experimental class. The results of the research conducted were based on the test scores of students' critical and creative thinking skills. The results of the analysis of critical and creative thinking skills in the experimental class can be seen in the table below:

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Table8. The Result of the Analysis of the Relationship between Critical and Creative Thinking Skills in the Experimental Class

Variable	R	R-square	F	Sig.
Critical (X) independent	0.876	76.7%	108,487	0.000
Creative (Y) dependent				

Based on the table above, it can be seen that the critical variable is the independent variable and the creative variable is the dependent variable. Significance 0.000 <0.05 this means that there is a relationship between variance which indicates that the relationship between the dependent and independent variables is strong. The correlation coefficient value is 0.876. While the coefficient of determination (R-square) is 76.7%.

3.3 Discussion

The prototype development stage directs researchers to create valid and practical interactive multimedia. The steps taken are interactive multimedia must be valid in terms of content, construct and technical. Validation is the accuracy, meaning, and usefulness of something made by researchers (Lufri, 2015). This stage consists of self-evaluation, expert review, one-to-one evaluation, small group evaluation, and field test. This evaluation is carried out to find out whether the problems that occur in the school can be resolved properly.

The first stage is self-evaluation, which is self-assessment of the instrument prototype by checking itself about the construct, language and content, whether it is appropriate and correct, after it is deemed sufficient to proceed to the next evaluation stage (Agustine, 2014). Researchers evaluate themselves to see whether the components contained in virtual-assisted interactive Multimedia***laboratory***developed has been fulfilled or not through filling out a self-evaluation questionnaire. The results of the self-evaluation carried out by researchers showed that the interactive multimedia developed had met the completeness of interactive multimedia with the intro page, login, main menu, user manual, to profile, then the material presented was in accordance with the 2013 curriculum, the presentation of the material was in accordance with KD 3.9 and KD 3.10 as well as the use of good and correct Indonesian and pictures that have been equipped with descriptions.

The next stage is validation which is done by expert review. Validation Interactive multimedia assisted by a virtual laboratory is validated by three experts or experts. The validity of the interactive multimedia developed is assessed by experts or experts based on 3 aspects, namely didactic aspects, construct aspects and technical aspects. The validity of interactive multimedia assisted by a virtual laboratory conducted by an expert review showed that it was very valid overall with an average validity value of 81.27%. The description of the average value of validity is from the didactic aspect of 80.56% with very valid criteria, the construct aspect of 82.29% with very valid criteria and 80.95% technical aspects with valid criteria. The validator provides suggestions, criticisms,

Based on the criteria in the didactic aspect, it is known that the multimedia developed is in accordance with the 2013 curriculum where there is a suitability of the material with indicators of competency achievement, the suitability of the material with learning objectives and the material is arranged systematically. The teaching materials developed must be in accordance with the applicable curriculum (Wiyanto, 208).

The problems given in interactive multimedia assisted by a virtual laboratory require students to provide problem solving solutions by working together. According to (Bengi, 2015) states that at this stage students participate actively to create solutions to everyday problems that students often encounter, the solutions expressed are very innovative and this is a learning experience for students. At this stage to train students' creative thinking skills.

The assessment of the construct aspect has very valid criteria by the validator with a value of 82.29%. interactive multimedia that has been developed has a clear identity and is systematically arranged, interactive multimedia is equipped with learning outcomes, the description of material in interactive multimedia is clear. Based on the use of language, the interactive multimedia developed has been in accordance with the rules of good and correct Indonesian and the use of appropriate terms. According to (Hamdani, 2011), language is one aspect that needs to be considered in the preparation of teaching materials and the language used should be simple and easy to understand. The opinion (Zulyusri S, 2019) states that the language used in interactive multimedia must be good, clear and does not cause confusion,

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The next aspect is the technical aspect which has very valid criteria by the validator with a value of 80.95%. According to (Trianto, 2011), the terms or criteria for technical aspects are related to writing, images and appearance in the manufacture of a product. Based on the criteria on the technical aspect, it can be stated that the interactive multimedia developed uses the type and size of letters that can be read clearly and uses appropriate punctuation marks. The presentation of images in interactive multimedia has a size and explanation that can be read clearly. According to (Sudjana, 2011), picture illustrations and animations can help students understand and remember the accompanying material.

Overall interactive multimedia developed has very valid criteria, so it can be tested for the next test stage. (Arikunto, 2009) which also explains the data generated from a product that is already valid, it can be said that the product has provided an overview of the development objectives correctly and in accordance with the actual reality and circumstances. Based on the results of the one-to-one evaluation, it was found that the interactive multimedia of the respiratory system and excretory system in humans that was developed received a positive response by students. Students in the one to one evaluation stated that the interactive multimedia developed had good writing, grammar, pictures and displays to help students understand the material.

The stage carried out after the one to one evaluation is the multimedia practicality stage. Practicality testing is carried out with two techniques, namely field trials and teacher assessments (Setiawan H, 2017). The first practical assessment was carried out in a small group. Students are selected based on low, medium and high ability levels. Each level of ability consists of two students. The next assessment is an assessment in a large group or field test consisting of 35 students and an assessment by one biology teacher. Practicality of interactive multimedia assisted by virtual laboratory is seen from the aspect of ease of use, efficiency of interactive multimedia, attractiveness, ease of interpretation and equivalence with existing learning resources.

Small group evaluation which has very practical criteria with a value of 95.71%. The results of the large group practicality (field group evaluation) also have very practical criteria with a value of 94.57%. Furthermore, the results of the assessment by the teacher have very practical criteria with a value of 96.66%.

The interactive multimedia that has been developed provides convenience in terms of use, both in the presentation of material using language that is easy to understand and also in clear font sizes. This interactive multimedia is also supported by images and animations, where from the images and animations students can focus and be interested in understanding the material so that it affects the level of understanding of the students' material.

On the aspect of ease of use of interactive multimedia in accordance with the available time so that it does not interfere with other learning. Practicality can be seen from the implementation time which should be short, fast and precise. Then, the attractiveness aspect has very practical criteria (Sukardi, 2012).

1. Assessment Stage

The assessment phase aims to determine the quality of interactive multimedia assisted by a virtual laboratory that was developed. The effectiveness of interactive multimedia assisted by a virtual laboratory that was developed can be seen from the students' critical and creative thinking skills obtained after students use interactive multimedia in the learning process. Product effectiveness is a product quality criterion developed based on the presence or absence of influence on users (Nieveen, 2007). The results of the effectiveness assessment show that the developed interactive multimedia is effectively used as teaching material in the learning process. Students' critical and creative thinking skills are assessed through daily tests of the human respiratory system. The instrument used in the form of essay questions as many as 6 items. Testing the effectiveness of interactive multimedia was carried out using the ANOVA test, because the data were normally distributed and homogeneous. Based on the ANOVA test, it was found that the hypothesis was accepted. Furthermore, the Bonferroni test was carried out to see the difference in the value of each item. Based on the Bonferroni test, it is known that the critical and creative thinking ability test scores in the experimental class are higher than the control class. Therefore, it indicates that the use of interactive multimedia assisted by a virtual laboratory on the respiratory system and excretory system materials in humans is effective for learning. Researchers continue to strive for an effective learning process using interactive multimedia assisted by a virtual laboratory. In line with the opinion (Zuriah,

Based on the prerequisite test, namely the normality test, all values in the experimental and control classes were normally distributed and all data were homogeneous. This means that the test value has met the prerequisites and is continued with hypothesis testing. Achievements in training students' critical and creative thinking skills can be proven by the average score of each aspect of students' critical and creative thinking skills in both classes.

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Based on the results of the hypothesis test presented in CHAPTER IV, the results obtained are that there are significant differences in the critical and creative thinking skills of students in the experimental class and the control class. The results for critical thinking in the experimental and control classes obtained p-value = 0.000 < (α = 0.05). The results for creative thinking in the experimental and control classes obtained p-value = 0.001 < (α = 0.05). The hypothesis is accepted if the significant value is <0.05 on the ANOVA test. The treatment in the experimental class used interactive multimedia assisted by a virtual laboratory, while the control class used teaching materials commonly used by teachers. Increasing the results of students' critical thinking skills is closely related to the learning process carried out. This is in accordance with Hanafi and Samsudin (2012) who stated that interactive skills, easy access, and fun are some of the advantages provided by electronic learning materials. In addition, creative thinking is also integrated where students are directed to be able to express ideas or ideas in more detail, clearly, and differently than in general. Students think in groups to relate problems to interactive multimedia by conducting literature studies so that problems can be solved optimally. and different than usual. Students think in groups to relate problems to interactive multimedia by conducting literature studies so that problems can be solved optimally. and different than usual. Students think in groups to relate problems to interactive multimedia by conducting literature studies so that problems can be solved optimally.

Based on the average value of the p test obtained by students and based on the results of research, interactive multimedia assisted by virtual laboratories is able to improve students' critical and creative thinking skills. In line with the research of Arda et al. (2015) which states that learning science with interactive learning materials is better than using conventional learning strategies, and being able to improve understanding of concepts also makes the learning process more interesting. Therefore, it can be concluded that interactive multimedia assisted by a virtual laboratory based on research results can improve students' critical and creative thinking skills.

2. Relationship between Students' Critical and Creative Thinking Skills

Critical and creative thinking are abilities that must be possessed by someone where these thinking abilities are two sides that cannot be separated and become the goals of national education. Both are said to be a necessary skill in life either alone or in groups. Based on research data, critical thinking skills have a relationship with students' creative thinking skills. The correlation/relationship between variables X and Y is 0.876 which indicates that the relationship between critical and creative variables is strong. Critical thinking skills affect 76.7% of the creative thinking skills of experimental class students. The relationship between critical and creative thinking skills is in line with (Treffinger DJ, 2007) that critical thinking skills and creative thinking skills are interconnected in producing an effective thought in solving a problem. The results of the study (Gunawan, 2014) also concluded that critical and creative thinking skills are simultaneously and significantly related to student learning achievement. Critical and creative thinking is needed to support the development of the 21st century. Critical and creative thinking plays an important role in the development of education and has a main goal in learning where there are four important components to build these abilities, namely (a) explaining and clarifying; (b) ask appropriate questions to clarify or challenge; (c) consider the credibility of the source; (d) problem solving and drawing conclusions (Iakovos, 2011). The ability to think critically and creatively is very necessary considering that today's science and technology is developing very rapidly and allows anyone to obtain information quickly and easily in abundance from various sources and any place. This has resulted in rapid changes in the order of life and global changes in life. If they are not equipped with critical and creative thinking skills, they will not be able to process, assess and retrieve the information needed to face these challenges. The ability to think critically and creatively is an important ability in life.

Critical and creative thinking skills can be trained through learning that requires students to explore, inquiry, discover and solve problems. Learning that can lead students to develop and or overcome critical and creative thinking can be assumed by using a problem-based learning model which requires students to be active in the learning process and have the opportunity to find and or apply their own ideas. Problem-based learning is an innovation in learning because in this learning students' thinking abilities are truly optimized through a systematic group or team work process, so that students can empower, hone, test, and develop their thinking skills on an ongoing basis.

4. CONCLUSION

Based on the development of interactive multimedia assisted by a virtual laboratory for class XI students of SMAN 1 Sitiung, the following conclusions were obtained.

1. Interactive multimedia has very valid, very practical and effective criteria.

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2. The use of interactive multimedia can empower students' critical and creative thinking skills.
3. Critical thinking skills are related to creative thinking skills after students use interactive multimedia.

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