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Effect of Interactive Multimedia Based on PBL on Critical Thinking Ability and Science Literacy VII Junior High School Student at Kupang

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Abstract. This study aims at describing the feasibility of PBL-based interactive multimedia, as well as improving students' critical thinking skills and scientific literacy. The formulation of the problem in this study is how is the feasibility and effectiveness of the results of the implementation of multimedia development based on Problem Based Learning (PBL) on environmental pollution material on critical thinking skills and science literacy of middle school students. The design used in this study was "Research and Development (R & D)" from Thiagarajan (Four-D). The research locations were in junior high schools in the city of Kupang, namely SMP Muhammadiyah, Kupang SMP Negeri 4 and SMP Negeri 16 Kupang in the Academic Years 2018-2019. The sampling taken by using purposive sampling method. The instruments used in this study were in the form of questions about the ability to think critically, questions of scientific literacy, and questionnaires and observation sheets. Quantitative data in the form of score data to increase students' critical thinking skills and scientific literacy, while qualitative data obtained when the small group test was analyzed descriptively in the form of validation results. The results showed that: 1) PBL-based interactive multimedia is suitable for use in the learning process in junior high schools, 2) PBL-based interactive multimedia is able to improve students' critical thinking skills and scientific literacy

1. Introduction

Changes in the era of globalization require human resources that have more effective quality of empowerment to be able to overcome various challenges that arise. The demands of 21st century education are changes in the educational paradigm by developing students' potential according to Higher Order Thinking Skills and the implementation of the 2013 curriculum (K-13) brings consequences for teachers who must be more qualified in carrying out learning activities. This shows that education is an important aspect in the development of a nation. In line with this shift in needs, education restructuring must be carried out. Education is expected not to be directed only at printing workforce for industry, but also for workers who optimize thinking skills in carrying out their jobs so as to produce graduates as expected competencies.

Various efforts have been made by the government to improve the quality or quality of education in Indonesia. The steps that have been taken are to make curriculum changes periodically with the aim of producing graduate competencies according to the demands of the 21st century. According to Cooper (2011), the determinants of the quality of education are the quality of teachers, and effective

teachers can produce significantly the learning benefits gained students compared to ineffective teachers. Teachers who dominate learning make the opportunity of students to be actively involved so they become less creative. Therefore the teacher should make the class supportive and pleasant so as to be able to motivate students to learn the material, because the role of the teacher as a giver as well as liaison of knowledge is the most important means in preparing education that is directly useful for the future (Wulandari & Surjono, 2013; Laelasari, et al., 2015). Some of the main factors that cause low achievement of student learning achievements in Indonesia are the lack of teacher skills in managing learning. In general, teachers still use conventional learning that is verbalistic and the learning process is very centered on the teacher (teacher centered).

The implementation of the curriculum according to the Minister of Education and Culture which is expected in learning or recommended to be applied is a method that is included in the scientific approach or problem-based approach. In addition to problem based, innovative and creative learning needs to be done so that the learning process runs in accordance with the competencies to be achieved. One example is the use of multimedia technology in educational institutions deemed necessary so that education remains relevant to the 21st century. According to Munir (2015), the use of multimedia has had a positive impact on the learning process, but the impact in reality still needs to be disseminated to educators. In fact educators find it difficult to understand the challenges of change demanded by multimedia technology and the limitations in exploiting these changes.

In addition to multimedia, learning is needed based on scientific literacy of students so that students have a high understanding of the material conveyed by a teacher. The ability of literacy in science becomes an important ability that must be mastered by students in order to live and live in the 21st century. having scientific literacy is students who are able to use science concepts, have science process skills to assess in making everyday decisions when dealing with other people, society and the environment, including social and economic development. Based on the results of observations made in class VII, learning does not yet have competence in improving students' critical thinking skills. This is characterized by a lack of students' ability to argue, and have not been able to interpret an issue given in the learning process. Learning has used several models, but not yet maximally. In fact, in the field, students are less motivated in participating in learning due to the lack of learning media that can attract students' attention, and the learning that has been done so far only uses images or chart. Based on the results of interviews with Biology Science teachers, science process skills have not been applied during the learning process. Students lack the ability to identify, and use a variety of models and clear representations. In learning science, students have not been able to submit hypotheses clearly, and have not been able to make and justify predictions appropriately. Learning that is done is only oriented to the completion of matter, so that more use the lecture method only.

Based on these problems, the learning model that can improve students' critical thinking skills is problem-based learning (PBL). According to Fallis (2013), PBL is an instructional strategy that allows students to develop critical thinking skills and solve problems that they can find in everyday life. The PBL model is used to help students develop high-level thinking skills by placing students in situations such as the real world. PBL syntax is problem orientation, organizing to research or study, guiding individual / group experience, developing and presenting work, analyzing and evaluating problem solving processes (Nur, 2011; Bilgin et al, 2008). In addition to aiming to improve students critical thinking skills, PBL aims to improve students' scientific literacy through learning that emphasizes processes not just products.

One of the factors that influence literacy skills is the ability to think critically. According to Uswaldi (2016), Science Literacy is assessed from four dimensions, namely science process, knowledge, application of science, and attitudes of students towards science. Building scientific literacy is building a number of competencies that must be possessed by students, and how the facts of science form certain skills in learning. The results of Shwartz al (2006) research, scientific literacy learning can improve learning outcomes of chemical reactions and the results of implementing scientific literacy must be integrated in the curriculum and learning objectives.

The purpose of this study was to develop interactive multimedia on environmental pollution material in the seventh grade junior high school students through a step to test the level of feasibility and effectiveness of PBL-based interactive multimedia products. Through the development of PBL-

based interactive multimedia, it is expected that students can find problems and solve problems with the science process in the learning process and change the new educational paradigm, namely student-centered learning.

2. Methods

This research is a development research, which is developing interactive multimedia in the material pollution of class VII SMP with reference to the development of Four-D models according to Thiagarajan and Semmel, which consists of defining, designing, developing spread (disseminate). The research was conducted in junior high schools in Kupang, namely SMP Muhammadiyah Kupang, SMP Negeri 4 Kupang, and SMP Negeri 16 Kupang to produce interactive multimedia validated by multimedia experts and Biology material experts. The sampling taken by using purposive sampling method. Data collection techniques used were questionnaires, tests, and observation sheets. While the instruments used were expert validation questionnaires, questionnaires validating student readability, student response questionnaires to learning using interactive multimedia developed as well as critical thinking test questions and scientific literacy questions. the data obtained in this study were analyzed using qualitative descriptive analysis

In general, the development steps consist of:

1. Expert Judgment

Expert validation conducted in the development of PBL-based interactive multimedia consists of:

a. Material Validation

Before being tested on students, the products developed, namely interactive multimedia, were validated first by Biology Science material experts. Validation is done to get assurance that the initial product developed is worth testing. Validator I (V I) is an expert lecturer in the development of media and teaching materials and validator II (V II) is an expert lecturer in Biology material and validator III (V III) is a class VII Biology Science teacher..

b. Validation of Development Experts

Expert validation for the development of interactive multimedia with the PBL model aims to obtain data in the form of assessments, opinions, criticisms, and suggestions on the development of the media developed.

2. Trial Small User Groups

Trial Small User Groups

Small group trials of interactive multimedia developed were conducted by giving questionnaires to Biology Science teachers with the aim of obtaining data in the form of opinions, criticisms, and suggestions on the effectiveness of learning media in the form of PBL-based interactive multimedia and also to students with the aim of getting responses, related to the media developed.

3. Field testing

Field trials were conducted on class VII students at SMP N 4,. Middle School 16 and Muhammadiyah Middle School in Kota Kupang. The purpose of the field trial is to find out whether the product produced has feasibility, both from the aspects of learning, content or material, and methods so that PBL-based interactive multimedia products are feasible to use. Based on the results of the field trials, the products are repaired again, so that it is more perfect to become the final product that is ready to be disseminated to the users. The field trials carried out were quasi-experimental because the control was only carried out on one variable, the most dominant variable..

The data obtained in this study were qualitative data obtained when the small group test was analyzed qualitatively and converted to a scale table. The scores obtained are then converted into four-scale qualitative data adopted from Millah et al. (2012), as presented in Table 1. as follows

Table 1. Four Scale Qualitative Data Score Criteria Value Calculation.

Score	Criteria	Score	
		Number	Calculated
A	Very good	4	3,51 – 4,00

B	Good	3	2,51 – 3,50
C	Less Good	2	1,51 – 2,50
D	Not Good	1	1,00 – 1,50

Source: Millah et al (2012)

To determine the effectiveness or increase of scientific literacy and students critical thinking skills using the formula:

$$g = \frac{\text{score post test} - \text{score pre test}}{\text{score max} - \text{score pre test}}$$

The results of the Gain calculation are then categorized into 3 categories contained in Table 2.

Table2. Conversion of gain score into qualitative.

Gain score	Category
g > 0,7	**Height**
0,7 > g > 0,3	**Medium**
g < 0,3	**Low**

Source :(Hake,1999)

3. Research Results and Discussion

Interactive multimedia compilation starts from field observations, literature studies, and preparation of initial prototypes. The next step is the identification or collection of material, until a trial is made of the product being developed. The preliminary study was conducted with question and answer and filling out questionnaires by Biology science subject teachers to find out the curriculum, and the learning process carried out in schools including the use of teaching materials or media and the learning model applied.

The next stage is the design and development stage of interactive multimedia, followed by the validation step of the data obtained in the development of learning devices consisting of product feasibility test data, limited trial data, and field trial data. In general, the characteristics of PBL-based interactive multimedia that are developed are there are experiments or experiments in an interactive manner, there are features to create works, as well as independent practice questions. Based on material experts and media development experts, PBL-based interactive multimedia on pollution material is included in the good category and is ready to be implemented in the learning process. While the recapitulation of the draft I Validation Results by experts and practitioners, namely the teacher, as presented in Table 3

Table 3. Recapitulation of draft I Validation Results by experts and practitioners.

	Scores and Ratings			**Average**	**Category**
	V1	V2	V3		
Syllabus	3,2	3,4	3,2	3,33	Good
Lesson Plan	3,2	3,3	3,4	3,33	Good
Questionnaire	3,2	3,4	3,5	3,4	Good
Evaluation	3,0	3,2	3,2	3,1	Good
Assesment	3,4	3,4	3,3	3,4	Good

Table 3 shows that the validation that has been done on the device and evaluation or instrument, shows that the average is in a good category. This shows that the results of validation by experts and practitioners can be implemented in Biology science learning VII grade students with environmental pollution material. validation by material experts, media experts, and practitioners so that learning

products after at least being in the good category are feasible for field trials. The results of the small group test questionnaire on interactive multimedia are developed as shown in Table 4 as follows:

Table 4. Results of Small Group Tests on interactive Multimedia developed

Aspect	Average	Category	%
Clear display	3,52	Very good	87,2
Clear visual and audio	3,43	Good	84,8
Organization/ Navigation	3,51	Very good	86,3
Language use	3,26	Good	81,5
Learning	3,21	Good	82,1
Accuracy of Content Coverage	3,26	Good	81,5
PBL Model	3,26	Good	81,5
Multimedia digestibility	3,37	Good	84,3
Total Average	3,35	Good	83,65

Table 4 shows that the evaluation of interactive multimedia developed has an average value of 83, 65 with a good category. This shows that PBL-based interactive multimedia developed does not need to be revised again because it is in a good category and is ready to be implemented in the learning process Small group examinations are carried out by giving questionnaires to students and science Biology subject teachers about PBL-based interactive multimedia developed. Based on the display and navigation aspects are in the excellent category with a value of 87.2% and 86.3%, while the aspects of language use, learning, PBL models and digestibility are all in the good category. This shows that the development of PBL-based interactive multimedia in pollution material is feasible to support Biology science learning.

Based on the results of small-scale tests, revisions were made in accordance with input from material experts and media experts. The next step is field testing or a wider scale test conducted on students in the real class. In this large-scale test the data collection was carried out in the form of critical thinking skills and scientific literacy of students after being given learning using PBL-based interactive multimedia obtained from the questions of the pretest and posttest as well as student worksheets. The results of the pretest and posttest critical thinking skills can be seen in Table 5 as follows:

Table 5. Average values of pretest and posttest critical thinking skills.

Component	Value
Average Pretest Value	48,72
Average Posttest Value	79,12
Gain	14,72
N-Gain	0,43

Based on table 5, the value of the pretest is 48.72 and the average posttest value of critical thinking skills is 79.12. While the gain of 14.72 and N-gain is 0.43. This shows that the increase in students' critical thinking skills is in the moderate category, meaning that the increase in critical thinking skills is in a fairly good category and shows that the selection of multimedia in learning is quite effective. The advantage of using multimedia in learning is that it can improve students' ability to understand an abstract concept more easily. Students who think critically about a problem will not be satisfied with a clear or tangible solution but will suspend judgment by looking for all relevant arguments, facts and

reasoning. can support good decision making PBL learning model can improve students' critical thinking skills in the subject matter of straight motion changes irregularly, and there is the influence of PBL learning on critical thinking skills, process skills and cognitive learning outcomes of students of Malang 1 Public Middle School. The link between PBL and critical thinking skills is that PBL provides an opportunity for students to develop their ability to think (Setyorini, 2011). This strategy emphasizes complex problem-solving abilities that indirectly develop thinking skills. students have developed the ability to think critically, the student can interpret the information obtained to draw conclusions into a concept that can be justified. The ability of students to increase will make it easier for students to absorb the concepts learned.

The best way to teach critical thinking is to demand students to write. Writing can train students to organize their thoughts, reflect on topics in learning, evaluate and convey persuasive conclusions. Science learning should be done by making meaningful connections between life experiences and learning. Science in class. The optimal level of meaningfulness in science learning for students can be obtained if students have good scientific literacy skills. The analysis of the results of the scientific literacy test of junior high school students in Kupang after being given the posttest question in PBL-based interactive multimedia learning shows that science learning should be done with regard to the science process not just a product. The percentage of science literacy in middle school students in Kupang as shown in Table 5 is as follows:

Table 5. Total scores of student Literacy tests.

No	School	Score Average	Percentage	Criteria
1	SMP N 16 Kupang	43,3	61,8	Medium
2	SMP Muhammadiyah Kupang	42,7	60,1	Medium
3	SMP N 4 Kupang	43,6	60,4	Medium
	Average	43,2	61,3	Medium

Based on Table 5 it can be seen that the average value of the results of the literacy test given to middle school students in Kupang is included in the medium category with an average score of 43.2 or in the percentage reaching a value of 61.3. The indication of student scores can be said to be moderate in accordance with the number of questions that can be answered correctly by students after being given posttest questions using environmental pollution material and PBL based.

People who have scientific literacy have a better chance to engage in the productive career of the world of work and the global community. This is because of his ability in applying scientific work., critical thinking and able to make decisions responsible for decisions made (Yuenyong and Narjaikaew, 2009).

Literacy is the skills needed in the 21st century. Scientific literacy results can be different if tested on a smaller scope. Given the diverse potential, regional, social and cultural characteristics of the community and Indonesian students, it certainly will have an influence on aspects of learning which also include students' literacy skills (Inzana, 2013). According to Holbrook & Rannikmae (2009), developing scientific literacy through science education is developing the ability to use scientific knowledge and skills creatively based on sufficient evidence, especially those that are relevant to careers and daily life in solving important and challenging problems.

4. Conclusion

1. Expert validation of interactive multimedia that was developed through the stages of validation, limited trials, and field trials showed that the display and navigation aspects were in a very good category with values of 87.2% and 86.3%, while aspects of language use, learning PBL models and digestibility are in the good category

2. Small Group Test Results for interactive Multimedia developed were 3.35 or 83.65% and stated good
3. The effectiveness of PBL-based interactive multimedia that was developed was able to improve students' critical thinking skills with a gain of 14.72 and N-gain of 0.43, and be able to improve scientific literacy of junior high school students in Kupang with a percentage value of 61.3 and included in the medium category.

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References

[1]. Asyhar R 2012 *Kreatif Mengembangkan Media Pembelajaran* (Jakarta: Referensi).

[2]. Bilgin, Ibrahim 2008 The Effect of Problem Based Learning Instrumen on University Students Performance of Conceptual and Quantitative Problems in Gas Concept (Turkis: Uni of Mustafa Kemal).

[3]. Fallis 2013 Penerapan Model Problem Solving dalam Kelompok Kecil untuk Meningkatkan Kemampuan Berpikir Kritis dan Hasil Belajar Journal of Chemical Information and Modelling Vo 53 pp: 1689-1699.

[4]. Cooper, James, M 2011 Clasroom Teaching Skills, Nine Edition. Cengage Learning Wadsworth United State of America.

[5]. Grigg, R and Lewis, H 2018 Moving the andragogy of Teacher Education forward: The Potential and Challenges of Problem Based Learning in Teacher Education Journal of Problem Based Learning Vol 5 pp. 5 – 19.

[6]. Hake, R 1999 Analyzing chane/gain scores (Indiana: Indiana University).

[7]. Holbrook, J., & Rannikmae, M 2009 The meaning of scientific literacy International Journal of Environmmental & Science education Vol 4 pp. 275-288.

[8]. Inzana 2013 Pengembangan Perangkat Pembelajaran IPA Berbasis Kurikulum 2013 untuk Melatihkan Literasi Sains Siswa SMP Tesis tidak dipublikasikan. (Surabaya: Universitas Negeri Surabaya).

[9]. Laelasari, Toto, S, dan Nurul, I.K 2015 Penerapan Model Pembelajaran Learning Cycle 7e dalam Kemampuan Representasi Matematis Siswa Jurnal Euclid Vol 1. Pp; 82-92.

[10]. Millah, E.S dan Budipramana, L.S 2012 Pengembangan Bahan Ajar Materi Bioteknologi di Kelas XII SMA IPIEMS Surabaya Berorientasi Sains, Teknologi, Lingkungan dan Masyarakat (SETS) *Jurnal Mahasiswa Teknologi Pendidikan* Vol 1(1): 19-24

[11]. Munir 2015 *Multimedia Konsep & Aplikasi dalam Pendidikan* (Bandung: Alfabeta) p 9.

[12]. Muhammad, Nur 2011 *Model Pembelajaran Berdasarkan Masalah* (Surabaya: Pusat Sains dan Matematika Sekolah UNESA)

[13]. Setyorini, U,Sukiswo, S.E., dan Subali, S. 2011.Penerapan Model Problem Based Learning untuk Meningkatkan Kemampuan Berpikir Kritis Peserta didik SMP. *Jurnal Pendidikan Fisika Indonesia*, 7(1): 1-7.

[14]. Sarwiko, D. 2009. *Pengembangan Media Pembelajaran Berbasis Multimedia Interaktif Menggunakan Multimedia Director Mx.* (Jakarta: Universitas Gunadharma).

[15]. Schwartz, Y., R. Ben-Zvi, and A. Hofstein 2006 The use of scientific literacy taxonomy for assessing the development of chemical literacy among high-school students. Chemistry Education: Research and Practise. Vol 7. pp 203-225.

[16]. Uswaldi. 2016. Pengembangan Model Pembelajaran Fisika Berbasis Riset dengan Pendekatan Scientifik untuk Meningkatkan Literasi Sains Peserta Didik. *Jurnal penelitian & Pegembangan Pendidikan Fisika*. 2(1): 1-8.

[17]. Wulandari, B.& Surjono, H.D 2013 Pengaruh PBL terhadap hasil belajar ditiinjau dari motivasi belajar PLC di SMK *Jurnal Pendidikan Vokasi* 3(2): 178-191.

[18]. Yuenyong, C., and P. Narjaikaew. 2009. Scientific Literacy and Thailand Science Education. *International Journal of Enviromental & Science Education*, Vol 4 pp: 335-34.