Sets vision of interactive multimedia on the problem based learning in science learning

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Abstract. The purpose of this study is to describe and to analyze the effectiveness of problem based learning (PBL) model in improving the ability of critical thinking and social skills of students in science learning based on gender. The research design used is Research and Development (R&D) design has been used in this study. The subjects of the study are students grade VIII Junior High School 7 Tegal in 2016/2017 academic year. Observations, interviews, tests, and questionnaires technique have been used to obtain the research data. The validity of learning tools and interactive multimedia are respectively 88.33% and 79.37%. The effectiveness of the improvement of learning is shown by the N-gain of 0.59. In this study it is shown that the critical thinking ability of female students is higher than that of male students. The result shown that the learning tool is valid, effective, and practical use as a tool of the PBL model and can improve the critical thinking and social skills of learners.

1. Introduction
The progress of technology in twenty first century has encouraged the learning approach to be more interesting and effective. The innovation in education has resulted a more creative development for interactive technology in many forms, such as: Computer Based Instruction, Intelligent Tutoring System, Integrated Learning System and Computer Based Evaluation and Communication [1].

The Ministry of Education Regulation number 16 year 2007 about Academic Qualification Standard dan Teacher’s Competency states that a science teacher of Junior High School is required to have the competency of applying concept, law and theory of science in daily life. Furthermore, a teacher is expected to be able to follow the technology development in education in order to improve the learning process of science in the classroom. One of the real steps is the use of software as a medium of learning in the form of interactive multimedia. Visualization through the medium of learning in the form of multimedia is meant to make something abstract becomes concrete. A computer supported with multimedia can provide a more interesting and interactive presentation. Using interactive multimedia in the teaching process is a growing phenomenon. Multimedia plays a very important role in assisting students in learning processes [2].

The learning of physics is a part of science that has abstract concepts. The role of analogies as tools for teaching difficult science concepts has been widely discussed in science education [3]. The teaching learning of physics about rectilinear and the influence of force on a movement based on the law of Newton is frequently faced to abstract material which causes confusion to the students. Based on the observation and interview on science teacher of grade 8 of Junior High School 7 Tegal, we got
information that the learning process of science on rectilinear and the laws of Newton still focus on the
mastery of the material, drill of calculation matter, there is no application of Newton Law in daily life,
lack involvement of the students, and the use of software as the medium of the learning process if not
yet optimized. Besides that, the available CD of interactive multimedia of physical learning does not
refer to 2013 curriculum and the material shown does not show the daily life issue which based on
SET vision with PBL model. Because of that, interactive multimedia needs to be developed to make
the physical material which is abstract becomes concrete in order to make learning becomes effective
and meaningful.

The partnership for 21st Century Skills maps some life and career skills which have to be possessed
by the students of grade 4-12, they are critical thinking ability and social skill. The Framework
highlights a combination of content knowledge, specific skills, and expertise that includes critical
thinking, problem solving, reasoning, analysis, interpretation, synthesizing, creativity, self-direction,
and perseverance [4]. Critical thinking ability is defined as the ability to interpret, evaluate, give
reason effectively, analyze, solve problem, make conclusion, and decide the credibility of the available
proof [5,6,7]. The social skill is an important factor for students in order to socialize with their
environment so that they can motivate themselves and affect their success in learning [8].

Research on PBL using interactive multimedia has been conducted. The result is that the interactive
multimedia has equipped the students to think sophisticatedly, skillful in solving problem and undergo
IT based learning situation [9]. The application of PBL model using CD multimedia gives positive
impact on students’ performance [1,10]. The learning of PBL using multimedia is better than using
modul on students’ performance [11]. There is a significant difference on the result of students who
use multimedia and those who do not use multimedia [12]. Averagely, the result of learning of the
students improves significantly after they use multimedia [13]. The development of interactive
multimedia based on PBL model has fulfilled the criteria of validity, practicality, and positive affect
on students’ study result [14].

Based on the previous background and research analysist, we need to develop interactive
multimedia with the vision of SETS using PBL model. The purpose of this research is: (1) to describe
the characteristics of the interactive multimedia which is being developed, (2) to analyse the
development of effective learning tool, to improve critical thinking ability and social skill.

2. Methods

The research is a research and development that has purpose to develop a set of learning. The products
that being developed are learning instrument and the media of science learning which have vision of
SETS PBL model to improve the students’ critical thinking ability and social skill. The components of
learning instruments that are being developed are in the forms of syllabus, lesson plan, and worksheet
as well as evaluation tool. The learning medium that is being developed is interactive multimedia of
rectilinear and the law of Newton based on adobe flash CS 6. The research procedure uses
development steps according to Borg and Gall.

The research conducted at SMP 7, Tegal, in November, first term of the year 2016/2017. The
subject of the research is students of grade 8. The step of wide range scale is conducted with Two-
Groups Pretest-Posttest Design. The technic of sampling that’s used is cluster random sampling each
class consists of 24 students. There are two classes: 8G as the control class (learning by using
cooperative model) and 8F as the experimental class (learning by using PBL interactive multimedia
model with the vision of SETS. The variable that being measured in the research is the characteristic
of the learning instrument, validity, practicality, effectiveness, response from the teacher and students.
The effectiveness aspects that being observed are: critical thinking ability, social skill and the result of
the students. The technics of data collection are in the form of interview, test, observation and
questionnaire. Data analysis for validity and practicality are conducted with percentage to determine
the conclusion of the instrument and learning medium that are being developed by using the following
formula:
\[ P = \frac{\sum X}{\sum X_i} \times 100\% \]

where \( P \) is percentage, \( \Sigma X \) is the amount of ticks in each column from the result of observation, and \( \Sigma X_i \) is the amount of tick in each evaluated aspect.

The test upon effectiveness is conducted by analyzing the students’ critical thinking ability and social skill by using test and observation. The normality and homogeneity of the test results are analyzed as the requirement of the statistic test. Statistic test uses the formula of correlated t-test, if the data is not distributed normally and homogeneous so we use non-parametrics statistic. The test which to improve the critical thinking ability is analyzed by using N-gain (g) test in each class that is the experimental and control class by counting the pre-test and post-test.

2.1. Newton’s Law
Newton’s Law learning is one of the topics that require a learning medium because in the topic of Newton’s Law there are many sub topics which cannot be observed directly by the five senses [15]. One of the examples is the concept of inertia and style depiction acting on an object such as static and kinetic friction [16]. In describing the concepts in conventional learning, such illustrations or drawings are sometimes less clear and hard to imagine that turn out less attractive to students.

2.2. Adobe Flash
The programming of physics education software in Adobe Flash has often been developed [17] because Adobe Flash is easy to learn even for those who do not have prior knowledge in programming languages.

3. Result and Discussion
3.1. The Characteristic of the Developed Learning Instrument
The result of developing learning instrument has some characteristics, they are: (1) the learning instrument that being developed on syllabus, lesson plan, and worksheet is to relate the SETS elements, critical thinking ability and social skill, (2) Interactive multimedia is designed using Adobe Flash CS 6, can be operated on Windows XP, Vista, and Windows 7, (3) Interactive multimedia integrated with PBL model consists of 5 phases, (4) This interactive multimedia contains the steps of GLB, GLBB experiment and the Law of Newton as a part of the worksheet, (5) Learning implementation contains the aspects of critical learning ability and the aspects of social skill.

The use of adobe flash media is very effective in learning [17]. This can be seen from the increased motivation when using computer media [18]. Besides, the use of flash media makes it easier for teachers to give understanding of the theory to the students [19].
Figure 1 is an example of the appearance of the interactive multimedia phase 1 that is about rectilinear. On phase 1, the students are encouraged to involve in problem solving by being given a question “How can a thing be called moving?” That question is meant to figure out the students’ early concept about the definition of movement. Interactive multimedia can function as the opening in the learning process which organizes the students’ conceptual framework and facilitate the concept of comprehension [20].

3.2. The Effectiveness of Interactive Multimedia PBL Model on the Critical Thinking Ability
Test on homogeneity data on both classes is conducted by using Compare mean One-Way Anova on SPSS 22 program. Analysis of the difference of the average score between experimental class and control class carried out with the analysis of pre-test using test Independent Sample T-Test and post test using statistics nonparametric that is Mann-Whitney Test because the data is distributed normally but not homogeneous. The result of analysis of the hypothesis test shows that the t-counting value for pre-test is at t-counting < t-table with the significance of 0,185 > 0,05 so can be concluded that the average of the pre-test score for both classes are the same as before they were given the twelfth treatment, they have had the same ability. The result of significance of the score for the post-test is as much as 0,000 so obtained that Asymp sig < 0,05, so it can be concluded that there is difference in score between experimental class and control class because of the influence of the instrument and learning medium used.

After finding out the pre-test value and post-test score of the students’ critical thinking ability, next is to compare the pre-test score and the post-test score to see if there is any improvement. It was done to know the difference in the critical thinking ability of the students from each class after having been given treatment. The experimental class uses interactive media with the vision of SETS Problem Based Learning (PBL) model and control class uses cooperative model. Test which to increase the critical thinking ability based on pre-test and post-test score is done by normalized gain formula <g> that is by comparing the pre-test and post-test score. From the analysis obtained information that the N-gain score from experimental class is categorized average, it means the experimental class experiences significant improvement and the average N-gain is 0,59 > 0,50. The result of the six aspects to think critically analysis of the experimental class is shown on Figure 2.

![Figure 2](image-url)
Table 1. The test result of Mann-Whitney Test

| Kind of Test | Group       | Result of the Analysis |
|--------------|-------------|------------------------|
|              | Experiment  | Control                | t_{calc} | Sig  | α   | Df | t_{nл} |
| Pre-test     | 57.08       | 58.00                  | 0.477    | 0.185| 0.05 | 48 | 1.6    |
| Post-test    | 82.50       | 62.67                  | 0.000    | 0.05 | 0.05 | 48 | 8      |

The N-gain score of the experimental class is categorized medium that is 0.59 it means there is improvement at critical thinking ability of the experimental class. It can occur due to learning in experimental class using interactive multimedia with PBL model with the vision of SETS. PBL is an approach of learning using real world problems, learning process centred on learners to learn how to think critically and problem solving skill, as well as gaining knowledge and essential concept of subject matter [21,22]. Instead of using the model of PBL, learning science with the vision of SETS (Science, Environment, Technology, and Society) can help learners to learn science, its development, and how it can affect the environment, technology, and society as a reciprocal [23]. Critical thinking is one of the main goals of higher education to train dependant and reasonable thinker as an efficient citizenship in modern society [24]. A learning model that can be applied to develop the critical thinking ability is learning which is based on problem and science learning society technology.

The development of learners’ cognitive can be formed gradually through investigation, experiment, invention, and problem solving. According to [25] study the discovery shows that knowledge can last a long time or more memorable investigation and problem solving.

Critical thinking ability is measured from the observations of the report written on worksheet by each group. The report has been written by each group is the result of observation of the experiment and the result of discussion that contains six critical thinking aspects, namely: (1) interpretation, (2) analysis, (3) evaluation, (4) inference (5), explanation (6) and presentation. The Newton Group obtained the highest average score on the interpretation, analysis, and presentation. The Archimedes Group obtained the highest average score on the evaluation. The Rutherford Group obtained the highest average score on explanation aspect. The Pascal Group obtained the highest average score on interpretation and analysis aspects. Newton and Pascal group which members consist of female learners gain the highest average score compared to the Archimedes group and Rutherford group which members consist of male learners. The results of this research are increasingly strengthened earlier research results that are the critical thinking ability of female students is higher than male learners. The ability of female learners in drawing up hypotheses, analysing, evaluating, explaining, inferring, and drawing conclusion is better than male learners [26]. According to [27] the structure of the female learner’s brain which deals with language works harder than male learner’s, so that female learner’s language skill is higher. The indicator that one has higher thinking ability can be seen from the ability in using language with good grammar. In term of delivering an opinion, female is better than that of male [28].

Animation on interactive multimedia based on PBL model with the vision of SETS can be used by teacher to demonstrate the laws of Newton so that the learners can understand the abstract concept of the physics law. The simulations that are shown are very useful for solving problems in physics so that learners are trained in their ability to think critically and be able to solve problems. This is in line with [29] research results; animation can be used by teachers to demonstrate the laws of physics and to increase students’ interest at school in science learning.

3.3. The Effectiveness of The Interactive Multimedia PBL Model with the Vision of SETS Towards Social Skill

The effectiveness test of the learners’ social skills obtained from observation data. The social skills of the learners were observed by 2 observers, namely science teacher of grade 8 and colleague for 3
meetings. The result of observation of the learners' social of control class and experimental class is presented in Table 2.

Based on the results in Table 2, the control class indicates the low criteria of 1 learner (4%), the medium criteria of 2 students (8.33%), the high criteria of 5 students (20.83%), and the criteria of very high 16 students (66.67%). In the experimental class there were no medium, low, or very low criteria, high criteria of 3 students (12.5%), very high criteria 21 students (87.50%). Thus, the social skill of the experimental class is better than the control class because the experimental class applies PBL learning with the vision of SETS using interactive multimedia. According to [8] reveals that the application of PBL model can improve the social skills of learners. The PBL model learning approach gives better influence to the students' social skills than ordinary learning [30].

The Application of PBL model in science learning can explore the ability of learners to develop their social skills through group discussion in solving a problem presented on worksheet and interactive multimedia. Through group discussion activities, the interaction among group friends becomes better than conventional learning. The finding in this study is that learners naturally group themselves according to gender, so that in the group division is not heterogeneous. However, this condition makes learning more active. Each group member is active in discussion, experimenting, and solving problem. Because of a good communication relationship among group members and peer acceptance, the social skills of learners can increase. Student’s skill is influenced by several factors: (1) student's condition, (2) age, (3) student's interaction with the environment, (4) gender, (5) social economic condition, (6) parent’s education, and (7) parent's job.

| Class       | VH | H  | M  | L  | VL |
|-------------|----|----|----|----|----|
| Control     | 16 | 5  | 2  | 1  | 0  |
| Experimental| 21 | 3  | 0  | 0  | 0  |

Note: VH (very high), H (high), M (medium), L (low), VL (very low)

4. Conclusion
The developed interactive multimedia and learning instrument have the characteristic of the vision of SETS and integrated with the syntax of Problem Based Learning (PBL) model which can be used as a teaching tool for teachers in science learning. The development of learning instrument and media developed using Problem-Based Learning (PBL) model with the vision of SETS is valid, practical, and effective to improve students’ critical thinking ability and social skill in the experimental class. Suggestion that can be given is the use of interactive multimedia can be implemented using other learning materials and model.

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