Development of Students’ Worksheet Problem Based Learning of Environmental Pollution to Improve Critical Thinking and Discipline

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Abstract. Globalism era makes one faces sophisticated problems, and solving the problems need a quality human that is able to critical thinking and discipline as part of science’s attitude. The problem is ability of Indonesian students in critical thinking mostly low order thinking and lack of learning discipline, as well this phenomenon acquired at preliminary study. Students’ Worksheet named LKS is a learning media to encourage students to think, act, and grow positive attitude. The aim of this research is to produce the LKS of Environment Pollution with Problem Based Learning (PBL) model order to grow students’ critical thinking and discipline. The research method used a research and development (R & D). The research subject were 76 students Seven Graders Junior High School of Baitul Jannah Bandar Lampung, Indonesia, with sample consisted of 40 students (age 13 years old) who were all simple randomly and assigned to LKS PBL (n=20), and Direct Instruction-lecturer (n=20) teaching groups of experiment-control. Data were collected by techniques of experts validation sheets, questionnaires, observation sheets, documentation, and test instrument for measuring critical thinking skill (CTS). The 26-item Test of Science CTS were applied as pretest and posttest, and three types of observation sheet were used for measuring six of discipline indicators. The data analysis techniques used percentage, t-test, and n-gain. The results indicated that is: (1) The development product of LKS with PBL formed, (2) The LKS effectively to improve students’ CTS with n-gain 0.59 (middle category) and six indicators of learning discipline mean n-gain 0.42 (middle category) and (3) Content, language and display of the LKS with PBL was very feasible based on assessment of experts (construct and media) and three senior science teachers with scoring of avarage 97.03% and students’ readability response mostly easy (73%), very easy (21%), enough difficult (6%), and no one mentioned the LKS very difficult. Thus the LKS with PBL was developed effectively to be used as a learning media of environment pollution lesson. It was significantly difference improvement of both students’ CTS and learning discipline in the experiment class who before and after used LKS with PBL rather than control class who used conventional model that is lecturer dominantly.
1. Introduction

Keys cognitive skills has been identified namely critical thinking skill and positive characters is discipline. The phenomenon of both lack of students’ critical thinking and learning discipline are being problems in the world included Indonesia. Reporting of PISA and TIMMS that achievement of Indonesia student on science mostly in low order thinking [1]. Evidences were acquired on the preliminary study at the subject seven graders of 4 junior high schools in 2 districts Lampung Province, Indonesia. The evidences were found namely the present LKS of science contains tasks and experimental exceeding the target, activities end with a discussion on questions, difficult, and students only follow the guidance as a blue print of book-LKS guidance. The LKS did not train thinking mechanism such as cause-effect to find out problems, to propose hypothesis, investigating data, to determine the experimental steps to solve the real problem. The LKS of science Seven Graders lack to encourage both students’ critical thinking skill and growing learning discipline as part of the science attitude. Based on these observations raised a question: what are the best learning media that can encourage growing of students’ critical thinking and discipline through environment pollution lessons? A good learning media named LKS that is the real media which is human, material, and eventually it makes the students acquire knowledge, attitude, and psychomotor. Students’ worksheet namely LKS is a learning media and mostly used by teachers and students in science learning. LKS have to become a source of students’ learning can provide first-hand experience in the learning process, as well it can build students’ knowledge, attitude, and psychomotor [2].

There needs to develop a LKS with PBL model to encourage the students to act and thinking like a junior scientist in solving a problem. The student is guided to create a tentative conclusion, which makes the learning activities similar to research activities that are usually performed by experts. In learning a concept of environment pollution, the student is needed to learn following the stages of the investigation as a whole, then the students' understanding more completed, integrated, merely memorizing the science’s concepts, and meaningful learning. LKS might become an effective learning media by selected appropriate learning model. The PBL as a model of learning, it took place a student-centered, actively, and promotes social collaboration. Core of PBL model namely students involve actively in taking of the steps on identifying problem come up solving the problem. The steps of PBL process that is: (1) problem orientation, define and hypotheses, (2) develop students organization, (3) problem investigations, data collection, data display, interpret the data, (4) presentation, conclusions, and solving the problems, and (5) Evaluation: analyze the problem solving result, feed back and reflection [3]. These steps are characteristic of the scientific approach as well as presented in PBL. The PBL model encourages students collaborate within groups, sharing thoughts, and viewing among group member [4].

The national standard of content of primary and secondary education, an objectives of science subjects at junior high school is students are expected to be able to develop their attitude of curiosity, honest, discipline, responsible, logical, critical, creative, and analytical [5]. Therefore, it needs to develop a learning media named LKS through R & D which is able to grow both of critical thinking skill and learning discipline as a positive students’ character. The LKS with PBL is expected can contribute direct and or indirectly to construct of a quality Human Resources (HR) who is required in the future generation of the nation character building, moral quality, and intelligences. Nowadays globalism many humans are intelligent, but might be lack of the morals included discipline. Now ones face more sophisticated problems, freewheeling live to
explode natural resources, rubbish, bullying act, and so on. Therefore, the future generations have to be taught a discipline character, including critical thinking skill in order to become the gold generation to build Indonesia’s glory [6].

The aim of carried out this R&D is to develop students’ worksheets, named LKS with PBL that is able to build the students’ critical thinking and learning discipline on the theme of environment pollution. The critical thinking aspect adopted Ennis conception, its thirteen items (generalization, consider information resource, information credibility, induction result, deduction result, question, observation, argumentation, reply based on fact, focusing in question, apply principles, identify, problem solving, and decision making [7]. The learning discipline observed namely: (1) follow school role regulation, (2) on time attending at classroom, (3) commitment on collaboration, (4) on time at assignment completion, (5) keeping of body clean, and (6) keeping of clean environment [8).

2. Method
The study used method R & D with a group trial test namely Quasi Experimental in forming of Nonequivalent Control Group Design, both of the experimental class and the control class were defined purposive randomly. The R & D divided into three mainly activities namely preliminary study (need assessment), designing, and development of LKS. The steps of sub activity R &D procedure shown in Figure 1[9].

The factors of the particular study were the feasibility of Students’ Worksheets, the differences in students’ achievement on critical thinking skill, and students’ discipline. Data collections used a questionnaire, test, observation sheets, and documentation. The data analysis techniques used percentage frequencies, t-test, and gain test. All the analysis results are continued to interpret on a qualitative scale.

2.1. Analysis of the Feasibility of student worksheet
The level of LKS feasibility is calculated through the percentage, the equation below might be used to calculate the percentage of a score as follow [10]:

$$NP = \frac{R}{SM} \times 100\%$$

Where:

- $NP = \text{The score of percentage}$
- $R = \text{The total of obtained score}$
- $SM = \text{The ideal maximum score}$

The level criteria of LKS feasibility:
- $21\% < p \leq 40\% = \text{poor of feasible}$
- $41\% \leq p \leq 60\% = \text{medium of feasible}$
- $61\% \leq p \leq 80\% = \text{feasible}$
- $81\% \leq p \leq 100\% = \text{very feasible}$

2.2. Analysis of Students’ Critical Thinking Achievement
The t-test was used to know the differences in the students’ score after treated using pre-posttest instrument student worksheet, t-test is formulated in the equation as follow [11]:

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\[ t = \sqrt{\frac{x_1 - x_2}{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} - 2r \left( \frac{s_1}{\sqrt{n_1}} \right) + \left( \frac{s_2}{\sqrt{n_2}} \right)}} \]

Where:
- \( r \) = correlation score X1 and X2
- \( n \) = total sample
- \( \bar{x}_1 \) = average score of the experiment class
- \( \bar{x}_2 \) = average score of the control class
- \( s_1 \) = standard deviation of the experiment class
- \( s_2 \) = standard deviation of the control class
- \( S_1 \) = Variance in the experiment class
- \( S_2 \) = Variance in the control class

The gain test was used to find out the improvement of students’ learning outcome on critical thinking skill, which is formulated in equation as follow [12]:

\[ g = \frac{(S_{\text{post}}) - (S_{\text{pre}})}{100\% - (S_{\text{pre}})} \]

Where:
- \( g \) = factor of gain
- \( S_{\text{post}} \) = average score of final test (%)
- \( S_{\text{pre}} \) = average score of initial test (%)

Gain criteria:
- \( g \geq 0.7 \) = High
- \( 0.3 \leq g < 0.7 \) = medium
- \( g < 0.3 \) = poor
3. Result & Discussion

Assessment of the students’ worksheets of science of environment pollution namely LKS with PBL shown at Table 1. The assessment of feasibility the LKS development was conducted by two experts and three science teachers, the LKS content feasibility obtained an average score of 3.87 (96.75%) with criteria of "very feasible", the language aspect obtained an average score of 3.90 (97.60%) with criteria "very feasible", and the display aspect obtained an average score of 3.87 (96.75%) with criteria "very feasible". Thus design of LKS with PBL could be claimed as very feasible to be used as a learning media, as well students experiment class were response on the LKS readability mostly easy, i.e: 21% very easy, 73% easy, 6% not easy, and no one student said the LKS was difficult (Table 2). It match with a result of research was conducted by previous researcher that is application of PBL model in science learning can improve students’ critical thinking and students’ positive attitudes [13], as well other result of research that the character-based students’ worksheets of science were effective to be used as teaching materials in the learning process due to more than 60% of students had mastery the learning objectives [14].

Cognitive achievement on critical thinking skills (CTS) were obtained through pretest-posttest instrument. The instrument test was formed 26 items multiple choice with using Ennis’ CTS. The cognitive learning achievement of CTS is analyzed by t test and n-gain for determining the significance improvement and the t-test to find out the differences average of learning achievement before and after using the LKS with PBL model.
The analysis results shown at Table 3, that both the students’ CTS increased in experiment and control class after learning, with obtaining of gain factor was 0.59 in the experiment bigger than n-gain 0.35 in the control class. Then, it might be stated that improvement of CTS on science of the environment pollution is medium criteria. Based on the analysis concluded that is the students' CTS grew higher at experimental rather than control class.

The analysis results of t-test at $\alpha = 5\%$ that $t$ accounting is -13.890 less than $t$ table is 1.729, thus there are significantly differences in the learning achievement of CTS between experiment and control class. From the differences in the learning achievement, the Students’ Worksheets named LKS with PBL are effective to be used as a means in science learning for students seven graders. The differences, might be caused by the learning process used LKS with PBL, students trained through a scientific investigation by providing of real problem pollution stimulation. The students have first hand experienced a scientific work process namely problem orientation, create problem statement and hypothesis, investigate data with experiment, taking conclusion, problem solving, and communicating.

Table 1. Result of Feasibility Assessment on the LKS with PBL

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Score of each component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Content</td>
</tr>
<tr>
<td>R01</td>
<td>3.75</td>
</tr>
<tr>
<td>R02</td>
<td>4.00</td>
</tr>
<tr>
<td>R03</td>
<td>3.80</td>
</tr>
<tr>
<td>R04</td>
<td>3.90</td>
</tr>
<tr>
<td>R05</td>
<td>3.90</td>
</tr>
</tbody>
</table>

Score average: 3.87 | 3.90 | 3.87
Percentage average (%): 96.75 | 97.60 | 96.75
Whole Average of Percentage & Criteria: 97.03 & Very Feasible

Table 2. Students Response on LKS with PBL Readability

<table>
<thead>
<tr>
<th>No</th>
<th>Description; N=20</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very Difficult</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Not Easy</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Easy</td>
<td>73</td>
</tr>
<tr>
<td>4</td>
<td>Very Easy</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>
The discipline aspects in the study that is D1-D6: school’s role & regulation, on time attending at class room, collaboration commitment, on time in assignment completion, self-help health care, and caring environment healthy. Data on six aspects discipline are obtained by Likert questionnaires. The values of students discipline development were analyzed by percentage, shown at (Table 4).

The Table 4 indicated that the six learning discipline indicators increased both in control class (1%-5%) least than experiment (4%-41%). Graph of Mean of frequence (before and after) of students’ learning discipline indicator shown in Figure 1 & 2, that D3/collaboration commitment indicator significantly increased (41.00%) after the learning using LKS with PBL, on the contrary in control class the D3 grew (3.00%) only, it might be caused in control class still using conventional learning model namely lecturer dominantly, lack of students actively in learning process including collaboration among the students, and passiveness learning atmosphere. At the experiment class, all of the learning discipline indicators increased in which the collaboration aspect extremly increased, the evidence rised might be due to the learning process used LKS with PBL which is developed. The learning groups have to discussed to explore, identify core problem, analyze cause-effect, and problem solving of the story board within the LKS, thus activeness of students learning atmosphere arise.

4. Conclusion
Based on the discussion are concluded: (1) the Students’ Worksheet of science named LKS with PBL is very feasible to be used in learning environment pollution for seven graders students of junior high school based on result of experts assessment, science teachers and students response; (2) there was a significantly difference improvement of the students’ CTS and learning discipline who used LKS with PBL at Experiment class compared at Control class who used old LKS with conventional model; (3) Effectiveness of the LKS with PBL on growing the students’ CTS and learning discipline at Experiment class both were medium category (0.59 and 0.42), while at Control class was medium category (0.30) for CTS and poor category (0.08) for learning discipline. It is recommended the LKS can be used in learning of environment pollution to improve students’ CTS and learning discipline.

<table>
<thead>
<tr>
<th>Table 3. The n-gain of Students’ Critical Thinking Skill (CTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
</tr>
<tr>
<td>Pretest</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table 4. The Analysis of Students’ Discipline at Six Indicators

<table>
<thead>
<tr>
<th>Discipline Indicator</th>
<th>Mean of Frequence; n=20</th>
<th>Mean of Improvement (%)</th>
<th>N-gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (%)</td>
<td>Eksperiment (%)</td>
<td>Control (%)</td>
</tr>
<tr>
<td>D1</td>
<td>69</td>
<td>69</td>
<td>71</td>
</tr>
<tr>
<td>D2</td>
<td>77</td>
<td>76</td>
<td>78</td>
</tr>
<tr>
<td>D3</td>
<td>60</td>
<td>54</td>
<td>63</td>
</tr>
<tr>
<td>D4</td>
<td>68</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>D5</td>
<td>71</td>
<td>71</td>
<td>76</td>
</tr>
<tr>
<td>D6</td>
<td>69</td>
<td>66</td>
<td>71</td>
</tr>
<tr>
<td>Mean N-gain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Catagory

Remark:

D1: School role & regulation  D4: Task completion on time  D5: Self help healthy
D2: Attend at class on time  D3: Collaboration commitment  D6: Care environment healthy

5. Acknowledgments

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Figure 1. Mean of Frequency Pre-Post Observation of Learning Discipline

Figure 2. Improvement of Mean of Frequency of Learning Discipline
6. Reference


[5] Per mendikbud No. 64 Tahun 2013 tentang Standar Isi.


