Problem Based Learning using Open Educational Resources to enhance Higher Order Thinking Skills in Physics Learning

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Abstract. This research aimed to find out the difference of higher-order thinking skills in terms of learning motivation and ICT literacy between students experiencing PBL (Problem Based Learning) assisted with open educational resources and those experiencing PBL without open educational resources. This research is a quasi-experimental with a pretest-posttest control group design. The population was eighth-grade students. The sampling technique used cluster random sampling. Variables in this research included an independent variable of the PBL model assisted with open educational resources, a dependent variable of higher-order thinking skills, and covariates of learning motivation and ICT literacy. Data collection used tests in the forms of question instruments, learning motivation questionnaires, and ICT literacy questionnaires. The data analysis technique used N-Gain and ANCOVA. The result of the research shows the difference of higher-order thinking skills between students in the experimental class that implemented the PBL model assisted with open educational resources and those in the control class that implemented the PBL model without open educational resources. This can be seen from the average score of the N-Gain test of the experimental class that is 0.35 with a moderate category while the average score of N-Gain of the control class is 0.29 with a low category. Therefore, there is an influence of the PBL model assisted with open educational resources on higher-order thinking skills.

1. Introduction

Education is essential for life since it is a manifestation of human’s culture that is dynamic and ever-changing [1]. Therefore, the education change or development is supposed to happen along with the change of life culture. A teacher as an education activator must develop approaches, techniques, and assessment instruments of learning outcomes with authentic approaches that make it possible for educators to implement remedial programs for students that are categorized as slow learners and enrichment for those that are categorized as fast learners [2].

The main characteristics of physics learning are being able to broaden knowledge by developing scientific process skills [3], being able to relate learning materials with daily experiences through the utilization of environment surrounding, being able to think critically and creatively, and being able to develop scientific attitudes through learning activities [4]. The results of an interview with a physics teacher at junior high school show that generally physics learning at schools has not been able to enhance student’s higher order thinking skills [5]; the lack of the implementation of online media learning resources to students and the low application of ICT literacy to students [6] influence the learning outcomes and the low learning motivation of students. Besides, student’s interaction in using
information technology is low and the teacher does not consider the significance of internet utilization as an alternative of Physics learning resources [7].

Based on the problem explanation both theoretically and factually at schools, one of learning models that can develop student’s higher order thinking skills is problem based learning (PBL). PBL needs to consider the psychological condition of students that have high capability to make students learning to solve problems that attract them [8]. PBL has several characteristics those are: a problem becomes a starting point in learning; the problem given is the factual problem in real life that is unstructured; the learning approach with factual life problem gives students opportunities to enhance the critical thinking process and acquire the problem solving skills effectively [9].

PBL has an orientation in order that students can think critically, analyze, and solve complex life problems, discover, evaluate, and use a variety of learning resources [10], work comprehensively in a team; and use learning materials and intellectual capability during the process as the provision of lifelong learning [11]. PBL is not designed to help the teacher in delivering knowledge in a huge number, but to help students in developing problem solving thinking skills, group organizing skills to solve problems, and individual independency [12]. Learning with PBL, students are introduced to factual problems and encouraged to explore them, know the problems, so they independently conclude on the happening situations and finally they find solutions for the problems [13]. This is strengthen by research conducted by [14] stating that the use of PBL encouraged students to be reliable problem solvers. Information and Communication Technology (ICT) has a critical role in assisting the improvement of teaching and learning process [15]. Students that have well ICT skills will find more complete information faster in solving problems [16]. As educational media, communication is carried out by using communication media such as computer, internet, online media and email [17].

2. Method
Type of Research
This research is quasi-experimental with pretest-posttest controlled group design. Population in this research was all students of eighth-grade at a junior high school in Bima, Indonesia. The research sample was two groups with total of 105 students. The sampling technique used cluster random sampling. The independent variable was PBL model assisted with open educational resources. The dependent variable was higher order thinking skills. The covariates were learning motivation and ICT literacy. The data collection instruments used tests for learning outcomes measured with pretest and posttest, and non-tests for learning motivation measured with learning motivation questionnaires and ICT literacy measured with ICT literacy questionnaires. The data analysis technique on the posttest result used N-Gain and ANCOVA.

Learning Process
On the first meeting, in both experimental and control classes, 20 minutes were used for introduction and brief explanation on assessment. The rest 60 minutes were used for pretest of higher order thinking skills. In the next meeting, questionnaires of learning motivation and ICT literacy were distributed to be filled out by students. In the next meetings, learning by using PBL model assisted with open educational resources was implemented in the experimental class for two meetings consisting of 40 minutes each.

| Session | PBL with online media | PBL without online media |
|---------|-----------------------|--------------------------|
| 1       | Pretest of high order thinking skills | Pretest of high order thinking skills |
| 2       | Questionnaires of student’s learning motivation and ICT literacy | Questionnaires of student’s learning motivation and ICT literacy |
| 3       | Learning by using PBL model assisted with open educational resources | Learning by using PBL model without open educational resources |
| 4       | Learning by using PBL model assisted with open educational resources | Learning by using PBL model without open educational resources |
| 5       | Posttest of high order thinking skills | Posttest of high order thinking skills |
In the control class, PBL without open educational resources was also implemented for two meetings consisting of 40 minutes each. The next meeting was for posttest of higher order thinking skills. The test of higher order thinking skills was used for measuring student’s higher order thinking skills after the implementation of PBL model (See Table 1).

3. Result
N-Gain

The similarity of N-Gain was to find out the increase of each student and the N-Gain average score of the experimental and control classes. The N-Gain average scores of the classes were then classified to find out the N-Gain categories of both experimental and control classes.

| Class     | N  | Mean of Pretest | Mean of Posttest | N-Gain | Classification |
|-----------|----|-----------------|------------------|--------|----------------|
| Experimental | 26 | 9.23            | 14.46            | 0.35   | Moderate       |
| Control    | 26 | 8.42            | 12.96            | 0.29   | Low            |

The table above shows that the N-Gain classification of the experimental and control classes are different. The N-Gain score of the experimental class is 0.35 and categorized as moderate. The N-Gain score of the control class is 0.29 and categorized as low. This shows that the learning treatment by implementing PBL model assisted with open educational resources on the experimental class can enhance higher order thinking skills of students on the materials of work and energy.

Statistical Analysis

The learning outcomes of student’s higher order thinking skills in terms of learning motivation and ICT literacy are seen from the ANCOVA test result of pretest and posttest between the experimental and control classes. The analysis result shows that F value for learning motivation is 4.804 with significance of 0.033. F value for ICT literacy is 4.537 with significance of 0.038. F value for learning model is 4.175 with significance of 0.047. Since the significance value for the whole is less than 0.05, it can be concluded that the learning treatment by using PBL assisted with open educational resources in terms of learning motivation and ICT literacy given to the experimental class can enhance student’s higher order thinking skills on the materials of work and energy.

| Source                  | Type III Sum of Squares | df | Mean Square | F        | Sig. |
|-------------------------|-------------------------|----|-------------|----------|------|
| Corrected Model         | .163*                   | 3  | .054        | 4.026    | .012 |
| Intercept               | .033                    | 1  | .033        | 2.476    | .122 |
| COV1(MOT)               | .065                    | 1  | .065        | 4.804    | .033 |
| COV2(IT)                | .061                    | 1  | .061        | 4.537    | .038 |
| Learning Model          | .056                    | 1  | .056        | 4.175    | .047 |
| Error                   | .649                    | 48 | .14         |          |      |
| Total                   | 6.010                   | 52 |             |          |      |
| Corrected Total         | .812                    | 51 |             |          |      |

* R Squared = .201 (Adjusted R Squared = .151)

The influences of learning motivation and ICT literacy on higher order thinking skills were analyzed by using regression analysis. Table 4 shows the result data of the regression analysis.
Table 4. Coefficient of linear regression

| Model   | B     | Std. Error | Beta  | t    | Sig.  |
|---------|-------|------------|-------|------|-------|
| (Constant) | .082  | .382       |       | 2.102| .047  |
| COV1    | -.009 | .002       | -.567 | -3.513| .002  |
| COV2    | .011  | .004       | .445  | 2.758| .011  |

Table 5 shows the contribution relationship among variables.

Table 5. The correlation coefficient

|          | DVAR  | COV1 | COV2 |
|----------|-------|------|------|
| Pearson Correlation | 1.000 | -.482 | .337 |
| COV1    | -.482  | 1.000 | .189 |
| COV2    | .337   | .189  | 1.000 |
| Sig. (1-tailed) | .013  | .354  |       |
| N       | 26     | 26    | 26   |

Table 6. Contribution of covariates towards dependent variable

| Variable | Regression Coefficient | Correlation | Effective Contribution |
|----------|------------------------|-------------|------------------------|
| COV1    | -.567                  | -.482       | 28.07                  |
| COV2    | .445                   | .337        | 14.66                  |

Table 6 shows that the amount of learning motivation and ICT literacy contributions (R Square) towards higher order thinking skills is 0.42 or 42%. This means that other influences is (100% - 42%) = 58%. 58% is other factors that influence higher order thinking skills of students. Besides, the significance of learning motivation and ICT literacy is less than 0.05, so it can be concluded that there is an influence of learning motivation and ICT literacy on higher order thinking skills. The amount of effective contribution of learning motivation and ICT literacy towards higher order thinking skills from the regression analysis is 42%.

4. Discussion

The N-Gain analysis was done to find out whether there is a difference between the experimental and control classes and the influence of the use of PBL model assisted with open educational resources on higher order thinking skills. The difference between the two classes is the N-Gain value of the experimental class is 0.35 and categorized as moderate, while the N-Gain value of the control class is 0.29 and categorized as low. Therefore, it can be said that there is a difference between the class using PBL model assisted by open educational resources and one without open educational resources. Using PBL model assisted with open educational resources is better than one without open educational resources. The N-Gain value of the experimental class is higher than the control class because the experimental class used learning video about the materials of work and energy that is more complete, while the control class did not use learning video. The N-Gain values of the experimental and the control classes are not significantly different because both classes used PBL model with the characteristics those are using actual problems of daily life that require learning need identification and new knowledge in
learning, development of problem solving skills to find solutions of a problems and PBL model includes evaluation and review of student’s experiences and learning process. Next, the influences of PBL model assisted with open educational resources are viewed from the test result of higher order thinking skills. The test of higher order thinking skills on the materials of work and energy in the experimental class using PBL model assisted with open educational resources shows that the average score of pretest was 9.23 and posttest was 14.46. This is because on the pretest students had not been treated, while on the posttest they had been treated. Therefore, it can be concluded that there is an influence of PBL model assisted with open educational resources on student’s higher order thinking skills.

The result of research by [18] indicated that by frequently being trained and guided, student’s higher order thinking skills can increase. The teacher plays a critical role in this matter. From the analysis result of student’s learning motivation and ICT literacy, the average score of student’s learning motivation of the experimental class is 3.68 with good category. The average score of student’s learning motivation of the control class is 3.64 with good category. Learning motivation of the experimental and control classes are not significantly different because when filling out the questionnaires, most students got tired so they filled out without deep consideration and both classes had not been treated with learning. The analysis result by using ANCOVA to determine the influence of learning motivation on the student’s higher order thinking skills shows that F value of learning motivation is 4.804 with significance of 0.033 that is less than 0.05, so the result shows an influence of student’s learning motivation on higher order thinking skills. The regression analysis shows that the effective contribution of student’s learning motivation is 28%. Therefore, it can be concluded that the predictor can be functioned to enhance student’s higher order thinking skills.

On the ICT literacy, the average score of student’s ICT literacy of the experimental class is 3.61 with good category. The average score of student’s ICT literacy of the control class is 3.59 with good category. ICT literacy of the experimental and control classes are not significantly different because even though there was no ICT materials in learning, students had already had prior knowledge about ICT. The analysis result by using ANCOVA test to determine the influence of ICT literacy on student’s higher order thinking skills shows that F value for ICT literacy is 4.537 with significance of 0.038 or less than 0.05. F value for learning model is 4.175 with significance of 0.047 or less than 0.05. Therefore, the result shows an influence of student’s ICT literacy on higher order thinking skills. It can be concluded that student’s higher order thinking skills are influenced by PBL model assisted with open educational resources in terms of student’s learning motivation and ICT literacy. The regression analysis shows the effective contribution of ICT literacy is 14%, so predictor can be functioned to enhance student’s higher order thinking skills.

The result of research by [19] showed that learning process at class critically needs to be student-centered to encourage student’s learning motivation in learning knowledge better. Learning strategies have a significant effect on achieving Physics learning outcomes that means there is a tendency that student’s learning motivation is higher.

5. Conclusion
Learning by using PBL assisted with open educational resources has an influence on student’s higher order thinking skills compared to that without open educational resources. In this research, learning motivation and ICT literacy can contribute to the success of student’s higher order thinking skills.

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