Problem-based learning skills and reflection skills of biology education students through the problem-based online tutorial

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Abstract. This study is part of the development of problem-based learning research in plant development using the Gibbs' reflective cycle and e-portfolio, namely the program implementation phase. The study aims to find out the problem-based learning skills and reflection skills of biology education students. The study conducted in the semester 2018.1 involving 24 biology education students participating in the Plant Development online tutorial. The study was conducted by providing discourse related to differences in Algae and Moss and asking students to carry out problem-based learning processes (PBL) and reflect on what they had done in the PBL process. The instruments used were the rubric of PBL and reflection skills five scales (range 0-4). The results showed that the average PBL skills score of biology education students is lower than their average reflection skills score. Of the six PBL components assessed, the students' ability to formulate problems is the highest ability, and the ability to answer the problem formulation is the lowest ability. Meanwhile, from the six components of reflection assessed, the students' ability to conclude is the highest ability, and the ability to provide an action plan is the lowest ability.

1. Introduction

The vision of the Biology Education Study Program at Faculty of Teacher Training and Educational Sciences, Universitas Terbuka (FKIP-UT) is to excel in producing professional biology educators through an open and distance higher education system. Students of Biology Education Study Program at FKIP-UT are in-service Biology teachers. As a teacher, they should have the skills as a professional teacher. One of such skills is reflective thinking skills that will help the teacher learn advanced, improve professional skills and other skills. Based on the results of the preliminary study conducted in the academic year 2015.2, the level of reflective thinking of Biology Education students in FKIP-UT in the academic year 2015.2, in general, is still at the level of understanding. Thus, the level of reflective thinking of Biology education students is still on a non-reflection [1]. The ability of reflective thinking can be developed through Problem-based Learning (PBL) [2]. PBL begins with the assumption that learning is an active, integrated, and constructive process influenced by social and contextual factors. PBL is characterized by a student-centered approach; teachers act as facilitators and open-ended issues that act as early stimuli and frameworks for learning PBL [3]. The starting point of PBL is a problem. In PBL, students are encouraged to analyze a problem and consider an alternative analysis. Therefore,
PBL puts students as the main actors in learning and thinking skills. Students are trained to think independently and develop confidence and appreciate the activities that are happening. PBL creates an atmosphere that supports students in improving their thinking skills. Many experts express the application of PBL into several stages. The stages of problem-based learning in a group that is developed by Johnson and Johnson are defining the problem or formulating the problem, diagnose the problem, formulate alternative strategies, determine and implement preferred strategies, and evaluate the process and the result evaluation [4]. PBL is one learning methodology that emerges from practice in a traditional classroom-based environment as a successful approach to strengthening learning. Therefore, designing distance learning experiences with PBL can be an alternative where institutions provide the same quality distance education for their student population [5]. Based on Johnson & Johnson PBL stages [4] and Paidi’s worksheets [6], PBL skills in this study include the ability to identify the problems that contained in the discourse, formulate the problem, write the possible answers to the problem formula, write the alternative solutions, determine one of the best alternative solutions, and to write the correct answers to the problem formula.

The concept of reflection must be understood first to understand reflective thinking. Reflection involves questioning or criticizing the existence or underlying problem during the exposure of the problem [7]. Reflection is described as an activity that takes place as one part of the learning cycle [8]. While doing this reflection, one evaluates what is good and bad from the experience, introspection, responding to a dilemma, reflecting on a problem solution, or linking experiences with prior knowledge [9,10,11,12,13,14]. Gibbs’ reflective cycle is the theoretical model often used by students as a framework in lecture work that requires reflective writing. The Gibbs reflective cycle can be seen in Figure 1.

![Figure 1. Gibbs’ reflective cycle (adopted from @2016 Petter Lia: Learning Support Tutor)](image)

Figure 1 shows that the Gibbs reflective cycle has six stages are description, feelings, evaluation, analysis, conclusion and action plan. The Gibbs’ model was developed from the four stages of the learning cycle of David Kolb. The Gibbs Model is sometimes referred to as an iterative model [15].

Along with the development of information technology, Universitas Terbuka provided learning assistance services in the form of online tutorials using Moodle as a learning management system (LMS). Structure and development of Algae and moss are one of the topics discussed on the online tutorial of plant development. Many people cannot clearly distinguish between the difference between algae and moss. The real case like this can be raised into the discourse for use in problem-based learning.

Problem-based learning program on Plant Development online tutorial with Gibbs' reflective cycle and e-portfolio has been developed. To see how PBL skills and reflection skills of biology education students after using the program, this paper will specifically address PBL skills and student reflection
skills through a problem-based online tutorial program with Gibbs's reflective cycle on algae and moss topics.

2. Methods
This study is part of the development of problem-based learning research in plant development using the Gibbs reflective cycle and e-portfolio, namely the program implementation phase. The study was conducted in the semester 2018.1, involving 24 biology education students participating in the Plant Development online tutorial. The study is conducted by giving discourse related to Algae and moss difference and ask students to do problem-based learning process (PBL) based on the discourse, and reflect on what they have done in the PBL process. The given discourse illustrates how the general public differs in deciding whether the green organisms they find on bathroom floors and walls, in fish ponds, in tanks, and drinking water belong to algae or moss. The stages of doing PBL are adapted from Johnson & Johnson's PBL stages [4] and Paidi's PBL worksheet [6]. The stages of doing reflection are adapted from Gibbs' reflective cycle [15]. The integration of Problem-based learning and Gibbs' reflective cycle can be seen in Figure 2.

Figure 2 shows that before reflection, students are asked to do PBL activities. PBL activities begin by identifying problems contained in the discourse and continued with formulating the problem, writing the possible answers to the problem formula, writing the alternative solutions, determine one of the best alternative solutions, and writing the correct answers to the problem formula. Afterward, continued with reflection through Gibbs' reflective cycle that consists of describing what happened, describing what is thought and felt, presenting the evaluation results, presenting the analysis results, communicating the conclusion, and explaining the next plan.

The instruments used were the rubric of PBL and reflection skills five scales (range 0-4). The rubrics can be seen in Table 1 and 2.
### Table 1. The rubric of PBL skills

| Component of PBL | Score | Indicator |
|------------------|-------|-----------|
| 1. Identify the problems | 4 | can identify at least 2 problems relevant to the discourse |
| | 3 | can identify at least 2 problems, but one is irrelevant to the discourse |
| | 2 | can identify 1 problem and be relevant to the discourse |
| | 1 | can identify 1 problem but is not relevant to the discourse |
| | 0 | cannot identify the problem / nothing / not clear |
| 2. Formulate the problem | 4 | able to make the problem formulation in the form of a standard question sentence and relevant to the problem |
| | 3 | able to make the problem formulation in the form of a question sentence but less standard, and relevant to the problem |
| | 2 | able to make the problem formulation in the form of a standard question sentence but not relevant to the problem |
| | 1 | making the problem formulation but not clear and irrelevant to the problem |
| | 0 | not making problem formulation |
| 3. Writing the possible answer to the problem formula | 4 | able to write more than 2 possible answers to the problem. |
| | 3 | able to write 2 possible answers to the problem |
| | 2 | able to write 1 possible answer to the problem |
| | 1 | write the possibility of an answer to the problem but not relevant |
| | 0 | not writing down the possible answers to problems |
| 4. Writing the alternative solutions | 4 | able to write more than 2 alternative solutions and all relevant to each problem to be solved |
| | 3 | able to write two alternative solutions but only one that is relevant to each problem to be solved |
| | 2 | able to write an alternative solution and relevant to the problem to be solved |
| | 1 | able to write an alternative solution but irrelevant to the problem to be solved |
| | 0 | write down alternative solutions but not clear / not write alternative solutions |
| 5. Determine one of the alternative solutions | 4 | able to determine one of the solution alternatives, the best, with the rational reason |
| | 3 | able to determine one of the solution alternatives, the best, but with no the rational reason |
| | 2 | able to determine one of the alternative solutions, which is not the best and not with a rational reason |
| | 1 | unable to determine any of the alternative solutions, not choosing the best, not with a rational reason |
| | 0 | not select / none / not clear |
| 6. Writing the correct answer to the problem formulation | 4 | able to answer the problem formulation correctly 100% |
| | 3 | able to answer the problem formulation correctly 75 - 95% |
| | 2 | able to answer the problem formulation correctly 55 - 70% |
| | 1 | able to answer the problem formulation correctly 25 – 50% |
| | 0 | able to answer the problem formulation correctly less than 25%/ the answer is not related to the problem formulation |

### Table 2. The rubric of Reflection skills

| Component of Reflection | Score | Indicator |
|-------------------------|-------|-----------|
| 1. Describing what happened | 4 | describes what happens to the process and the results of problem-solving and is supported by relevant data |
| | 3 | describes what happens to the process and the results of problem-solving but only one of them is supported with relevant data |
| | 2 | describes what happens to the process and results of problem-solving but is not supported by relevant data |
| | 1 | describe what happens only in the process or results of solving the problem |
| | 0 | does not provide an overview related to the process and results |
| Component of Reflection | Score | Indicator |
|-------------------------|-------|-----------|
| 2. Describing what is thought and felt | 4 | explain what was thought and felt before, during and after the process is carried out and explain what was thought and felt before, during, and after the results were obtained. |
| | 3 | only describes what was thought and felt before, during and after the process was carried out. |
| | 2 | only describes what is thought and felt before or during or after the process is done OR simply describes what is thought and felt before or during, or after the results are obtained. |
| | 1 | describes what is thought and felt but does not refer to process and outcome. |
| | 0 | did not respond. |
| 3. Presenting the evaluation results | 4 | describes what worked well and what did not work well from the process and the results obtained and illustrate how the situation ends. |
| | 3 | describes what worked well and which did not work well from the process and the results obtained but does not illustrate how the situation ended. |
| | 2 | only describes what worked well and which did not work well from the process undertaken or the results obtained and describes how the situation ended. |
| | 1 | only describes what worked well and which did not work well from the process undertaken or the results obtained but does not describe how the situation ended. |
| | 0 | do not describe anything or nothing or does not refer to the process and the outcome of problem-solving. |
| 4. Presenting the analysis results | 4 | mentioning the process that went well and the process is not working well accompanied by the cause AND mention the results in accordance with expectations and results that are not in accordance with expectations accompanied by the cause. |
| | 3 | mention the process that worked well and/or what worked wrong and the cause and mention the results as expected and/or the results are not in accordance with expectations and the causes. |
| | 2 | only mention the process that runs well or that runs badly as well as the cause OR only mention results that match expectations or results that are not in accordance with expectations and causes. |
| | 1 | only mentioning a well-run process or an unfavorable run without explaining the cause OR only mentioning results that match expectations or outcomes that do not match expectations without explaining the cause. |
| | 0 | do not explain anything / not clear. |
| 5. Communicating the conclusion | 4 | explaining in detail the lessons learned from the situation at least 4 of 6 things *) |
| | 3 | explaining in detail the lessons learned from the situation at least 3 of 6 things *) |
| | 2 | explaining in detail the lessons learned from the situation at least 2 of 6 things *) |
| | 1 | explaining in detail the lessons learned from the situation at least 1 of 6 things *) |
| | 0 | do not explain anything / not clear. |
| 6. Explaining the next plan | 4 | describes more than 3 things that will be done that will make it more ready if similar events happen again. |
| | 3 | describes 3 things that will be done that will make it more ready if similar events happen again OR describes 2 things that will be done that will make it more ready if similar events happen again. |
| | 2 | describes 1 thing to do that will make it more ready if similar events happen again. |
| | 0 | does not describe anything / is unclear. |

*) 1) other ways that can be done; 2) what has been learned; 3) responses in different ways; 4) positive things; 5) avoid negative things; 6) make sure the negative does not happen again.

3. Result and Discussion

3.1. PBL Skills and Reflection Skills
The task of reflection is done after the students do PBL. PBL skills and reflection scores for each student who participated in the plant development online tutorial can be seen in Figure 3.
Figure 3 shows that PBL scores and reflections from each student as follows: some PBL scores are lower than reflections (18 students), some higher than reflections (2 students), and there are similar PBLs with reflections (4 students). It can be concluded that overall PBL skills of online tutorial participants are lower than their reflection ability. This is in line with the opinion of some students who declare that the task of reflection is easier than the task of solving the problem, as revealed in some student statements as follows.

"The task of doing reflection is easier to do because problem-solving requires the ability to fully understand the problem. If you do not understand, the problem will not be solved or wrong."

"The task of reflection is easier to do because we are required to state the process of what we have done, and we are required to assess what we have done from all activities/tasks that have been implemented."

"Doing reflection is easier than doing PBL because we only do flashbacks or reviews in summary form."

"The task of reflection is easier because it is a way of correction in my learning process than the problem-solving tasks that are sometimes too broad and not contained in the module."

Students' difficulties in conducting PBL are in line with Pawson et al. (2006) which states that there is a risk of PBL for students, namely 1) previous learning experience does not prepare students well for PBL; 2) PBL requires more time and takes time from other subjects; 3) creating anxiety because learning is more difficult; 4) sometimes the problem of group dynamics disrupts the effectiveness of PBL; and 5) lack of knowledge about content that can be learned [16].

3.2. The skills of PBL Components

In conducting PBL, students must go through the following stages (which are components of PBL skills): identify the problem, formulate the problem, writing the possible answers to the problem formula, writing the alternative solutions, determining one of the alternative solutions, and writing the correct answers to the problem formula. The average PBL skills’ component score of the students who follow the online tutorial of plant development can be seen in Figure 4.
Figure 4 shows that of the 6 PBL components, formulating the problem is a component with the highest score of 2.9 and writing the correct answer to the problem formula is the component that has the lowest score of 1.3. This indicates that the student has good ability in formulating the problem and has a poor ability to answer the problem formulation. The component that has the highest score is assumed to be the most easily answered component, while the component with the lowest score is the most difficult component to answer/do. Problem formulation is the highest score, but it is not in line with students' opinions stating that the easiest component is identifying problems. Meanwhile, identify the problem is the lowest score, but it is not in line with students' opinions stating that the most difficult is writing the alternative solutions.

When observed from the work of students in formulating the problem, they able to make the problem formulation in the form of a question sentence but less standard, and relevant to the problem. Meanwhile, in writing the correct answer to the problem formula, the average student able to answer the problem formulation correctly 25 – 50%.

3.3. The Skills of Reflection Components
In conducting reflection, students must go through the following stages (which are components of reflection skills): describing what happened, describing what is thought and felt, presenting the evaluation results, presenting the analysis results, communicating the conclusion, and explaining the next plan. The average reflection skills' component score of the students who follow the online tutorial of plant development can be seen in Figure 5.

Figure 5 shows that of the six reflection skills' components, communicating the conclusion is a component with the highest score (3,8) and delivering the next plan is the component that has the lowest score (0,9). This indicates that the student has an excellent ability in communicating the conclusion and has a poor ability to explain the next plan. Components with the highest score are assumed to be the easiest to answer/do while the component with the lowest score is the most difficult component to answer/do. Communicating conclusions is the highest score, but it is not in line with students' opinions stating that the easiest component of reflection is to answer/do is describe what happened. Meanwhile, explaining the next plan is the lowest score, this is in line with the student statement which states that explaining the next plan is the most difficult reflection component compared to the five other reflection components.

When observed from the work of students in communicating their conclusions, they can conclusively average at least 4 of 6 of the following: 1) other ways that can be done; 2) what has been learned; 3) responses in different ways; 4) positive things; 5) avoid negative things; 6) make sure the negative does not happen again. Meanwhile, in explaining the next plan that will be done if similar events happen again, the average student only answers one plan only.

4. Conclusion
PBL skills of online tutorial participants are lower than their reflection ability. Of the six PBL components assessed, the ability to formulate the problem is the highest ability, and the ability to answer
the problem formulation is the lowest ability. Meanwhile, of the six reflection components assessed, the ability to conclude is the highest ability, and the ability to give the action plan is the lowest ability. However, the component with the highest score is not always the easiest to be answered or to be done, and the component with the lowest score is not always the hardest to be answered or to be done.

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