Problem-based learning (PBL) and blended learning in improving critical thinking skills and student learning activities in biochemistry courses

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Abstract. This study aims at improving students’ critical thinking skills and student learning activities in biochemistry courses. The efforts in improving critical thinking skills are carried out by applying the problem-based learning model using “blended learning” method. Blended learning method is implemented by integrating the face-to-face learning with online learning into the syntax of problem base learning. Face-to-face learning is done in the classroom, while the form of online learning is done by utilizing internet facilities and online discussion forums. Data from observations of learning activities are also calculated using a range of values that appear and determine the criteria. The results showed that the percentage of students’ critical thinking skills in the first cycle was 52.29% (quite critical), while in the second cycle it increased to 64.43% (critical). The teaching activities of lecturers in the first cycle and the second cycle were 36 (good category). Student learning activities in the first cycle is 35 (good category) and in the second cycle is 34 (good category). The conclusion of this study is the application of problem-based learning (PBL) using the blended learning method can improve critical thinking skills and student learning activities in biochemistry courses.

1. Introduction

The theme of 21st century learning skills stands around the problem solving skills, communication and collaboration, and critical thinking. Critical thinking is deemed as an important skill for the success of study, work, and life in the 21st century of information and technology. Critical thinking as focused reflective thinking on making decisions about what is believed or done. Indicators of critical thinking ability can be seen from the ability to formulate problems, argue for deduction, induction, evaluation, and decision making [1]. Critical thinking skills are one of the skills needed to survive in the 21st century [2]. to be a superior human being in the 21st century, one needs to have several important components, one of which is the ability to use technology, information and communication media.

21st century learning cannot be separated from the developments in technology and information. Along with the rapid development of Information and Communication Technology (ICT), the need for an information technology-based concept and learning mechanism becomes inevitable. Blended learning can be interpreted as learning that combines or combines face-to-face learning with e-learning that utilizes media such as computers (online or offline), multimedia, virtual classrooms, internet, CDs, cell phones, and so on [3]. Blended learning is a form of hybrid learning that communicates conventional face-to-face learning with online learning, both of which can be done in class online or
anywhere as long as there are facilities for online [4,5] defines that blended learning is learning that combines two different models, namely conventional learning and distance learning.

Biochemistry is a compulsory subject taught to students of Biology education programs at Universitas Bengkulu. Evaluation of the quality of the results and the process of teaching and learning activities in biochemistry courses that have been conducted by the instructor shows that students' critical thinking skills are still very low. This can be seen from the lack of student participation in asking students questions, answering questions, responding to information, and not being able to use their thinking skills to solve problems. Students have not been able to express arguments and connect one concept with another concept based on their analysis and critical thinking about an existing problem. About 65% of the total number of students has not demonstrated critical thinking skills or it can be said that critical thinking skills are still very low. The low critical thinking skills of students in basic biology courses is a challenge for lecturers/researchers to make improvements to the teaching and learning process in class.

Improving students' critical thinking skills requires learning strategies that can direct students to be able to develop their critical thinking skills, and also need to be supported by involving information technology-based learning activities by combining conventional learning methods with e-learning based learning. One alternative learning that can improve students' critical thinking skills is problem-based learning (PBL). Problem-based learning (PBL) strategies that show real-world situations, aiming at students being able to develop knowledge and skills in solving a problem. PBL consists of five stages namely 1) student orientation towards problems, 2) organizing students into learning, 3) guiding students to solve problems, 4) developing and presenting work, and 5) analysis and evaluation of problem solving [6].

2. Methods
This type of research is classroom action research. This research will be planned in two cycles. Each cycle consists of four stages, namely planning, implementation, observation, and reflection. The instrument used to collect data was a critical thinking test sheet and an observation sheet. This activity involved 30 students taking biochemistry courses in the Program Studi S-1 Pendidikan Biologi, Universitas Bengkulu, Indonesia. The study was conducted for 2 months from June 2019 to August 2019. Data on the results of critical thinking tests is done by calculating the percentage of critical thinking and determining the criteria. Data from observations of learning activities are also calculated using a range of values that appear and determine the criteria. Students' critical thinking skills are analysed according to the critical thinking ability indicators contained in the problem, which consists of formulating problems, giving arguments, making deductions, doing induction, evaluating, and making decisions. Each indicator is calculated the total score and then the percentage is calculated and the percentage is determined by the criteria of critical thinking ability. The formulas used are [7]:

\[
\text{Percentage} \% = \frac{\sum X}{N} \times 100\%
\]

Information:

\[\sum X = \text{The overall score of students}\]

\[N = \text{The total number of students}\]
The criteria of critical thinking can be seen as follows based on Table 1.

| Percentage     | Criteria         |
|----------------|------------------|
| 81% - 100%     | Very critical    |
| 66% - 80%      | Critical         |
| 56% - 65%      | Critical enough  |
| 41% - 55%      | Less critical    |
| 0% - 40%       | Not critical     |

3. Results and discussion

According to the results of observations made by two observers in observing the activities of lecturers on problem based learning using the blended learning method in cycle I and cycle II, the results are included in both categories. In cycle I and cycle II, the lecturer has applied learning steps in accordance with the planned syntax and method. Data regarding the observations of lecturer activities in the first cycle can be seen in Table 2.

| No | Observer | Score |
|----|----------|-------|
| 1  | Cycle I  | 36    |
| 2  | Cycle II | 36    |
|    | Total observation | 72 |
|    | Mean score     | 36    |
|    | Criteria       | Good  |

Table 2 shows that there is an increase in the teaching activity of lecturers in problem based learning by using the blended learning method in cycle I and cycle II. The results showed that the activities of lecturers and students in cycle I and cycle II were included in both categories. Through the application of problem-based learning, students become more motivated to learn, besides the level of student activity to participate in learning is also increasing. In this learning, lecturers apply learning that focuses on students, and emphasizes problems that occur in the real world. From problems that are oriented to students, students are directed to find the concept of knowledge of these problems, so the problems that students learn become a source to develop the knowledge needed to solve problems.

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PBL learning that is implemented in biochemistry courses, is not only done conventionally, it is also done using modern technology. The use of technology makes student learning activities increase, thus providing an increase in students’ thinking skills. This is in accordance with the opinion which states that modern technologies are assimilated with the instructional design models for students to construct their knowledge, meaningful learning and critical thinking [9].

Based on the results of observations made by two observers in observing student learning activities in problem based learning using the blended learning method in cycle I and cycle II, the results are included in both categories. In cycle I and cycle II, students have learned by applying learning steps in accordance with the planned syntax and method. Data on the results of observations of student activities in the first cycle can be seen in Table 3.
Table 3. Data observation results of student activity in cycle I and cycle II.

| No | Observer | Score |
|----|----------|-------|
| 1  | Cycle I  | 35    |
| 2  | Cycle II | 34    |
|    | Total observation | 72    |
|    | Mean score | 34,5  |
|    | Criteria   | Good  |

Table 3 shows that there is an increase in the teaching activity of students in problem-based learning by using the blended learning method in cycle I and cycle II. In the 21st century, learning not only emphasizes the mastery of concepts, but students are directed to open up insights and skills that lead to solving various problems and finding solutions. Biology in the 21st century, has undergone a paradigm shift, so that it affects the changes in 21st century learning. At this time, biology puts forward some integration of scientific disciplines and the application of applicable science to be used in overcoming various problems such as food, energy, health, and the environment. Therefore, students at the tertiary level need to be directed to apply the concept as a whole and be able to think critically to overcome these problems. Research conducted by other researcher shows that PBL learning is able to improve students’ critical thinking skills [10].

In implementing problem-based learning, learning activities are not only carried out face-to-face, but are also directed at the use of technology and internet communication and using ICT equipment. Problem-based learning does not only focus on problem solving efforts through conventional discussion or question and answer activities, but rather combines it with e-learning learning. Such learning is known as blended learning. In the application of blended learning, students create discussion groups online in this case the WhatsApp group. This group will later function as a means of online class discussion. The application of blended learning in PBL learning is applied to all steps of learning. At the stage of student orientation towards a problem, the lecturer introduces the problem using laptop and LCD media. At the stage of organizing students to study, the lecturer instructs students to work in groups by searching for information using smartphone media to access the internet to look for concepts related to the problem to be solved. In this case the lecturer acts as a learning facilitator. This is consistent with the other opinion which states that in PBL learning the instructor acts as a facilitator [11].

From the results of the application of problem-based learning (PBL) using the blended learning method in Cycle I and Cycle II, the obtained results showed that students’ critical thinking skills for biochemistry subjects were included in the critical enough critical and in Cycle II it had increased to become critical. Data on the value of critical thinking skills of students in Cycle I and cycle II can be seen in Table 4.

Table 4. Percentage and criteria for students’ critical thinking skills in cycle I and cycle II.

| Cycle | Percentage of critical thinking skills | Criteria     |
|-------|---------------------------------------|--------------|
| I     | 52,29 %                               | Critical enough |
| II    | 64,43 %                               | Critical     |

Table 4 shows that there is an increase in the students' critical thinking skills in cycle I and cycle II. At the stage of developing and presenting the work, the lecturer asks students to arrange their work in the form of power points, then present it to the class, then distribute it into class learning groups. Lecturers use class discussion tools online. This is a form of implementation of blended learning. The process of evaluating the investigation is carried out directly by confirming and clarifying the concepts discussed. Increased lecturer activity and student learning activities on PBL learning with blended learning shows that PBL combined with blended learning methods provides a positive influence on learning activities.
This is in accordance with the opinion which states that the Blended-PBL Environment provides opportunities for teachers and students to collaborate to take the same opportunity in building knowledge. Blended learning is hybrid learning, which means there are learning interactions face to face and online [12].

In connection with the efforts to develop students' critical thinking skills, through the application of PBL learning with blended learning methods, an increase in students' critical thinking skills from cycle I to cycle II. In the first cycle, the category of critical thinking students appeared in the quite critical category, whereas in the second cycle, their critical thinking skills improved. After learning PBL in class, at the end of learning students are then asked to work on critical thinking skills. The level of thinking of students who previously only focused on the ability to memorize, is now increasingly developed to be directed at developing higher thinking skills. This is consistent with the opinion of Sujanem [13] which states that problem-based learning implemented with blended learning can improve students' critical thinking skills. In biochemistry course, students not only learn in face-to-face meetings, but also conduct online learning activities using several online tools such as WhatsApp and Facebook. These tools are used to communicate and exchange information about the material being studied. Through this online tools, students can explore their knowledge more broadly, thereby affecting higher order thinking skills. According to Hussin et al. [14], PBL with the aided of online tools is the best teaching strategy to enhance students' critical thinking skills.

Improving learning outcomes by applying PBL using the blended learning method is supported by research conducted by Derby and Williams [15] which state that Blended-PBL based on website technology has a positive impact on student achievement. Blended learning in biochemistry courses provides opportunities for students to use technology in searching libraries, interacting between lecturers and other students. This can be seen from the increase in student learning activities when compared with problem-based learning without using blended learning methods. According to Bregger [16], blended learning provides an outside opportunity for students to use access to existing technology and it influences motivation, ways of learning, and communication. Integration of PBL learning and blended learning in higher education has a positive influence on the teaching process and is able to provide positive interactions between students and students or between students and teachers [17]. PBL learning with blended learning not only has a positive influence on students' critical thinking skills, but also has an influence on student learning outcomes. This is supported by the other opinion which states that PBL learning with blended learning can improve student learning outcomes [18].

4. Conclusion
Based on the results of research conducted, it can be concluded that problem-based learning that is applied by using the blended learning method can improve student learning activities, lecturer teaching activities, as well as critical thinking skills of students.

Acknowledgments
Authors would like to thank Fakultas Keguruan dan Ilmu Pendidikan, Universitas Bengkulu, Indonesia for providing research grants so that we can conduct research and publications.

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