Project-based learning to improve the conceptual knowledge of students in environmental microbiology topics

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Abstract. Students have difficulty mastering conceptual knowledge on the topic of environmental microbiology so learning is needed that can involve students in learning contexts that can enhance their conceptual knowledge. Project-based learning is expected to overcome these learning problems. The approach used in this study is a qualitative approach and this type of research is Classroom Action Research (CAR). The results of the study indicate that the average conceptual knowledge of students has increased in each cycle. Students show a positive response to Project-Based Learning. There are difficulties encountered during the learning process such as, (a) difficulties in assisting all groups at any time with action in the form of implementing team teaching in learning; (b) difficulties in mastering learning material with completion measures in the form of the application of peer tutors; and (c) difficulties in monitoring plans that have been made by students with action in the form of asking students to document each work.

1. Introduction

Experience has an important role in the learning process so it is important for educators to incorporate experience-based learning into real-world problems in the design of their learning both for children and adults [1]. Adults learning in higher education is a means for students to construct educational experiences that prepare them to answer the challenges of real-world problems they will face after graduation. The need for learning that requires a variety of specific experiences in solving problems related to the disciplines that are being cultivated by students requires learning design that is rich in educational experience and not only focused on educator-centered learning. Perception and learning approaches used by students in learning have a positive effect on their learning outcomes and are able to encourage quality learning [2].

The quality of learning experiences obtained by students is inseparable from the efforts of educators in designing learning, the ability of educators to provide real-world problems in learning by the subjects being taught is a driving force for students to construct educational experiences that are expected to improve student learning outcomes. The pedagogical skills of educators in designing
learning are important factors in producing quality learning. Some of the experiences included in the learning process included reading activities at Universitas Muhammadiyah Buton [3] and practicum at SMA Negeri 2 Baubau [4] were both learning activities were able to improve learning outcomes. Need more experience given by educators to students so that knowledge construction can occur optimally.

The selection of the right learning model can help students to learn more optimally and obtain the experience they want to master by students [5]. One of the lessons that can provide contextual learning experiences is project-based learning, through project-based learning students respond to authentic challenges that can increase knowledge while providing a context for real-world activities for students [6]. In addition to providing real-world experience for knowledge construction, project-based learning is also expected to improve student learning outcomes. Improving learning outcomes and providing educational experiences through the implementation of project-based learning becomes a component that needs to be considered in the construction of student learning objectives.

One type of knowledge in the taxonomy of learning objectives is conceptual knowledge. Conceptual knowledge contains the relationships between elements in a large structure that allows the elements to function together [7]. Mastery of conceptual knowledge important for every student who is engaged in a particular field of science, including in the field of microbiology.

Microbiology is a course that studies microorganisms and their implementation to solve problems faced by humans. One of the topics of microbiology's original eyes is environmental microbiology where on this topic, one of the focuses is to study microorganisms that can be used to overcome environmental problems faced by humans. Based on the description, research on the potential of project-based learning to improve student conceptual knowledge needs to be implemented. This study aims to improve student conceptual knowledge through the application of Project-based learning on the topic of environmental microbiology.

2. Methods
The approach used in this study is a qualitative approach and this type of research is Classroom Action Research (CAR). Research which is an observation in learning activities in the form of an action that is deliberately raised and occurs in a class together [8]. This study refers to the Kemmis and Mc Taggart models [9]. The action taken in this study is the application of the Project-based learning model.

This research was conducted in the even semester of the academic year 2018-1919. This research was conducted in the Department of Biology Education of Universitas Muhammadiyah Buton. The subjects in this study were sixth grade B students in the 2018-2019 academic year. The research subjects were 25 students consisting of 21 female students and 4 students. The study was conducted in three cycles where each cycle consisted of two meetings concerning the design developed by Kemmis and Mc Taggart [9] where each cycle consisted of stages: (1) planning; (2) acting; (3) observation; and (4) reflection.

The data collected in this study are quantitative data and qualitative data. Quantitative data in the form of ratio data are scores of students' conceptual knowledge results, and qualitative data in the form of ordinal data, namely the results of observations of learning implementation using the Project-based learning model and student responses to learning using the Project-based learning model.

The instruments used in this study are conceptual knowledge test questions, learning observation sheets using Project-based learning models, and student response questionnaires to learning using the Project-based learning model. The indicator of this research is that if more than 80% of students fulfill the minimum completeness of the conceptual knowledge score.

Data collection techniques carried out during and after the learning process using the Project-based learning model. Observation of the implementation of learning was carried out during the learning process each cycle took place and involved an observer who was a lecturer at the department of biology education Universitas Muhammadiyah Buton. While the test of conceptual knowledge and the giving of student responses to learning questionnaires using the Project-based learning model is done after the learning process is completed. The data obtained will then be analyzed using a technique
developed by Miles and Huberman [9] which consists of stages namely: (1) reducing data; (2) presenting data; and (3) present conclusions.

3. Results and discussion

Project-based learning is one form of learning method that is recommended to be implemented in higher education [10]. Project-based learning provides learning situations for students through the execution of certain projects. The data collected in this study are, (1) scores on the results of student conceptual knowledge tests; (2) learning implementation observation sheet; and (3) student responses to project-based learning. The mean score of the results of the student's conceptual knowledge test in each cycle is presented in figure 1, while the frequency of scores from students' conceptual knowledge tests is shown in table 1.

![Figure 1](image-url) (The average score of student conceptual knowledge test results for each cycle)

### Table 1. Frequency of student conceptual knowledge test score

| Score range | Minimum completion | Frequency | Completeness | Classical completeness |
|-------------|--------------------|-----------|--------------|------------------------|
|             |                    | cycle I   | cycle II     | cycle III              |                        |
| 85 – 100    |                    | 3         | 3            | 13                     | Complete              |
| 75 – 84     | 75                 | 14        | 14           | 8                      | Complete              |
| 55 – 74     |                    | 3         | 5            | 3                      | Not complete          |
| 0 – 54      |                    | 5         | 3            | 1                      | Not complete          |
| Total       |                    | 25        | 25           | 25                     |                        |

Figure 1 shows that there is a conceptual increase in students throughout the learning process in the three learning cycles that have been carried out. This increase illustrates that students experience an increase with time when learning through project-based learning. This increase is due to Project-based Learning that can encourage students to learn effectively through active student involvement in project-based activities [11]. Project-based learning also helps students in universities to develop critical thinking skills that can help students to analyze the problems faced to express solutions to these problems [12]. Average teacher and student activities are shown in table 2 as follows:
Table 2. Observation of teacher activities

| No. | Learning steps                                    | Average indicator achievement (%) | Explaination       |
|-----|--------------------------------------------------|-----------------------------------|--------------------|
| 1.  | Preparing project questions or assignments       | 100                               | Implemented        |
| 2.  | Designing project planning                       | 100                               | Implemented        |
| 3.  | Compile the project schedule                     | 100                               | Implemented        |
| 4.  | Monitor project activities and development       | 80                                | Implemented        |
| 5.  | Test the results                                 | 80                                | Implemented        |
| 6.  | Evaluating activities/experiences                | 85                                | Implemented        |
|     | Average                                          | 90.83                             |                    |

Based on table 2, it was found that on average for 3 cycles, the implementation of teacher and student activities was above 80%, namely 90.83% for teacher activities and 86.67% for student activities. The first and third steps are the learning steps that show the highest implementation both by the teacher and the student that is 100%, while the fourth step is the step where the teacher and students show a low level of activity that is 80% for teachers and 75% for students.

Table 3. Student response to learning

| No. | Student response                                                                 | Agree | %  | Not agree | %  |
|-----|----------------------------------------------------------------------------------|-------|----|-----------|----|
| 1.  | Project-based learning helps me to be more thorough in analyzing problems        | 23    | 92 | 2         | 8  |
| 2.  | Project-based learning trains me to think critically                             | 20    | 80 | 5         | 20 |
| 3.  | I find it difficult to arrange a product completion schedule while studying      | 0     | 0  | 25        | 100|
|     | through Project-based Learning                                                   |       |    |           |    |
| 4.  | Project-based learning helps me to carefully monitor the progress of the project | 20    | 80 | 5         | 20 |
| 5.  | Project-based learning helps me to test every product of the project being worked | 18    | 72 | 7         | 28 |
| 6.  | Project-based learning helps me to evaluate the advantages and disadvantages      | 20    | 80 | 5         | 20 |
|     | of the project that has been done                                                |       |    |           |    |

Based on table 3, it was found that students showed a positive response to the implementation of Project-Based Learning in their learning when studying environmental microbiology topics. Some difficulties and efforts to resolve the learning process during the learning cycle are listed in Table 4 as follows:

Table 4. Learning cycle

| No. | Difficulty faced                                           | Action taken                                                        |
|-----|-----------------------------------------------------------|----------------------------------------------------------------------|
| 1.  | Difficulty in accompanying all groups at any time         | Team teaching                                                       |
|     | Some students have difficulty mastering learning material | Apply peer tutors for students                                       |
| 2.  | Difficulty monitoring the plans set by students          | Ask students to document every implementation of their project plan |

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4. Conclusion
Based on the results of the research and discussion it was found that Project-Based Learning can enhance students' conceptual knowledge on the topic of environmental microbiology. The average conceptual knowledge of students has increased in each cycle. The average in cycle 1 is 68.68, cycle 2 is 71.84 and cycle 3 is 81.2. This increase was supported by the implementation of teacher activities which was 90.83% and the implementation of student activities was 86.67%. Students show a positive response to Project-Based Learning. There are difficulties encountered during the learning process such as, (a) difficulties in assisting all groups at any time with action in the form of implementing team teaching in learning; (b) difficulties in mastering learning material with completion measures in the form of the application of peer tutors; and (c) difficulties in monitoring plans that have been made by students with action in the form of asking students to document each work.

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