Impact of the Implementation of Problem Based Learning in Soil and Rock Mechanic Subject to Activities and Student Learning Outcomes of Study Programs Outside Domicile, Sawahlunto State Community Academy

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Abstract. This research was motivated by the low achievement of learning outcomes of Land and Rock Mechanics subject by students of Study Program Outside Domicile of Sawahlunto State Community Academy. This study purpose was to reveal the impact of Problem Based Learning application to the activities and the learning outcomes of Soil and Rock Mechanics subject of students of Study Program Outside Domicile of Sawahlunto State Community Academy. This research was in the form of Class Action Research Model Kemmis and Mc Taggart, consisting of four components (planning, action, observation, and reflection). After learning in three cycles, the results showed that the application of Problem Based Learning in Soil and Rock Mechanics subjects to Study Programs Outside Domicile of Sawahlunto State Community Academy turned out to be able to increase student learning activities, reaching very high categories, and achieving student learning outcomes average 83.33, above of the Minimum Graduation Standards value (70).

1. Introduction
Community Academy is an advanced secondary education that aims to prepare a skilled, professional, and highly disciplined workforce in accordance with the demands of the world of work. Community Academy is one of the higher education institutions apart from the existing forms of higher education, namely: universities, institutes, high schools, polytechnics, and academies [1]. The Community Academy organizes Vocational Education in Diploma One (D-I) and/or Diploma Two (D-II) Programs in one or several branches of certain science and/or technology based on local excellence or to meet special needs.

The Study Program Outside Domicile of State Community Academy of Sawahlunto (SPOD SCA Sawahlunto) under the guidance of Padang State University has a Mining Engineering and Heavy Equipment Engineering Study Program. One of the subjects at the SPOD SCA Sawahlunto is Soil and Rock Mechanics. The problems that exist in learning Soil and Rock Mechanics are the low learning activities and the low achievement of learning outcomes. Based on the preliminary survey, it can be seen that learning is still centered on lecturers (teacher center), students listen more (passively), almost no discussion or question and answer between lecturers and students and vice versa. While the achievement of learning outcomes is still low, even tends to decline (see Table 1).
Table 1. Average Value of Soil and Rock Mechanics

| No. | Year of Entry | Average Learning Outcomes | Point ≤ 70 | Number of students |
|-----|---------------|---------------------------|-----------|--------------------|
| 1   | 2014          | 74.56                     | 11 people | 47 people          |
| 2   | 2015          | 70.55                     | 4 people  | 42 people          |
| 3   | 2016          | 62.67                     | 24 people | 49 people          |

Source: Soil and Rock Mechanics Lecturer (2017).

Implementation of 2013 Curriculum implies the application of learning models that further activate students, including inquiry based learning, discovery based learning, project based learning, and problem based learning, etc.

In the course of Soil and Rock Mechanics the students are required to solve various problems related to the style or strength of the soil and rocks that will be used for various mining activities, such as for making tunnels, reclamation slopes, drainage, and others. In learning, students must be able to solve problems given both personally and in groups. Generally the conventional learning approach taken is a combination of lectures and giving practice questions.

In order to stimulate learning activities as well as to improve the learning outcomes of SPOD SCA Sawahlunto students in the future, it is necessary to develop the existing learning models. One learning model that is very relevant to this course is Problem Based Learning (PBL). In PBL students are expected to use various intelligences needed to deal with problems in the real world, so that they are able to solve new and complex problems [4] and [5]. PBL models provide skills to recognize problems, practice critical thinking to solve problems, express hypotheses and collect data, process data, and convey conclusions [6], [7], and [8].

This study aims to reveal the impact of the application of PBL on improving learning activities and learning outcomes of Soil and Rock Mechanics of students of SPOD SCA Sawahlunto.

2. Literature Review

2.1. Soil and Rock Mechanics Course

The Soil and Rock Mechanics course (subject) in the Mining Engineering Study Program on SPOD SCA Sawahlunto has a weight of 4 credits, which consists of 1 theory credit and 3 credits practice. The subject matter of the lecture includes: (a) soil origin and rock cycle, (b) physical properties of soil and rocks, (c) relationship between volume of soil aggregate weight, (d) soil compaction in the field, (e) voltage definition and strain, (f) Mohr circle, (g) relationship of stress and strain, (h) theory of Brazilian attraction, and (i) theory of compressive strength [9].

Soil Mechanics is a branch of engineering that studies the behavior of soils and is caused by stresses and strains of forces acting. Soil is a very complex material to be revealed in scientific experiments [10]. Whereas in Rock Mechanics rock reactions are studied against an interference from the outside. The material contains: geological structure deformation, which is related to folds, faults, and fractures. Some types of engineering that involve rock mechanics are civil, mining, and petroleum work.

2.2. Problem Based Learning

Problem Based Learning (PBL) has been known since the time of Jhon Dewey. In PBL there is an interaction between stimulus and response, which describes a two-way relationship, namely learning and the environment. The environment gives input to students in the form of assistance and problems, while the brain's nervous system functions to interpret the aid effectively so that the problems faced can be investigated, assessed, analyzed, and sought for solutions well [11] and [5].

PBL is characterized by the existence of real (contextual) problems faced by students, henceforth by critical thinking they can solve problems, and obtain basic scientific concepts from the problem. PBL is an effective model for learning high-level thinking processes, helping students to process the information that has been formed in their minds and compiling their own knowledge about the social world and its surroundings. This learning is suitable for developing basic and complex knowledge [5].
PBL is an innovation in learning, where the ability to think of students is optimized through a systematic process of group work or teams, so that they can empower, sharpen, test, and develop their thinking skills on an ongoing basis [4]. PBL is based on the idea that student learning understanding is guided by experiences that have been passed [12]. Based on the opinions of experts above, it can be concluded that PBL is one of the innovative learning models that can provide active learning conditions to students, because it involves students to solve problems scientifically (scientific method).

In simple terms, PBL syntax has 5 steps [14], this can be seen in Table 1 below.

| Stage | Lecturer (Facilitator) |
|-------|------------------------|
| Stage 1 | Explain the purpose of learning, explain the logistics needed, propose phenomena, demonstrate or tell the emergence of problems, motivate students to get involved in solving selected problems. |
| Stage 2 | Helping students define and organize learning tasks related to the problem. |
| Stage 3 | Encourage students to collect appropriate information, carry out experiments, to get explanations and problem solving. |
| Stage 4 | Helps students plan and prepare suitable works such as reports, videos and models and help them to share assignments with friends. |
| Stage 5 | Helps students reflect or evaluate their investigations and the processes they use. |

3. Research Methodology

The study was designed as Kemmis Model and Classroom Action Research Taggart. Research subject of the second semester student of the Mining Engineering Study Program at SPOD SCA Sawahlunto 2017, who took the Soil and Rock Mechanics course. The number of students in the study group was 21 people. The observer as well as the research partner in reflection is a lecturer in SPOD SCA Sawahlunto's Crystallography and Mineralogy subject. The research instruments consist of: (a) Observation sheets and (b) Test sheets. The observation sheets and test sheets can be seen in Table 2 and Table 3 below.

| Variable | Indicator | No. Item |
|----------|-----------|----------|
| Learning Activities | Students carry out discussions in solving problems. | 1 |
| | Students participate actively in groups in solving problems. | 2 |
| | Students identify the problem given by the lecturer. | 3 |
| | Students record the concepts used in problem solving. | 4 |
| | Students actively interact with lecturers and fellow students if they do not understand the problem. | 5 |
| | Students look for various information needed in problem solving | 6 |
| | Students actively implement problem solving | 7 |
| | Students submit the results of problem solving. | 8 |
| | Actively responds to the results of problem solving. | 9 |
| | Students provide ideas in problem solving. | 10 |
| | Respect and accept the opinions of others. | 11 |
Table 4. Learning Outcomes Test Sheet

| No | Cycle | Subject | Problem Indicator | Total Question |
|----|-------|---------|-------------------|----------------|
| 1. | 1     | • Compaction  
• Proctor Test  
• Compaction of soil in the field  
• Security figures | General principles of compaction, proctor test, compaction in the field. | 20 |
| 2. | 2     | • Stability of the dud  
• Definition of rocks  
• Rock properties  
• The scope of rocks | The number of security, stability of the talus without seepage of stability of the talud with seepage  
Knowledge of rock definitions, rock composition, and rock properties. | 20 |
| 3. | 3     | | | 20 |

The instrument has been through expert validation and the test sheet has been statistically validated by calculating the validity of the test, the power difference, and the index of difficulty.

The criteria for success of the action are: (a) If the results of observations of student activities reach high criteria (more than 70% of students are active), (b) If the test results of students have reached an average of more than KKM (score 70).

The research scheme can be seen in Figure 1 below.
4. Results and Discussion

The following is described an increase in the activity and learning outcomes of the Soil and Rock Mechanics of SPOD SCA Sawahlunto with the application of PBL in 3 cycles.

4.1. Cycle 1

The steps of classroom action research conducted consist of planning, implementation, observation, and reflection.

Planning Phase

The lecturer prepares learning devices and research instruments which include Learning Event Unit, Student Worksheet, Teaching Material, Exam Question and Answer Sheet, Observation Sheet for student learning activities. All research instruments and instruments have been validated by the validator.

Implementation Phase

In Cycle 1 two meetings were held. Lecturers condition the room assisted by observers to measure student learning activities using the observation sheet format, then continued with learning activities. Lecturers do attendance, convey the objectives of the lecture, describe various logistical needs, motivate students to be involved in activities to solve problems related to general principles of compaction, proctor test, and factors that influence compaction.

The lecturer divides students into 5 discussion groups, each group is given problems regarding soil compaction. The direction of learning activities is to find the definition and purpose of soil compaction, and carry out compaction testing practices in the field.

Lecturers encourage students to discuss with friends to get the information they need. As long as students discuss the lecturer is in charge of supervising and guiding students to get a solution. The lecturer guides students to plan and prepare reports on discussion and practice of soil compaction testing in the field and conclude. After the report is complete the students take turns presenting the results of the discussion and the practice of testing the soil compaction alternately. The results of the discussion were then concluded. The lecturer helps students carry out analysis and evaluation of the soil compaction testing process in the field.

Observation Phase

The Observer observes the learning process and records the results in the Observation Sheet provided. In addition, observers also observe various weaknesses that may exist in the learning process, which will be conveyed during the reflection process. After the implementation of PBL and examinations in Cycle 1, the following results are obtained:

Reflection Phase

The results of observations in Cycle 1 show that student learning activities have not achieved the expected results (only 51.94% of students are active in learning), while the achievement of learning outcomes is still not maximum (the new average reaches 69.90). For this reason, it is necessary to do the 2nd Cycle learning.

4.2. Cycle 2

The results of the second cycle are that student learning activities have not achieved the expected results (only 63.19% of students are active in learning), while the achievement of learning outcomes has increased above the KKM average, which is 73.33, but still exists students who have not reached the KKM score, therefore it was decided to conduct the 3rd Cycle learning.
4.3. Cycle 3
The results of observations in the 3rd Cycle showed that student learning activities were quite high, reaching 76.19, while the achievement of learning outcomes had increased significantly, namely 83.33 (KKM score was 70). In connection with this, it was decided to provide learning until the third cycle.

5. Conclusion
Based on the results of the study it can be concluded that the application of PBL turned out to be able to improve learning activities and learning outcomes of Soil and Rock Mechanics students of SPOD SCA Sawahlunto. For this reason, peer lecturers need to apply PBL in learning Soil and Rock Mechanics.

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