The implementation of project-based learning model to improve students’ learning outcomes

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Abstract. This study aims to determine the improvement of students’ cognitive learning outcomes after the implementation of the PjBL model combined with PDEODE (predict-discuss-explain-observe-discuss-explain). This research was conducted at several senior high schools in Banda Aceh from September to October 2018. The Pre-test post-test control group design was employed in this research. The total of 172 students was involved as subjects which was divided into 2 groups (control and experiment). The students’ learning outcomes were measured by calculating gain normalization (\(g\)) and the Mann-Whitney test. The results showed a significant difference between control group and experiment group \(\alpha =0.05\), the value of Asymp. Sig. (2-tailed) \(0.00<0.05\). To concluded, the PjBL model combined with PDEODE has significantly improve the cognitive learning outcomes of students.

1. Introduction
One of the things that the government does to measure education quality is by holding a national exam. In general, the role of the national exam is as an evaluator of actual education. As for further explanation of the role of the national examination as an actual evaluator as follows, the national examination as a consideration for mapping the quality of programs or educational units, furthermore, though, national examinations are no longer the only determinant of student graduation, but national exam scores play a single indicator for selection entering the next level of education, and from the results of national examinations are also taken into consideration as an effort to improve the quality of education by providing guidance and assistance to educational units [1].

Based on the results of the average national exam for biology at the Banda Aceh senior high school many have decreased in the last 3 years (2015-2017). Based on the results of interviews with biology teachers in several high schools in Banda Aceh, cognitive test results of class X in the odd semester of 2017 there were still students who had not yet reached the minimum completeness criteria was 70. In the teaching and learning process, students were still often indifferent to learning subjects and not all students dared to convey their ideas.

The increase can be done by examining the factors that influence the national examination results in the form of management, teachers, educational facilities and infrastructure, and community culture [2], the process learning will affect students’ understanding [3]. Furthermore, a less varied learning model will have an effect on cognitive learning outcomes [4]. One effort to improve students’ cognitive learning outcomes is to implement a varied learning model, that is with the PjBL (Project-Based Learning) model combined with PDEODE, while the combination reasons are explained as follows.
Project-based learning directs students to find their own knowledge, and work collaboratively to research and create projects that reflect their knowledge [5]. Some of the advantages of project-based learning include: focusing on the main concepts and principles of a scientific discipline, involving other parties that are relevant to the needs in the field, providing opportunities to work autonomously to construct their own learning, and culminating in producing work products that valuable and realistic [6]. However, it is possible that students cannot understand the topic as a whole [7].

To avoid the overall misunderstanding of students, one of the efforts taken can be by adding PDEODE. PDEODE was effectively used in the learning process to help students feel certain situations in learning and changing concepts in a material [8].

Biodiversity is a material/concept that discusses the diversity of living things in nature with all forms of utilization and conservation, one of the efforts to produce maximum student cognitive learning outcomes is by implementing the project-based learning model which is a learning model that provides an opportunity to work autonomously to construct learners' own learning by directly making projects based on things learned specifically about biodiversity material, combined PDEODE to help students not only understand on one part of the material by conducting discussions and also observations and exposures first.

Based on this explanation, it was designed by the author an attempt to improve student’s cognitive learning outcomes based on the implementation of the project-based learning model combined with PDEODE on biodiversity material in Banda Aceh senior high school.

2. Methods

The research method used was an experiment with a pre-test post-test control group design [9]. The design can be illustrated in the following Table 1. This research was conducted at several senior high schools in Banda Aceh in September to October 2018. The study population was all students of class X (Science) totaling 432 students. Research samples were taken randomly. The research subjects were 172 students from 2 groups (control and experiment) of X class (science) from each school.

| Group  | Pretest | Treatment  | Posttest |
|--------|---------|------------|----------|
| Experiment | O1 | X1 | O2 |
| Control | O3 | X2 | O4 |

Information:
O1 = Pre-test (before treatment) of the experimental group
O2 = Post-test (after treatment) of the experimental group
O3 = Pre-test (before treatment) of the control group
O4 = Post-test (after treatment) of the control group
X1 = Treatment with the PjBL model combined with PDEODE
X2 = Treatment with the PjBL model

The experimental group implements the PjBL model combined with PDEODE while the control group implements the PjBL model. The PjBL model combined with PDEODE is done by following the syntax in Figure 1.
The PjBL Model Syntax combined with PDEODE

1. Prediction and determination of projects based on fundamental questions
2. Strengthening the concept (Discuss-Explain-Observe-Discuss-Explain (DEODE)) and project planning design
3. Compilation of project implementation schedules
4. Completion of the project with teacher facilitation and monitoring
5. Testing project results
6. Experience evaluation

Figure 1. The PjBL Model Syntax combined with PDEODE

The cognitive learning outcomes instrument was a written test, an objective test about biodiversity which consisted of 40 items. The test is given before treatment (pretest) and after treatment (post-test). Data obtained from pretest and posttest scores from the control and experimental groups. The pretest and posttest scores are tabulated and averages are calculated. Next, the gain is calculated. The gain that has been obtained is then normalized [10]. Increased cognitive learning outcomes were measured by calculating gain normalization (g), whereas to compare the increase in cognitive learning outcomes tested by two different test averages using the Mann Whitney test. This test uses SPSS version 20.

3. Result and Discussion

Based on the research that has been done, the data obtained from the implementation of the project-based learning (PjBL) model combined with PDEODE on the cognitive learning outcomes of students in the biodiversity concept at the Banda Aceh Senior High School. The following table presents a recapitulation of pretest scores and gains normalization (g) students from the results of the normality, homogeneity, and hypothesis testing between experimental and control groups in Banda Aceh senior high school can be seen in Table 2.

| Cognitive Learning Outcomes | Group | Normality* | Homogeneity** | Mann Whitney Test*** | Description |
|-----------------------------|-------|------------|---------------|---------------------|-------------|
|                             | Exp   | Sig. 0.00<0.05 (Not normally distributed) | Sig. 0.17>0.05 (Homogeneous) | Asymp. Sig. (2-tailed) 0.69<0.05 | Not statistically significant |
|                             | Con   | Sig. 0.00<0.05 (Not normally distributed) | | | |
| N-Gain                      | Exp   | Sig. 0.20>0.05 (Not normally distributed) | Sig. 0.00<0.05 (Not homogeneous) | Asymp. Sig. (2-tailed) 0.00<0.05 | Statistically significant |
|                             | Con   | Sig. 0.09<0.05 (Not normally distributed) | | | |

*) = Normality test (sig. > 0.05 = Normal)  
**) = Homogeneity test (sig. > 0.05 = Homogeneous)  
*** = Mann Whitney test (Asymp. Sig. (2-tailed) <0.05 = Statistically significant)

Provisions for Hypothesis Testing:
- Sig>0.05 = Accept H0
- Sig<0.05 = Decline H0
Based on Table 2, it shows that the results of the analysis of students’ initial learning abilities (pretest) using the Mann Whitney test at the senior high school of Banda Aceh were not significantly different, meaning that \( H_0 \) was accepted and \( H_1 \) was rejected. Thus, it can be seen that there is no difference in the initial ability of students between the experimental and control groups in Banda Aceh Senior High School. Recapitulation of gain normalization cognitive learning outcomes (g) overall students at the Banda Aceh Senior High School indicate that \( H_0 \) is rejected and \( H_1 \) is accepted. Thus it can be concluded that there are differences in the increase in student learning outcomes between the experimental and control groups in Banda Aceh Senior High School, which means that the application of the project-based learning Model combined with PDEODE can improve students’ cognitive learning outcomes in biodiversity concept at Banda Aceh Senior High School.

Based on the research results, an increase in cognitive learning outcomes in the experimental group higher than the control group was inseparable from the learning process that had been carried out. This explains that the project-based learning PjBL model combined with PDEODE is effectively used in the learning process. This is supported that PDEODE is effectively used in the learning process to help students feel certain situations in learning and changing concepts [4]. This explanation is supported that the average cognitive learning outcomes of students in the learning process using the PjBL were higher than the group without using the learning model [11]. Furthermore, with PDEODE the understanding of students’ concepts also increased [12].

Based on the research results, the control group that only used the PjBL model had lower cognitive learning outcomes than the experimental group, it was possible for students to only understand one or more topic sections of the biodiversity concept, students in the control group only worked on the project in accordance with group parts and in the classroom there were no previous presentation and discussion concepts that were in-depth with all the topics. This is in accordance with Wena’s PjBL model that allows students not to understand the topic as a whole. The main focus of PjBL is the project, therefore, students must learn the concept of problems through the project [13]. Students are not successful in learning topics through projects [13]. In fact, it states that projects cannot function to provide illustrations, examples, and practical applications for concepts taught because students will make traditional instructions [13]. In this research, some students were unable to show their actual academic performance due to disagreement with group members.

The PDEODE in the learning process can help students not understand only one part of the topic, especially the topic of group projects. In the learning process with the PjBL model combined with PDEODE, students discuss all the problems of the discussion first and then make the project, this is what helps to avoid the understanding of the topic in just one section.

In the first step, students predict the answers to fundamental questions or phenomena and determine which object to become the group project in the future is done on the worksheet of students, by doing this it can explore students’ initial knowledge. Based on the opinions of constructivists like Piaget explained that someone builds their own knowledge by continuing to develop their curiosity [14]. Furthermore, the benefits obtained at the prediction stage can increase students’ curiosity [15]. With PjBL students can be encouraged to be more active in completing projects by solving problems described in the form of products [16].

Furthermore, in the second stage there is concept strengthening (DEODE) and project planning design, in the learning process there has been a process of discussion and presentation in 2 stages, then there is also an observation process to confirm the truth of facts predicted by students so students are more confident in the knowledge that relates to making projects, but not only satisfied with the results of observations, students can also strengthen the concept through discussion and exposure to groups in the class at the discussion stage and presentation of the second stage.

The following is the support of experts on the importance of strengthening concepts in particular (DEODE). Students who take part in learning with PDEODE not only stop building or strengthening their knowledge through observation alone but students can also replace or strengthen their new structure of knowledge through discussion, exposure and observations that have been made [17]. The discussion and presentation stages can encourage students to work together to solve problems, gain
knowledge by improving their thinking skills, and encourage them to dare to express their arguments, and at the observation stage encourage students to know the truth [15]. In PDEODE with predictions, observations, and discussions, students are directed to find out the problems that will be found right and replace their wrong knowledge with the right ones, in addition, students can also complete their knowledge through observation and discussion with friends in the [12,18].

In the predict process, discuss, explain, observe, discuss (PDEODE), explain being able to encourage students to organize their own experiences into meaningful knowledge. Furthermore, the profit is carried out a discussion process twice so that it helps students convey their observations more confidently [8].

In the third stage students and teachers arrange a project implementation schedule, at this stage discussions occur based on the design that has been made and the timeline of the activities of each group. In the fourth stage, namely the completion of the project by facilitating teacher monitoring. Students can actively review the concepts discussed to be done outside of lesson hours so that students better understand the concept. This is supported that PjBL makes students have the opportunity to practice their understanding of learning material by interacting and communicating with their peers in groups [11]. Students not only memorize concepts, but they also learn deeply through the shared responsibilities they have set in completing group projects. Students who work and think for themselves on assignments they are working on can make students remember lessons. Vygotsky argues that through social interaction students can achieve a higher level of development than they will achieve by working and studying alone [19]. With project-based learning (PjBL) students can be encouraged to be more active in completing projects so that students can improve understanding, so students can work and think for themselves so they can remember and understand the subject matter.

Furthermore, Bruner also explained that the need for active students to be involved in the learning process and to believe that actual learning takes place through the discovery of the learner himself [20]. Piaget and Vygotsky agreed that a child is an active student. In this case, the teaching and learning process involves children actively absorbing knowledge, meaning children are not only used as listeners or absorb knowledge passively [14].

In the fifth stage, namely testing the results of the project, students publish the results of their products in the class of teachers assessing based on products that have been made supported by presentations explaining the process of making these products. In the sixth stage, namely evaluation of experience, teachers, and students reflect on a series of activities that they have taken along with the results obtained. Teachers and students also provide input and considerations with the quality of work that has been done.

In summary, the Model PjBL stages combined with the PDEODE are explained as follows, students make instructions in accordance with the worksheet, students make prior predictions about the problem then determine the project to be implemented, then strengthen the material with the existence of stage I discussion about problems predicted by the group. friends and then explain the results of the prediction group, then make observations to confirm the correctness of predictions, then students conduct stage II discussions with the group and explain it again, then design the project plan that has been determined, then arrange the implementation schedule and collection, then students complete the project with teacher guidance/monitoring by discussing unclear matters, then the project is tested by publishing in front of the class, then evaluating the experience of the activities that have been carried out.

Based on the learning process, the PjBL model also plays an important role in the learning process, moreover, the PDEODE model requires good time management, so that all learning steps can be done with the PjBL to complete very limited time. The advantage of applying the PjBL model in the learning process is to focus on the main concepts and principles of discipline and provide opportunities to work independently to build their own learning [21]. Furthermore, the PjBL model is one model that supports the learning process to achieve better quality learning [22]. Furthermore, students produce valuable and realistic work products [6]. Furthermore, learning to use PjBL makes
students feel the process is more meaningful [21].

Based on the research conducted, it can be summarized some of the advantages of applying the PjBL model combined with the PDEODE makes students not only able to create group projects but also able to improve cognitive learning outcomes with better understanding. Based on the research conducted, it needs to be given more attention to time management and also how to respond to students who are not too familiar with the model applied so that the learning process can be carried out well.

4. Conclusion
Based on the results of research on the PjBL model combined with PDEODE, it can be concluded that the implementation of the project-based learning model combined with PDEODE can improve students’ cognitive learning outcomes.

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