The effect of project based learning and authentic assessment on students’ natural science learning outcome by controlling critical thinking skill

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Abstract. This experimental research aims at discovering the effect of project based learning and authentic assessment on natural science learning outcome by controlling critical thinking skill. This research was done on eighth grade students in Amlapura City with 2x2 factorial design. The data of learning result and critical thinking skill were collected by using test. The obtained data were analyzed by using two ways Analysis of Covariance. The result of this research discovers that by controlling critical thinking skill, both project based learning and authentic assessment have positive effect on students’ learning outcome. In addition, there is an interactional effect of instructional model and assessment type on students’ natural science learning outcome. Project based learning is more appropriate to authentic assessment; meanwhile conventional model is more appropriate to conventional assessment. Based on those findings, it is recommended to implement project based learning by considering the assessment typed used.

1. Introduction

The problem of low learning process and result of natural science subject in junior high school is still faced until now. It is proven by the PISA data in 2009 discovering that the result of National Examination of Junior High School in academic year 2015/2016 in Amlapura City and researcher’s observation. PISA data showed that almost all Indonesian students only master learning until level 3, while other students in different countries have reached level 4, 5, even 6. It could give a picture about the level of students’ comprehension and mastery upon the knowledge is in low level. Meanwhile, National Examination result of junior high school in Amlapura City in academic year 2015/2016 showed that the mean score of the students was only 59.74. It is definitely not a good score considering the passing grade of science subject in Amlapura City was 70.00.

In relation to learning process, many teachers still position students as object of learning who passively accept learning transfer from the teacher. Based on the observation for one month (January 2017) in SMP Negeri 4 Amlapura and SMP Negeri 5 Amlapura, it was found that teacher was dominantly using lecturing and question and answer methods in science learning. It makes the students to be passive and just memorize what the teacher explained. To assess the students’ learning, objective types test was dominantly used. It just focused on the product of learning and rarely concerned on the learning process. As the result, the students’ science achievement is just in level C1 and C2.

It implies that inappropriateness of learning model and assessment to the science essence is the root of the problems. The learning model and assessment should be directed into the nature of science itself...
as a process of discovering through scientific method [1,2]. The processes such as observing, analyzing, experimenting, and concluding shape the students’ understanding in the science topic. It makes the students to have productive and critical thinking. The critical thinking helps the students to solve problems on science. For that reasons, the application of innovative learning model based on constructivism needs to be done because 1) problems in the real world are increasingly complex so it needs critical thinking and comprehension to find the solution, 2) considering the nature of science, this subject is complex and 3) commonly technological progress is started from in the field of science [3].

The previous explanation implies on the implementation of project based learning and authentic assessment in natural science subject. Project-based learning is a systematic teaching model which involve the students in the how to learn and comprehend through discovery learning, complex structured processes, authentic questioning and careful designed product and tasks. The tasks are structured based on questions and problem that are very challenging, and demand the students to design how to solve the problem, make decisions, conduct investigative activities, and provide opportunities for students to learn independently [4,5].

To support the effectiveness of project based learning, authentic assessment is required [6]. Both of them focus on the process of learning. Furthermore, authentic assessment is required in project-based learning because its components are student reflections for different periods, improving their development and prosperous goals. The use of authentic assessment enables the students to realize their real and holistic learning which encourages them to be active seeker and constructor [7].

In addition to the model of learning and the type of assessment, student learning outcomes are also determined by students’ critical thinking [8]. Critical thinking is thinking to do their own thinking process and people who will equip the child to the best possible information they hear, read, the events they experience and the decisions they make every day [9,10]. Through critical thinking, students will learn filtering out information about whether something is true or not so they can get the truth.

Researches on the areas of project based learning [11,12] and authentic assessment [13,14] have been done previously. However, the setting is mostly in higher education and senior high school level. Furthermore, the fields are computer, math, and specific branch of branch, chemistry, biology, or physics. Besides on the area of the students’ achievement, the topic is also area of affective domain, such as: motivation and perception of the students toward the implementation of project based learning.

Based on all previous explanations, this research aims at investigating the influence of project based learning and authentic assessment on the learning outcomes of science, for that students’ critical thinking ability was controlled. Here, critical thinking is controlled to get pure effect so the results of the study would be biased. The research is focused on junior high school students with integrated science subject.

2. Methods
This research is classified as a quasi-experiment with 2 x 2 factorial design [15]. The population of this research is all students of SMP class VIII in Amlapura City. There were 160 students selected as research samples with cluster random sampling technique. To collect data of science learning outcome, a test in the form of expanded multiple choice test was used, while students’ critical thinking skill was collected by using multiple choice test. The obtained data were then analyzed by using two way ANCOVA.

3. Results and discussion
The result of analysis by two way ANCOVA covers seven investigated problems and the results are summarized in the table 1.

| Source of Variance     | Probability | Conclusion |
|------------------------|-------------|------------|
| Instruction Model (A)  | 0.0001      | Significant|
| Assessment Type (B)    | 0.004       | Significant|
| Interaction A*B        | 0.0001      | Significant|
| X B A*B I              | 0.0001      | Significant|
| X B A*B I              | 0.0001      | Significant|
Table 1. Cont.

| X A A*B 1 | 0.0001 | Significant |
| X A A*B 2 | 0.0001 | Significant |

From result of hypothesis testing, it was found that main effect of the learning model used significantly influenced the science learning outcomes after controlling critical thinking skill of class VIII student of SMP Negeri in Amlapura City. This is shown by the coefficient ANCOVA (F) of 25.04 which was significant. Furthermore, it is proven that the corrected average of science learning outcomes of students who were treated with project based learning model was 125.237 higher than the corrected average of science learning outcomes of students who were treated with conventional learning model which was only amounted to 119.463. It means that the project-based learning model has a positive effect on the science learning outcomes of eighth grade students in SMP Negeri in Amlapura City after students’ critical thinking skills was controlled.

Theoretically, the positive effect of project-based learning model on science learning outcomes is inseparable from the learning experience that students go through. According to Dewey, learning will be effective if it is done directly (learning by doing). The process of obtaining learning outcomes by doing certain actions in accordance with its purpose, especially the process of controlling the child about how to do a goal. In the learning process, teachers should encourage students to engage in project or problem-oriented tasks and help students to investigate intellectual and social issues. By direct involvement of students to conduct an investigation, the students will build their own knowledge and understanding gradually.

The project-based learning model requires students to produce a product. This product can be generated through several steps such as focusing on meaningful questions and problems, problem solving, decision-making, the process of finding sources and giving members the opportunity to work in collaboration [16]. Students in the learning process will be given a problem and they must solve it through certain projects. Of course, there are clear rules and guidelines on project implementation.

Students will be motivated to learn if they directly involved in a project that makes them feel interested [17]. This interest makes students learn their best to create projects. In project-based learning, students do it themselves, the teacher only facilitated them. Even they were involved, only if the students have difficulty during the learning process, while engaging in a project the students certainly trained their skills of thinking and hard working. If the project can be implemented ideally, then it will give birth to an ideal society as well.

Learning science highly depends on students’ critical thinking. Critical thinking will be generated through student-centered activities and in the form of discovery or inquiry. This can be generated by some of the learning processes provided by project-based learning models such as (1) defining project themes, (2) learning context, (3) planning activities, (4) processing activities, and (5) implementing activities to implement projects [18]. Through these activities the students will be directed to think both of planning and doing projects so that students will generate productive thinking. This critical thinking facilitates the students to solve the problems that exist in the science which is related to concept.

From result on hypothesis testing for main effect, the used of assessment type significantly influenced the science learning outcomes after controlling critical thinking skill of eighth grade students of SMP Negeri in Amlapura City. This is shown by the coefficient ANCOVA (F) of 8.79 which was significant. Furthermore, it is proven that the corrected average of science learning outcomes of students who were treated with authentic assessment was 123.997 higher than the corrected average science learning outcomes of students who were given conventional assessment was only 120.703. It means that authentic assessment has a positive effect on the science learning outcomes of eighth grade students in SMP Negeri in Amlapura city after critical thinking skills were controlled.

Theoretically, authentic assessment is an integrated process to determine the characteristics and levels of learning and learning development of learners [19]. This means that assessment becomes a unity with the learning process. Student learning process is assessed so that it can be known the authentic performance or performance of students while learning. Thus, the teacher as a learning facilitator will
help students overcome their learning problems. This is different from the conventional assessment. If it refers to a multiple-choice objective test, students cannot demonstrate their ability authentically because they can cast the answer. This means there is a factor of luck on student learning outcomes.

When it is associated with the psychology of junior high school students in science, it is stated that students should be given time to share with their friends about the quality of their work and how their work is evaluated [20]. This turn can reduce the gap between students who are smart and less. With students who are unable to learn the work of the theme, they begin to explore the work of their friends. From there, they learn the standard that is needed. Students will continue to learn and learn to achieve the standards possessed by their smart friends. This kind of evaluation is one of authentic assessment characteristics, especially peer assessment. This clearly shows that in science for junior high school students authentic assessment facilitates those who are lacking to discuss learning the standards of smart friends and pursue those standards.

Further results on the interactional effect, it was found a significant interaction between learning model and the type of assessment of science learning outcomes. This is proved by the coefficient value which was found that the value of coefficient ANCOVA (F) of 147.62 was significant. The result of the descriptive analysis shows that the students’ science learning outcomes who were given the treatment of project-based learning model and authentic assessment have a better effect than the students’ science learning outcomes who were given the project-based learning model and the conventional assessment. However, the learning outcomes of the students who were given the conventional learning model with conventional assessment was better than the students learning outcomes who were given the project-based learning model and the conventional assessment.

This result shows that project-based learning model is more suitable when it is combined with authentic assessment. Among four sub-groups show that the students’ learning outcomes of science who were given the treatment of project-based learning model with authentic assessment is the highest. It is in line to the finding of Dharma and Adiwijaya who discover that a students-centered learning model is more appropriate to be combined with authentic assessment [21]. Therefore, it can be concluded that students’ learning outcomes will be maximal if they are given the treatment of problem-based learning model and authentic assessment.

Meanwhile, project-based learning model is less suitable when it is combined with conventional assessment. Among four sub-groups show that the students’ learning outcomes of science who are given the treatment of project-based learning model with authentic assessment is the highest. It is in line to the finding of Dharma and Adiwijaya who discover that a students-centered learning model is more appropriate to be combined with authentic assessment [21]. Therefore, it can be concluded that students’ learning outcomes will be maximal if they are given the treatment of problem-based learning model and authentic assessment.

Fortunately, the result of further analysis on the simple effect shows that there is a difference of science learning outcomes of the group of students following the project-based learning model with the group of students following the conventional learning model in the group of students following authentic assessment after controlling the critical thinking skill of the class VIII SMP students Negeri in Amlapura City. This is proven from the value t = 13.651 which was significant. Furthermore, it is proven that the corrected average of science learning outcomes of students who were treated with project-based learning model with authentic assessment was 135.177 higher than the corrected average of science learning outcomes of students who were treated with conventional learning model with authentic assessment which was only 112.816.

The main strength of authentic assessment is the provision of feedback for student learning. Authentic assessments are formative, not summative. This means that assessment is done during the learning process. Each student’s performance is assessed and information about the students is gathered to get a holistic picture of student’s competency. This is also in line with the project-based learning step which is an ongoing process. This project-based learning process is facilitated by authentic assessment. That is, any performance or ability of students during the project to make conclusions can be collected.
which further implies on project improvements. If during the learning process students’ weaknesses can be known and given feedback, the students will be able to improve the quality of learning. Improving the quality of learning is certainly a positive impact on student’s learning outcomes.

The combination of project-based learning model and authentic assessment creates an inquiry and discovery learning condition. Through authentic assessment in the project-based learning model, students will be guided to discover the concepts of science. If it is not supported by an assessment that facilitates it then of course the result is not maximal. Assessment of performance and self-assessment leads students to apply project-based learning to stay in line with the flow. Especially for Junior High School students, it will be very difficult. The presence of these authentic assessments gives them signs of what and how to learn.

The project-centered, student-centered learning process brings positive impacts that can provoke students’ creativity in thinking that will result outputs in (1) tangible products, (2) increased student responses to changes and consequences of a situation, (3) enhancement of skills in self-management, (4) enhancement of ability to demonstrate an event process and, (5) the habit of self-evaluation [22].

This is also supported by the view that the inquiry aspects of project-based learning provide knowledge construction and allow students to do scientific activities rather than memorizing facts [23]. Therefore, teachers guide or lead students on tasks, present ideas and build relationships. Judging from the demands of learning in the form of scientific activities, the traditional assessment will not be able to provide complete information about learning activities because it only focuses on the end result and low level cognitive abilities.

The result of further analysis on the simple effect shows that there is a significant difference of science learning outcomes of the group of students following the project-based learning model with the group of students following the conventional learning model in the group of students following the conventional assessment, after controlling the critical thinking skills of the class VIII SMP Negeri students in Amlapura City. This is proven by the value of \( t = -5.615 \) which was significant. Furthermore, it is proven that the corrected average of science learning outcomes of students who were treated with project-based learning model with conventional assessment was 115.298 lower than the average of science learning outcomes of students who were treated with conventional learning model with conventional assessment which was only 126.109.

The project-based learning model is sustainable and constructive or design-oriented, which means that projects involving lessons in constructive investigation which can be in form of design, decision making, problem discovery, problem solving, discovery but the core activities of the project must include knowledge transformation and construction [24]. Unlike project-based learning, conventional learning is a learning that is often done by teachers and tend to be centered on teachers (teacher-centered). Conventional learning activities is based on behavioristic theory which is dominated by teachers.

If it is connected them in the application of project-based learning and conventional assessment, holistic information about students’ abilities can not be known comprehensively. How students at each learning phase are also completely unknown. As a result, feedback becomes very minimal. In addition, conventional assessments cannot diagnose students’ abilities at each learning phase where students may experience many problems during a project. This is because the project-based learning model is very complex. If it is not given the right assessment, of course the result will be in contrast.

4. Conclusion
The results of hypothesis testing with two-way ANCOVA showed that by controlling critical thinking skills, both project-based learning model and authentic assessment had a positive effect on the science learning outcomes. It was also found that the influence of learning model interaction and the type of assessment on the learning outcomes of science. Project-based learning model is compatible with authentic assessment and conventional learning models more suited to conventional assessment. Referring to the findings, it is recommended to apply a project-based learning model by considering the type of assessment used.
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