The effect of problem based learning and authentic assessment on students’ natural science learning outcome by controlling achievement motivation

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Abstract. This experimental research aims at discovering the effect of problem based learning and authentic assessment on natural science learning outcome by controlling achievement motivation. This research was done on eighth grade students in Manggis Subdistrict with 2x2 factorial design. The data of learning result were collected by test and achievement motivation data were collected by questionnaire. The obtained data were analyzed by using two ways Analysis of Covariance. The result of this research discovers that by controlling achievement motivation, both problem 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. Problem 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 problem based learning by considering the assessment typed used.

1. Introduction
Education aims at actively developing the students’ potency which includes academic and non-academic fields (Law No. 20 year 2003 about national education system). It implies that education should be led into modern education underlying on the constructivist perspective. Education has to be innovative and meaningful for the students. They have to be viewed as the active seeker and constructor of knowledge for their learning. The concept should be applied all subject lessons in all levels of education [1].

In the context of natural science subject, the students should be led into science nature as the way to discover knowledge systematically to master, such as: facts, concepts, principles, discovery process and scientific attitude. To reach it, the students have to be involved actively during instruction process. They have to be involved in certain activities, such as: observing, collecting information, identifying, making hypothesis, testing hypothesis and drawing conclusion. By doing those activities, the students can have critical thinking in understanding science concept. In the end, high learning outcome can be achieved [2].

However, in real life the condition was different. Based on the observation on Junior High School No 2 and 3 Manggis, natural science subject was still taught in conventional ways or it was so far from the constructivism concepts. The teachers were less creative in designing instruction to lead the students constructing their knowledge. The teachers still explained the materials and they were assessed by using
paper pencil test. This condition made less participation of students during instruction process. Moreover, the students’ actual performance cannot be obtained holistically because they were only assessed at the end of learning. As the consequence, the students’ learning outcome was low. It can be seen from the students’ cognitive level which only achieved level 3 [3].

It is urgent to do innovative ways as solution so that the same problems can be solved in the future. One way is to experiment teaching models and assessment types having different characteristics, i.e. problem based learning (PBL) [4] and authentic assessment [5].

Problem based learning is an approach in which the students are given authentic problem so they can construct their own knowledge, develop their high skill and inquiry, make the students to be independent, and increase the students’ self-confidence. In the implementation, the activities done by the students are: observing phenomena or problems, collecting information, questioning, making hypothesis, testing hypothesis, and presenting the hypothesis testing. Here, there is no memorization process [6]. The students have to be active in constructing knowledge which leads to have good understanding and critical thinking skill.

Furthermore, the activities in problem based learning facilitate the occurrence of (1) meaning relationship exploration leading into an understanding, (2) information manipulation process (learning materials) through the series of analyzing a synthesizing will cause the students to think critically [7]. So, the students’ science learning outcome can be improved.

Besides teaching model, the use of authentic assessment should also be taken into account in improving the students’ result of learning. Authentic assessment is a good way to solve the problems of learning achievement measurement because it can reflect the students’ learning, motivation, and attitude in classroom activities [8]. Education ministry law No 104 year 2013 about assessment standard states that there are four types of authentic assessment which can be used, namely: performance assessment, portfolio assessment, project assessment and self-assessment. Performance assessment is an assessment method covering self-regulation consideration, critical thinking, and self-decision on the students’ performance [9]. Meanwhile, portfolio assessment is a collection of product used to demonstrate what a student has done, and by inference, what a person is capable of doing [10,11]. Self-assessment is an assessment in which the students assess what they have made or their own works [12]. Lastly, project assessment is an assessment on the finishing of certain project based on the established time.

Besides teaching model and assessment, the students’ achievement is also influenced by achievement motivation. It is a motivation in which the individual is in case i.e. learning target [13]. When the students are highly achievement motivated, they will do hard working to achieve their own target. Since this research is aims at discovering the pure effect of problem based learning and authentic assessment, so the students’ achievement motivation should be controlled. By doing it, the goals of this research i.e. discovering the effect of problem based learning and authentic assessment on students’ achievement can be achieved.

2. Methods
This was an experimental research involving 132 eighth grade students in Manggis sub-district with 2 x 2 factorial design. The sample was selected by using cluster random sampling. There are groups intact groups form, namely: a) the group of students taught by using problem based learning and authentic assessment, b) the group of students taught by using problem based learning and conventional assessment, c) the group of students taught by using conventional model and authentic assessment, and d) the group of students taught by using conventional model and conventional assessment. The treatment was given for 12 times in each group. Data of students’ natural science result were collected by test and achievement motivation were collected by using questionnaire. The collected data were analyzed by using two way ANCOVA.

3. Results and discussion
The result of data analysis by using two way ANCOVA covers tested hypothesis dan the result can be presented in the table 1.
Tabel 1. The summary of hypothesis testing.

| Source of Variance          | Probability | Conclusion |
|-----------------------------|-------------|------------|
| Instruction Model (A)       | 0.009       | Significant|
| Assessment Type (B)         | 0.001       | Significant|
| Interaction A*B             | 0.001       | Significant|
| X B A*B 1                   | 0.0001      | Significant|
| X B A*B 2                   | 0.0001      | Significant|
| X A A*B 1                   | 0.0001      | Significant|
| X A A*B 2                   | 0.0001      | Significant|

In general, this research aims at discovering the effect of problem based learning and authentic assessment on students’ natural science learning outcome. The hypothesis testing shows that problem based learning and authentic assessment affects significantly on students’ natural science learning outcome by controlling students’ achievement motivation level. In addition, it is found that there is an interaction between instructional model and assessment type on students’ natural science learning outcome by controlling students’ achievement motivation level. Furthermore, they are explained in detail as follows.

Based on the result of hypothesis testing on the main effect, it was discovered that PBL has positive effect on students’ result of learning. It can be known from the students’ score taught by PBL (123,057) which is higher than conventional model (120,71) with F value of 7.04. It indicates that PBL is appropriate to be implemented in natural science subject. The provided learning syntax directs the students to construct knowledge deeply.

According to Vygostsky in social constructivism, two learning principles in learning, social learning and ZPD (zone of proximal development). PBL has applied those principles through group discussion. Through discussion, the students can share and exchange their knowledge with their friends. By learning together with their age, they can be more comfortable and easy to understand concepts because they are in nearly same development stage. So, the students can follow their friends’ understanding or learn from their friends.

Problem based learning emphasizes on investigation, analysis, and discovery to shape students’ cognitive which facilitates productive thinking [14]. Furthermore, this model leads the students to internalize what they discover by themselves, not what they memorize. It is automatically saved in the students’ long term memory [15]. In the context of natural science subject, the concepts of energy, vibration, wave, etc are not memorized, but they have to be understood. It implies that learning should provide investigation and analysis process to shape students’ understanding. By mastering the concepts, the students can solve the science problems. The concept of problem based learning is problem solving and inductive [16]. Through inductive learning, the students are challenged to search facts relating to certain concepts. Learning is started by a series of practicum. From it, the students are led to discover science concepts and they can save them in their memory for longer time than just memorizing them.

Lastly, it is discovered that the strengths of problem based learning effectiveness lies on the group discussion [17]. During discussion, the students are involved actively in identifying problems. Here, sharing information among students is occurred. It creates a scaffolding among group member in constructing knowledge. When they ask questions to their friends and their friends answers them, they do not realize that they slowly acquire new cognitive skills.

Furthermore, based on the hypothesis testing, by controlling students’ achievement motivation it is discovered that authentic assessment has positive effect on students’ learning outcome. It can be known from the students’ score assessed by authentic assessment (123.615) which is higher than conventional assessment (120.71) with F value of 15,933. It indicates that authentic assessment is appropriate to be implemented in natural science subject. The assessment which concerns on both process and product of learning leads the students to have good understanding on science concepts.

Authentic assessment is students centered, real as life, ongoing, and process-product oriented [18]. When it is applied in science, the teachers can measure the students real performance. It is different from
conventional assessment which cannot measure directly students’ performance because they do not perform it. Furthermore, ongoing process characteristics own by authentic assessment helps the teacher monitor students’ learning development. It means that if the students face difficulty so the teachers can directly lead the students into right ways. In addition, the students tend to be more reflective in learning and having chance to improve their learning.

Authentic assessment measure directly students skills which then affects their skill and attitude. Since they are assigned to demonstrate their ability, the students will learn how to understand and perform well on what they do. Comparing to multiple choice test, the students can ask the answers from their friends or making lottery for their answers. Of course, it will not give holistic and real information about students’ skills. By asking the students to demonstrate, it means leading them to be more responsible on their performance.

Lastly, assessment emphasizing on learning activity or performance like authentic assessment gives important and valuable information which can affect the students’ learning result [19]. The provided information is mostly about the students’ ability development, seriousness and mastery level. By knowing all of them, the teacher can give appropriate suggestions and guidance so the students can improve their skills.

Furthermore, the hypothesis testing on the interactional effect discovers that there is a significant interactional effect instructional model and assessment type on students’ natural science result of learning. It is proven from the ANCOVA coefficient of 618.645. On descriptive statistical analysis shows that the students’ science learning outcome treated by problem based learning and authentic assessment is higher than those treated by problem based learning and conventional assessment. On the contrary, the students’ science learning result treated by conventional model and assessment is higher than those treated by problem based learning and conventional assessment. It indicates that problem based learning is more appropriate combined with authentic assessment and it is less appropriate to be combined with conventional assessment.

Problem based learning should be integrated with learning result expected by the curriculum [20]. It means that besides measuring content/knowledge acquisition, assessment in problem based learning should also measure problem solving, teamwork and communication skills. It needs various assessment methods and strategies including observation sheet, journal reflection, presentation checklist, problem solving checklist, peer assessment and self-assessment. All of them are parts of authentic assessment. The result of this research shows that the highest students’ science learning is gotten by the students treated by problem based learning and authentic assessment. it means that getting maximum learning result in science, science instruction should be directed into the implementation of problem based learning and authentic assessment.

Remembering problem based learning is a continuous instruction and there is a must to knowledge demonstration, so it needs authentic assessment which directly measure the students’ performance. In implementing it, there are several related steps which are faced by the students so they need guidance in solving the given problems. Here, authentic assessment reports directly on how students’ learning process, what possible problems faced which affects further step. In addition, authentic assessment can be a monitor for students’ learning. If the students’ problem solving is not reported, the result will not be maximum. Problem based learning is very students’ centered. If they are not guided well, they may be out of tract. As the consequence, it makes the students to be depression.

It is different from conventional instructional model given conventional assessment. both of them have same character i.e. final result. The students are accustomed to do and feel comfortable on it. They do not think hard to discover something and demonstrating their knowledge. They just need to listen on their teachers’ explanation. At the end of the learning, they are given multiple choice test. if the students are given problem based learning with multiple choice test, the result will not be maximum. It is because the students’ progress and process in learning cannot be known and improved because there is less feedback.

The result of hypothesis testing on simple effect discovers that by controlling achievement motivation, Problem Based Learning combined with authentic assessment affects significantly on
studnets’ natural science result of learning. It can be known from the corrected students’ mean score treated by problem based learning and authentic assessment (136.63) which is higher than those treated by Problem Based Learning combined with conventional assessment (111.597) with t value of 19.277. It means that problem based learning is more appropriate to be combined with authentic assessment than conventional assessment.

Authentic assessment is more appropriate than conventional assessment to be used in problem based learning [21,22]. It is because authentic assessment accommodates students’ performance or learning activities which demands the students to use high critical thinking skill. The students’ performance in each learning step is evaluated to know the level of students’ understanding. If the criteria were not achieved, the students would be given feedback so the same mistakes do not happen again.

Furthermore, it is argued that by using authentic assessment in problem based learning: 1) the students’ critical thinking process can be observed and facilitated, 2) clear criteria on assessment, 3) all problem settings can be accommodate, and) the students becomes more active [23]. They will bring positive effect on students’ result of learning. Furthermore, Tan states that problem based learning effectiveness can be monitored from the evaluation methods. The evaluation should be able to monitor students’ development.

Lastly, the assessment needed in problem based learning is an assessment which can measure process, product, and students’ performance during teaching and learning process [24]. The assessment should be integrated and it gives information on step by step learning until the students can producing certain product. Furthermore, it is appropriate to be implemented in the adolescence age because it can reduce students’ anxiety.

The result of hypothesis testing on simple effect shows that by controlling achievement motivation, problem based learning combined with conventional assessment does not affect significantly on students’ natural science result of learning. It can be known from the corrected students’ mean score treated by problem based learning and conventional assessment (110.07) which is lower than those treated by conventional model combined with conventional assessment (129.824) with t value of -15.711. It strengthens the finding that problem based learning is not appropriate combined with conventional assessment or conventional assessment is appropriate with conventional model of learning.

It is argued argued that conventional assessment (1) tends to measure factual knowledge, (2) measures in one context, (3) focuses on final product, and (4) tests the students’ performance [25]. It means that conventional assessment is less effective in accommodating understanding and skill process. The information acquired is only a final score, but how learning development cannot be measured or acquired. It does not match with the problem based learning which focuses learning process and skill demonstration.

Meanwhile, it is stated that problem based learning leads the students into high critical thinking. The students are not assigned to memorize learning materials, but they are led to think productively through problems investigated [26]. By problem Based Learning, the students follow activities such as: analyzing, applying, and testing hypothesis. If those activities were only assessed at the end, the learning process and knowledge forming cannot be accommodate.

According to Ward and Lee, in problem based learning, conventional assessment is less effective. It is because conventional assessment just measures the students’ memory [21]. The students’ understanding and knowledge construction cannot be accommodated. The use of standardized test in problem based learning only make the students stressful. The inappropriateness of problem based learning and conventional assessment is also stated by Baptiste. It is stated strongly that conventional assessment cannot help the students to their maximum performance in problem based learning. It is because problem based learning is a continuous process so the assessment must be done continuously. For that reason, the use of conventional assessment is not recommended because it make the students to be less responsive and sensitive on the problems.
4. Conclusion
Based on the result of hypothesis testing by two way ANCOVA, it is discovered that by controlling achievement motivation, both problem based learning and authentic assessment have positive effect on students’ result of learning. In addition, there is an interactional effect of instructional model and assessment type on students’ natural science result of learning. Problem based learning is more appropriate to authentic assessment; meanwhile conventional model is more appropriate to conventional assessment. However, the highest score is obtained by the students instructed by using problem based learning and authentic assessment. Natural science subject should be directed on it so the maximum ability of the students can be achieved.

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