The effect of Problem Based Learning (PBL) model on elementary school students’ science higher order thinking skill and learning autonomy

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Abstract. This research aimed to improve the effect of the implementation of PBL model on higher order thinking skill and learning autonomy of the grade five students at SD Gugus VI Abiansemal district, Badung, Bali. The research used a single factor independent groups design. The population of this study was all of the fifth grade students at elementary schools in Gugus VI in the academic year 2017/2018 with the total of 176 students. The sample was obtained by using random sampling technique from 69 students. Based on the statistical test, the higher order thinking skill of science obtained through essay test and data of learning autonomy that were obtained through questionnaire were valid and reliable. Then, the obtained data were analyzed by using MANOVA test at the 5% level of significance. The result of hypothesis testing showed that, first, the higher order thinking skill of the students who learned through the problem based learning model was better than that of the students who learned through the conventional learning model (F = 4.643; ρ<0.05); secondly, the learning autonomy of the students who learned through the problem based learning model was better than that of those who learned through the conventional learning model (F = 13.211; ρ<0.05); thirdly, the higher order thinking skill and learning autonomy of the students who learned through the problem based learning model was better than that of those who learned through the conventional teaching model (F = 7.445; p < 0.05).

1. Introduction

One of the objectives of elementary education is to help children to understand problems that are faced in their environment or in the daily life. At various levels of education, particular subjects are taught that can give the students knowledge that can be used as reference in facing problems in daily life. Science is one of the subjects taught at each level of education, starting from elementary school through college. Science is a structured and systematic series of activities for finding concepts, principles and laws about natural phenomena. This shows that the teaching of science does not only require the teaching of fundamental principles, but it also develops positive attitude toward learning, evaluation, findings, and problem solving based on one’s own ability [1].

Science education at elementary school is a program for developing knowledge, thinking skill and scientific attitude in the students [2]. Science at elementary school becomes very important because at elementary school children start to be introduced to basic concepts of science to prepare them for a higher level. However, the reality shows that the quality of science education in Indonesia has not met...
the expectation, Programme for International Student Assessment (PISA) that studied about literacy in reading, mathematics and science showed that Indonesian children’s literacy ranks 71st with the score of 403 from 79 participating countries. Trends in International Mathematics and Science Study (TIMSS) showed that the ability of the Indonesian fourth and eighth grade students in 2015 ranks 45th from 50 participating countries with the score of 397 points. For science, Indonesian students got 397 points and ranked 45th from 48 participating countries [3]. Indonesian students’ science knowledge and understanding appear to be limited so that very little of it can be used in everyday life. This is also supported by Indra Charismiadiji (in Jawa Post daily newspaper, May 29, 2018) who stated that the cause of the low national examination result at junior higher school (the average for science was 47.43) is the fact that the method of teaching has not been oriented to HOTS (higher order thinking skill). On the other hand, this era and the future era need creative people who have good characters, and higher order reasoning, and teachers have to be trained for that [4].

So far, the model of teaching implemented by teachers in teaching science still uses direct instruction teaching model. Direct instruction can be defined as a teaching pattern in which the teacher transmits information or skill directly to the students and the teaching is oriented towards the objectives and is structured by the teacher [5]. The direct instruction model is very teacher-centered. Teacher-centered teaching causes the students to have less opportunities to express their ideas (their prior knowledge). This is in line with Lufri’s statement that the teaching will be vivid and interesting if it can activate the students’ thinking [6]. Boredom experienced by the students in science teaching process is largely caused by didactic factors, including the teacher-centered teaching method. The implication is that the students’ thinking ability becomes lower and ends up with a low science quality.

This factor is also supported by the results of observation and interview with the fifth grade teachers at SD Gugus VI in Abiansemal district. From the observation of science teaching in the classroom it was found out that 1) the teachers used the ordinary teacher-centered approach without actively involving the students; 2) the students had not been able to see the relationship among science concepts; 3) the students could not explain about the concepts of the material that had been taught; 4) when the teachers gave a problem, the students were confused in finding the problem and the steps to take in answering the solution to the problem; and 5) the students very often asked the teacher to guide them in solving a problem or doing something, and it was very rare that the students had an initiative to learn.

The results of the observation agreed with the results of the interview. The interview was done with the science teacher with the following results: (1) the teachers admitted to face difficulties in using innovative models of teaching, so that in teaching the teacher more often used lecturing, question and answer and the giving of tasks; (2) the students often could not find the problem given by the teachers, the teachers were aware of it. The students had this problem because they were rarely trained to solve problems and rarely asked questions about what they had not understood; (3) the students had not been able to apply concepts learned into their life, because they could not relate materials given to the real life; (4) in teaching the students the teachers still used one-way teaching so that the teachers were more active than the students, this was caused by the fact that in the teaching process the teachers still used the traditional teacher-centered approach; and 5) the teachers were aware that the questions given to the students were still factual questions so that they rarely motivated the students to think more deeply of a problem.

Based on the problems encountered at SD Gugus VI in Abiansemal district, an improvement and innovation need to be done in teaching. These can be done by implementing teaching that demands active participation from the students so that higher order thinking skill and learning autonomy can be improved. An alternative in making an improvement and innovation in the model of teaching that is relevant to the problem is by using Problem Based Learning (PBL) model. This model enables the development of the students’ thinking skill in problem solving, especially in supporting higher order thinking skill. Happy, et al. stated that PBL is a teaching model that is designed to develop the students’ ability to solve problems [7]. Furthermore, Arends stated that PBL is a teaching model that is based on constructivism that accommodates students’ involvement in learning and solving authentic problems.
With this model, the students will be directly involved and acquire their knowledge by themselves through problems that they really face. The problems can train and develop their thinking ability and learning autonomy. This is in line with Wijaya, et al who stated that PBL motivates the students to solve authentic problems with the intention to structure their own knowledge, develop inquiries and higher order thinking skill, self autonomy and self-confidence [9]. Thus, there are six reasons why Problem Based Learning is selected: (1) it provides problems that are close to real life that probably occur in the real life; (2) it motivates the students to be involved in the learning activities; (3) it motivates the use of various approaches; (4) it gives the opportunity to the students to make a choice on how and what to learn; (5) it motivates collaborative learning and (6) it trains and develops the students’ thinking ability to achieve quality education [9].

PBL model has some characteristics that make it different from other teaching models. The outstanding characteristic in this model is the use of problems as learning resources and the teaching is done through group discussion. Rusman stated that the steps in PBL as follows: (1) orienting students towards a problem, (2) organizing students to learn, (3) guiding the students’ experience, (4) developing and presenting students’ works, and (5) analyzing and evaluating [10]. Teaching with PBL model starts with a problem, then the students enrich their knowledge about what they have known what they need to know to solve the problem. The problem that is made the focus of learning can be solved through group work so that it can give learning varied experiences to the students such as cooperation and interaction in a group. The presence of a real problem that is given will make the teaching become student-centered, active and meaningful. This condition shows that PBL model demands preparation, both on the teacher and the students. The teacher plays the role as facilitator and guide, while the students have to be involved actively and autonomously in learning by optimizing their thinking ability. In other words, the use of PBL can enhance the students’ thinking ability and autonomy to learn about what they learn.

Through PBL the students are demanded to be skillful to ask questions and express opinions, finding relevant information, finding some alternative ways to find solutions and determining the most effective way to solve the problem. This conforms to Sugandi [11] and Wulandari [12] who stated that there is a positive and significant effect of the implementation of PBL on the students’ learning autonomy. With learning autonomy, the students become persistent in facing problems and are motivated to select a suitable strategy to solve the problem. Amalia stated that one of the important thinking skills that is acquired by the students is a higher order thinking skill [13]. This is caused by the fact that higher order thinking skill is one of the stages in thinking that cannot be separated from daily life and every student is directed towards the acquisition of the higher order thinking skill because it makes a person be able to think critically and creatively in solving a problem in his or her life. It is so important to be acquired by the students, so that through this study the effect of PBL on science higher order thinking and students’ learning autonomy at elementary school was studied through an experimental study.

2. Method
This study was a quasi experimental study using a single factor independent group design. The population consisted of all students of the fifth grade at SD in Gugus VI, Abiansemal district, Badung regency that implemented a school-based curriculum with the total number of 176 students. The sample was determined using a random sampling technique to the existing classes. The sample size was 69 students obtained by doing an equivalent test of every class. The selected classes as sample were the fifth grade of SDN 1 Mambal as the experiment class and the fifth grade of SDN 3 Mambal as the control class.

This study involved independent and dependent variables. The independent variable in this study was the teaching with PBL model while the dependent variables were science higher order thinking skill and learning autonomy.

This study used science higher order thinking skill test and learning autonomy questionnaire as the instruments. Fifteen items were made to test the science higher order thinking skill. After testing the validity using Pearson’s Product Moment it was obtained that 10 items met the validity criterion. The
Ten items were subjected to a reliability test using Alpha Cronbach and yielded the reliability value of 0.88 (high). The ten items were then used in this study. Thirty-five items were made to test students’ learning autonomy. After testing the validity, 30 items met the validity criterion. The 30 item questionnaire was subjected to a reliability test using Alpha Cronbach and yielded the reliability value of 0.82 (high). The 30 items were then used in measuring the students’ learning autonomy.

The data collected were tabulated and their mean and standard deviation were calculated. The data were analyzed using the Multivariate Analysis of Variance (MANOVA) at 0.05 level of significance aided by SPSS 16.00 for windows.

3. Results and discussion
The results of descriptive data analysis, both for experiment and control group are as shown in table 1.

Table 1. Recap of the students’ science higher order thinking skill and learning autonomy for experiment and control groups.

| Statistics                  | Variable | A1 Y1 | Y2 | Y1 | Y2 |
|-----------------------------|----------|-------|----|----|----|
| Number of Respondents       |          | 33    | 33 | 36 | 36 |
| Mean                        |          | 30.51 | 118.57 | 28.11 | 106.05 |
| Median                      |          | 31    | 122 | 28 | 106.5 |
| Mode                        |          | 28    | 123 | 28 | 100  |
| Standard Deviation          |          | 4.30  | 12.95 | 4.90  | 15.41 |
| Variance                    |          | 18.57 | 167.81 | 24.04  | 237.65 |
| Range                       |          | 17    | 45  | 21 | 60   |
| Minimal Score               |          | 21    | 92  | 16 | 74   |
| Maximal Score               |          | 37    | 136 | 36 | 133  |
| Total                       |          | 1007  | 3913 | 1012 | 3818 |

Notes:
A1Y1 = Score in higher order thinking skill of the students taught with PBL model
A1Y2 = Score in learning autonomy of the students taught with PBL model
A2Y1 = Score in higher order thinking skill of the students taught with conventional teaching model
A2Y2 = Score in learning autonomy of the students taught with conventional teaching model

The mean in science higher order thinking skill of the students who learned with PBL model was 30.51, categorized as a very high category. The mean in learning autonomy of the students who learned with PBL model was 118.57, also categorized as a very high category. The mean in science higher order thinking skill of the students who learned with conventional teaching model was 28.11, categorized as a higher category. The mean in learning autonomy of the students who learned with conventional model was 106.05, categorized as a high category.

Normality testing of data distribution with Kolmogorov-Smirnov technique aided with SPSS 16.00 for windows yielded a significance value higher than 0.05. Thus, all of the data had a normal distribution. Homogeneity testing using Box’M test produced a significance value of 0.672 and Levene’s test yielded a significance value of 0.618 for science higher order thinking skill and 0.437 for learning autonomy variable. Based on the results of analyses it appears that the significance values produced both individually and simultaneously were higher than 0.05. Thus, it can be concluded that the variance-covariance matrix of the variables of the students’ science higher order thinking skill and the students’ learning autonomy is homogeneous.

Correlation test using product moment correlation at 5% level of significance was used to determine the type of statistical analysis to be used to test the hypotheses. The correlation test result of the students’ higher order thinking skill and the students’ learning autonomy showed that they did not correlate. Thus, the hypothesis testing could be continued by using MANOVA technique.
The result of MANOVA analysis aided with SPSS 16.00 for windows showed the following findings. First, the science higher order thinking skill of the students who learned with PBL model was significantly higher than that of those who learned with the conventional teaching model with $F_{obs} = 4.643 \quad (p < 0.05)$. Viewed from the fact that the mean for the science higher order thinking skill of the students who learned with PBL model was 30.51 (a very high qualification) which was higher than that for those who learned with conventional teaching model of 28.11 (high qualification). Secondly, the learning autonomy of the students who learned with PBL model was higher than that of those who learned with conventional teaching model ($F = 13.211; \quad p<0.05$). This can be seen from the mean for learning autonomy with PBL model (118.57, falling into a high qualification) and that of those who learned with conventional teaching model (106.05, also falling into a high qualification).

Theoretically, PBL model is used to stimulate students’ higher order thinking skill, especially reasoning [14]. Furthermore, Barrow and Tamblyn stated that PBL is a teaching model that motivates, challenges, and arouses students’ interest to learn [15]. Treffinger, et al, stated that PBL motivates students to engage themselves in complex and systematic thinking [16]. Ibrahim and Nur stated that PBL gives meaningful experiences by giving students freedom to choose actions and analyze them through discussions so that it can develop knowledge in the students themselves and the students will understand that they have different opinions, make the best decision and sharpen their higher order thinking skill [17]. Furthermore, it is said that PBL has some advantages such as: (1) it trains the students to think logically and critically through the activities of analysis, evaluation and creation; (2) the students solve problems by themselves and become the source of learning, so that their memory of the knowledge that they got is more durable; (3) the problems presented can encourage the students to solve them, so that they will be more enthusiastic in learning; and (4) it enhances the students’ participation in learning. The findings of this study conform to the results of Happy, Djamiah and Widjanti that showed that the use of PBL is more effective than conventional teaching in terms of (1) mathematical thinking ability, and (2) student’s self-esteem. Based on relevant research findings, it has been proven that PBL is more effective than conventional teaching method in developing science higher order thinking skill [7]. This is caused by the fact that PBL enables the students to use various learning sources in the form of self-initiative, autonomy, self-regulation, self-exploration, and freedom to learn to achieve an optimal learning achievement.

The high mean for the learning autonomy of the students who learned with PBL teaching model might have been caused by the following reasons: 1) with this teaching model the students could solve problems that they faced by themselves. This might be the case because the students often faced contextual problems that they solved by themselves; 2) the teaching model could give a number of learning experiences from various situations in life. Through contextual problems presented in PBL model, PBL model gave real problems to the students; and 3) it could develop inquiry and problem solving skills and practices in finding a solution to a problem; and 4) it could help the students to use their rational thinking skills together with their friends [10]. PBL model helps the students in solving problems by themselves, the considerations that are related to the learning activity are thought by the students themselves and they are fully responsible for their learning process. What is learned from the teaching of science with PBL model is retained longer and understood better because the problems used are contextual and in solving the problems by themselves the students can think logically based on the existing learning resources. The learning process will become more meaningful when the students construct their own knowledge and directly experience what they learn. The students participate in group discussion according to the action taken so that the knowledge and experience in science become deeper. With a student-centered learning the students can experience and feel directly what they learn and can develop their own knowledge. This finding conforms to the finding in Wulandari that showed that there is a significant positive effect of the implementation of PBL on autonomy in learning science compared to the conventional model [12]. In addition, the study done by Sugandhi showed that there is a significant difference in learning autonomy between the group of students who were taught with PBL teaching model with Jigsaw cooperative setting and the group of students who were taught with conventional teaching model [11]. Referring to the relevant research findings, it can be said that PBL is more effective...
than conventional teaching model in enhancing students’ learning autonomy. This agrees with what was expressed by Roh that PBL is designed to stimulate the students to demonstrate their skill, enhance their thinking skill, direct them towards autonomy in working and develop their metacognition [18].

The improvement that had occurred in the autonomy of the students who learned with conventional teaching model was caused by 1) the fact that the conventional teaching model implemented did not only focus on lecturing method, but it was interspersed by individual assignment; 2) sometimes the teacher gave opportunities to the students to ask questions and the questions were not directly answered by the teacher, but the teacher gave opportunities to other students to answer them first; 3) the conventional teaching that was implemented demanded the students to always finish tasks on time and the teacher guided the students to focus their attention on the attainment of learning objectives. This is in line with Rasana’s opinion that the conventional teaching process activities do not only consist of lecturing, but it is also done through discussion and doing tasks given by the teacher [19]. These of course can motivate the students to be autonomous in learning.

Students’ science higher order thinking skill and learning autonomy between the students who learned with PBL model and those who learned with conventional teaching, in which all values of Pillae Trace, Wilk Lambda, Hotteling’s Trace, Roy’s Largest Root are significant.

On the basis of the data of the result of analysis, theoretically it can be stated that the use of PBL model is better and more effective in enhancing science higher order thinking skill and students’ autonomy in the learning process PBL teaching model has some advantages: (1) it arouses the students’ interest to learn because the students will discuss with their friends about problems that are close to their life; (2) it trains the students to think logically and critically through the activities of analysis, evaluation and creation; (3) the students solve problems by themselves and become learning resource that extends the retention of the things that they learned; (4) the problems presented can encourage the students to solve them, so that they will be more enthusiastic to learn; (5) it can develop cooperation and respect for other people; (6) it enhances the students’ participation to learn; and (7) it is able to help the students to use their rational thinking skill together.

The teaching with PBL model starts with a problem, then the students learn more deeply the knowledge about what they have known and what they need to know to solve the problem. Arends stated that PBL is a teaching model based on constructivism in which the students themselves develop their knowledge through real problem solving so that it can develop higher order thinking skill and students’ self-confidence [8]. Furthermore, Yew & Goh stated that PBL has been adopted in education to enhance critical thinking skill and problem solving in real situations [20]. The problem made the focus of learning can be solved through group work so that it can give learning experiences to the students such as in cooperation and group interaction. The presence of real problems given will make the teaching become student’s centered and active and meaningful. This condition shows that PBL in teaching demands readiness, both on the part of the teacher and the students. The teacher plays the role as facilitator and supervisor while the students should be involved actively and autonomously in learning by optimizing their thinking skill. In other words, the use of PBL can enhance the students’ thinking skill and learning autonomy about what they learn. Based on this discussion, PBL teaching model is effective in enhancing science higher order thinking skill and students’ learning autonomy.

4. Conclusion
PBL is effective in developing science higher order thinking skill and students’ learning autonomy at elementary school. Students with higher learning autonomy learn better with PBL model, while those with low learning autonomy learn better with direct instruction. It is suggested to elementary school teachers to identify students’ learning autonomy to determine a suitable model to use. The use of PBL is recommended at elementary schools in the effort of developing students’ higher order thinking skill. To other researchers who are interested in studying the use of PBL further, it is suggested that they study other aspects such as learning style, IQ gender and students’ cognitive style as moderator variables in a longer time.
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