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The Effect of Using PjBL in Students' Conceptual Understanding and Science Process Skills

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Abstract: The Effect of Using PjBL in Conceptual Understanding and Science Process Skills Students'. Objectives: This study is a quasi-experimental study that aims to understand whether there are differences in the ability to understand the concept and science process skills among learners using a PjBL model with learners using the 5M learning model on Acid-Base material of high school Class XI. **Methods:** The research sample was taken by cluster random sampling technique and obtained class XI MIA 1 as the Experimental Class and class XI MIA 3 as the Control Class. Data were collected by the test method to measure the conceptual understanding and non-test methods to measure the science process skills. The analysis of hypothesis testing was carried out by using the manova test. **Findings:** The results showed that the Hotelling's Trace value on the manova test had a significance of 0.793. **Conclusion:** there is no difference in the ability to understand concepts and science process skills between students who use PjBL models and students who use 5M learning models.

Keywords: PjBL, Conceptual Understanding, Science Process Skills, Acid-Base

Abstrak: Pengaruh Penggunaan PjBL terhadap Pemahaman Konsep dan Keterampilan Proses Sains Peserta Didik. Tujuan: *Penelitian ini merupakan penelitian kuasi eksperimen yang bertujuan untuk mengetahui ada tidaknya perbedaan kemampuan pemahaman konsep dan keterampilan proses sains antara peserta didik yang menggunakan model PjBL dengan peserta didik yang menggunakan model pembelajaran 5M pada materi asam basa SMA Kelas XI.* ***Metode****: Sampel penelitian diambil dengan teknik cluster random sampling dan diperoleh kelas XI MIA 1 sebagai kelas eksperimen dan kelas XI MIA 3 sebagai kelas kontrol. Data dikumpulkan dengan metode tes untuk mengukur kemampuan pemahaman konsep dan metode nontes untuk mengukur keterampilan proses sains. Analisis uji hipotesis dilakukan dengan uji manova.* ***Temuan****: Hasil penelitian menunjukkan nilai Hotelling's Trace pada uji manova memiliki signifikansi 0,793.* ***Kesimpulan:*** *tidak terdapat perbedaan pada kemampuan pemahaman konsep dan keterampilan proses sains antara peserta didik yang menggunakan model pembelajaran berbasis proyek dengan peserta didik yang menggunakan model pembelajaran 5M.*

Kata Kunci: *PjBL, Pemahaman Konsep, Keterampilan Proses Sains, Asam Basa*

▪ INTRODUCTION

The progress of a nation can be seen from the quality of human resources based on the quality of education. Therefore, the government always embed the existing educational system in Indonesia. Improving the education system is improve the curriculum that will be applied. Curriculum 2013 is the latest curriculum enforced by the government with student-centered characters and put forward all aspects of life skills. The curriculum focuses on active, creative, innovative, and meaningful learning. A curriculum update is a form of effort in improving the history of education in a country for the better (Öztürk, 2011).

Chemistry is one of science that is considered to be difficult for learners due to the abstract of chemistry theory, learners' lack of ability in doing chemical counting operations, the difficulty of learners to access various chemical literature, and there are many chemical terms similar to daily life-day but in fact has a different meaning (Ozmen, 2011). One of the most difficult chemical materials and often makes misconception for learners is Acid-Base (Bayrak, 2013). In studying chemistry, learners need to have a qualified ability to master chemistry, such as the ability to conceptual understanding and science process skills (SPS).

The ability of conceptual understanding is a competence that must be had by learners in understanding the concept and performing algorithmic procedures (BSNP, 2006), while the science process skill or SPS is a procedural skill to experiment to improve scientific thinking ability (Zeidan & Jayosi, 2014). The SPS are consist of the basic-skills and integrated-skills. The first is the basic skills consist of observing, classifying communicating, measuring, predicting, and inference, while integrated skills consist of control the variables, composing the hypotheses, interprete the data, and doing the experiments (Yildirim et al., 2016).

Skills of the student's learning process in learning chemistry can be honed through work in the laboratory, while the ability of learners' conceptual understanding can be honed through the provision of chemistry questions that have been studied by learners as a material mastering. The conceptual understanding is the main thing for learners in problem-solving that given for learners (Agustina, 2016) with indicators learners can comprehend concept (BSNP, 2006) are (1) can reiterate a conceptual, (2) can classify an object according to certain characters based on concept, (3) can give either example or not of a concept, (4) can present concepts in various forms, (5) can develop a concept, (6) may use, utilize, or select certain procedures, (7) may apply the concept or problem-solving algorithm.

It should be realized that the most common problems encountered in the implementation of chemistry learning are not exactly between the use of selected learning models with the material to be delivered. Teachers tend to use the same learning model to convey different material. In addition, teachers also tend to achieve the only cognitive aspects in learning. As a result, the psychomotor aspect of the learner can not be honed properly. In fact, the ability of learners in studying chemistry is not only measured through the student's ability to solve the problem, but also measured by the ability of students to do the work activities in the laboratory appropriately. Learning activities that involve learners in laboratory activities can provide experience for learners and make learning more meaningful. Furthermore, learning activities conducted through the use of laboratories can stimulate an increase of confidence, knowledge, and learners' interest in performing scientific work procedurally (Movahedzadeh et al., 2012).

Reviewing the problems that often occur in learning chemistry, it is necessary to make suitability and accuracy between the selection of learning models with materials that will be taught to learners so that learning takes place not only tend to use the same learning model from time to time and not only take the achievement on the cognitive aspect, but also the achievement of the psychomotor aspect especially the science process skills. One of the learning models that is considered appropriate to sharp conceptual understanding ability and skills of the students' learning process for Acid-Base material is a project-based learning model or PjBL. PjBL model is a learning model that has a term, process-centered, problem-focused, and meaningful learning unit (Sastrika et al., 2013). The PjBL model can perform using the reconstructive approach (John Dewey), the project method (Klipatrick), and using the finding-based learning system (Bruner) (Bilgin et al., 2015).

The characteristic of PjBL is the demand for learners to be able to design their projects to be done within specified time limits. The George Lucas Educational Foundation (Nurohman in Jagantara et al., 2014) mentions the stages in PjBL consisting of asking essential questions to learners, designing project plans, organizing activities schedule, monitoring student activities, assessing success learners, and evaluate the experience of learners. The advantages gained from the application of PjBL can encourage the motivation of learners, especially in solving problems, planning, directing the project to be done (Trippelt & Amaros, 2003), (2) able to increase the frequency of attendance, cultivate a sense of independence, and positive attitudes toward learning activities, (3) able to provide equal or better academic results than other learning models, (4) able to provide opportunities for learners to develop their complex skills, and (5) to expand learners' access to learning (Sutirman, 2013).

Several studies have shown that the effect of PjBL models is powerful enough to create active learning (Chiang & Lee, 2016). Some research results are also able to demonstrate the success of PjBL models in improving the skills of scientific process skills such as research conducted by (Ozer & Ozkan, 2012). The PjBL model has also proven to be quite powerful in improving students' conceptual understanding ability such as research conducted by (Johnson & Delawsky, 2013).

The study of PjBL in chemistry in this study was carried out on Acid-Base material by using lab activities in the laboratory by giving the students the opportunity to design their practical projects, especially in determining the tools and materials to be used and the practicum procedure to be performed. So that learners could plan their own that was arranged according to the character of PjBL. The role of teachers in this study was only as a facilitator and learning activities are entirely on the learner's activeness. The model used as a comparison in this research is the 5M learning model used by teachers in learning. This study was conducted to know whether there were differences in the conceptual understanding ability and SPS among learners using a PjBL model with learners take the 5M lesson on Acid-Base material.

▪ METHOD

This research was a quasi-experimental research with a posttest control group only design. The design of this study can be seen in Table 1.

Table 1. Posttest Control Group Only Design

Class	Treatment	Posttest
Control	X_1	O_1
Experiment	X_2	O_2

Information:
X1: Students in the C-Class who apply the 5M Learning Model
X2: Students in the Ex-Class who apply the PjBL model
O1: Posttest scores obtained by C-Class students
O2: Posttest scores obtained by Ex-Class students

Population and Sample

The population in this research were all students of class XI MIA at SMAN 1 Tegal. The samples were students in class XI MIA 1 as an Experimental Class (Ex-Class) that applied a PjBL model and students in class XI MIA 3 as a Control Class (C-Class) that applied the 5M learning model with each class consisting of 32 students. The sample was selected using a cluster random sampling technique.

Data Collection

Data collection were carried out by test and non-test. The test was conducted to collect data on students' conceptual understanding of Acid-Base material and non-test were conducted to collect data on SPS. The technique of collecting test data is done by giving posttest questions. While the non-test techniques in this study include observation techniques, project assignments, and documentation.

Research Instrument

The test instrument was carried out using posttest questions in the form of descriptions consisting of 10 questions to measure students' conceptual understanding abilities by paying attention to the assessment guidelines for essay questions and arranged by taking into account the distribution of cognitive dimensions C1-C4 (Knowledge, Understanding, Application, and Analysis) as well as the distribution of dimensions knowledge of K1-K4 (Factual, Conceptual, Procedural, and Metacognitive) and has met the standard of different test and level of difficulty of the questions.

The non-test instruments used include Student Worksheet, Observation Sheet and Rubric for Assessment of Students' SPS, and Document data on Semester I Final Semester Test Chemistry. Observation sheets and rubrics for assessing SPS are used to measure the ability of the science process skills of the students in the two sample classes during the three Acid-Base practicums. Student Worksheet is used as a guide for the implementation of learning for students in carrying out practicum. The Student Worksheet in this study was composed of 2 types, namely 1 type of Student Worksheet for the PjBL model and 1 other type of Student Worksheet for the 5M learning model. Testing the validity of the instrument in this study includes content validity (based on the material taught), construct (based on research indicators), and empirical (testing in the field). The reliability of the concept understanding instrument was tested using the Cronbach Alpha test.

Data Analysis

Data analysis was carried out using the MANOVA test which was analyzed using the SPSS version 16.0 program. Manova analysis was conducted to test two dependent variables at once (concept understanding and SPS). The prerequisite tests that must be met before conducting the MANOVA test include the homogeneity test, normality test, and correlation test which were analyzed using data on concept understanding scores and data on the average score of SPS for three practical sessions. The homogeneity test for the Manova prerequisite test was carried out using the Box's M test and the normality test was carried out using the Mahalanobis distance test. In addition to the prerequisite test, the analysis in this study was carried out using a different subject t-test to determine whether there was a difference in the students' initial chemical abilities before the research was carried out using final semester scores.

▪ RESULT AND DISCUSSION

Descriptive analysis in this study was conducted on the conceptual understanding data (posttest) and the students' SPS data. A description of the posttest score data and students' initial knowledge of chemistry can be seen in Table 2 below.

Table 2. Description of the Initial Knowledge Scores of Chemistry and Posttest Scores

Data	Description	C-Class	Ex-Class
Initial Knowledge Scores	Total Students	32	32
	Average	52.03	51.16
	Max Score	80.45	72.90
	Min Score	26.89	30.25
Post-test Scores	Total Students	32	32
	Average	77.64	75.60
	Max Score	100	100
	Min Score	50.50	50.00

Based on Table 2, the average score of students in the C-Class is always superior to the Ex-Class. The highest score was obtained in the C-Class for initial knowledge of chemistry and the posttest score was also higher than the Ex-Class. It means that students in the C-Class have a slightly higher initial knowledge than the Ex-Class. Furthermore, a description of the summary of the results of the acquisition of SPS scores of students in the C-Class and Ex-Class obtained during three practicums can be seen in Table 3.

Table 3. Description of Students' SPS Scores

Description		C-Class	Ex-Class
SPS I	Average	47.75	47.06
SPS II	Average	50.87	49.47
SPS III	Average	49.38	49.00
Average		49.33	48.51

The average acquisition of students' SPS scores in the two sample classes shows that the average acquisition of SPS scores of students in a C-Class is greater than that of an Ex-Class, which is 49.33 > 48.51. The acquisition of SPS scores from each practicum session, from the first to the third practicum also shows that the scores obtained by students in a C-Class are always higher than the scores obtained by students in an Ex-Class. The results regarding the description of the average acquisition of SPS scores in each aspect can be seen in Table 4.

Table 4. Description of the average SPS of Students in Each Aspect

Science Process Skills Aspect	C-Class	Ex-Class
Observing	3.67	3.78
Classifying	3.80	3.80
Planing the Experiment	3.87	3.83
Using Tools and Materials	3.27	3.22
Measuring	3.43	3.20
Concluding	3.77	3.86
Applying the Concept	3.70	3.66
Communicating	3.80	3.82
Average	3.66	3.64

Based on Table 4, the average acquisition of students' SPS scores in a C-Class XI MIA 3 is higher than the Ex-Class XI MIA 1, which is 3.66 > 3.64. Students in the Ex-Class have a superior score in the aspects of observing, concluding, and communicating. Obtaining the same score occurs in the aspect of classifying. Overall, the SPS of students in the C-Class XI MIA 3 dominate more than the Ex-Class XI MIA 1, as indicated by the higher scores for aspects of using tools and materials, measuring, planning experiments, and applying concepts. The results of the comparison of the ability to understand concepts and science process skills in the two sample classes can be briefly seen in Figure 1.

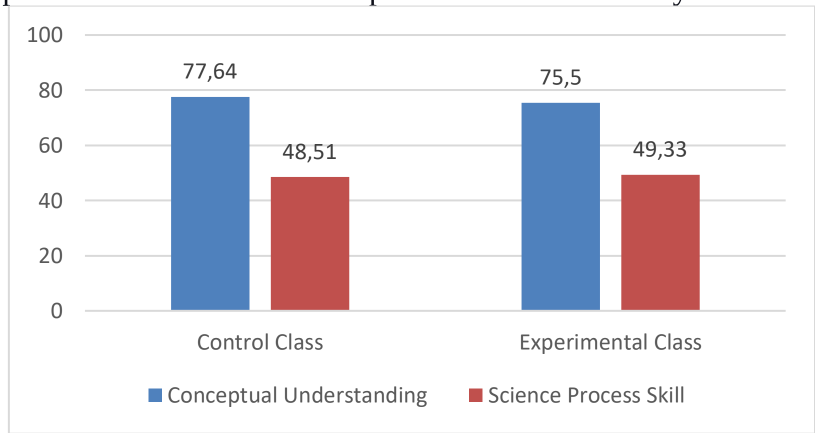

Figure 1. Score Diagram of Conceptual Understanding and SPS

Based on Figure 1, the posttest scores and SPS obtained by students in the Ex-Class are lower than the C-Class. Furthermore, a t-test analysis of different subjects was carried out using data on the value of prior knowledge of chemistry, namely the Chemistry Final Semester Test score. It is to test whether there is a difference in the initial abilities of the students in the two sample classes before being treated. This test was conducted to determine the direction of the hypothesis testing technique to be taken in the study. The results of the t-test analysis of different subjects, the significance is more than 0.05, i.e. 0.810 > 0.05. These results indicate that there is no difference in initial chemistry abilities between students in the Ex-Class XI MIA 1 and students in the C-Class XI MIA 3. The initial chemical abilities possessed by students in the two sample classes can be considered the same. Furthermore, data analysis to test the research hypothesis begins with analyzing the Manova prerequisite test. The Manova prerequisite test carried out included normality, homogeneity, and correlation tests. The results of the Manova prerequisite test can be briefly seen in Table 5.

Table 5. The results of the Manova prerequisite test

The Correlation of Conceptual Understanding and Science Process Skills		**Mahalanobis Distance Normality**			**Homogenity**	
Sig.	Correlation	Class	Sig.	Normality	Sig.	Homo genity
0,000	There is a Correlation	Ex-Class C-Class	0,000 0,000	Normal Normal	5,389	Homogen

Based on Table 5, the significance of the correlation test is less than 0.05, which is 0.000 <0.05. These results indicate that there is a correlation between the ability of conceptual understanding and SPS. The significance of the normality test using the Mahalanobis distance in both sample classes is also less than 0.05, i.e 0.000 < 0.05. These results indicate that the data to be analyzed is normally distributed. The results of the homogeneity test of the Manova test using the M Box's Test show a significance of more than 0.05, namely 5.389 > 0.05. It is indicate that the data to be analyzed is homogeneous. Further results regarding the summary of the Manova hypothesis test can be seen in Table 6.

Table 6. Manova Test Results on the Ability of Conceptual Understanding and Science Process Skills of Students

Model	**F**	**df**	**Sig.**	**Result**
Hotelling's Trace	0.233	61	0.793	No difference

Based on the T^2 Hotteling manova test, the significance is more than 0.05, i.e. 0.793 > 0.05. These results indicate that there is no difference in the ability of conceptual understanding and SPS between students who take lessons using a PjBL model and students who take lessons using the 5M learning model on Acid-Base materials.

The absence of differences in the ability of conceptual understanding and SPS of students in the two sample classes in this study could be caused by several factors. The most important factor is that students are not accustomed to participating in PjBL which demands the activeness and creativity of students in designing the practicum projects that they will do. Students need time to be able to adapt to follow the learning model that is considered new for students. In addition, the implementation of PjBL also requires a lot of time because it consists of several stages so that the implementation of learning becomes fast-paced. As a result, many students find it increasingly difficult to participate in PjBL. Sani (2014) stated that some of the obstacles in implementing PjBL include not being suitable for students who have an easy-to-give character and lack the necessary skills, and the difficulty of involving all students in participating in group work.

The activities shown by the students in the two sample classes during the practicum are also different. The students in the C-Class seem to be able to follow the practicum activities well. This could be due to the fact that the tools, materials, and practicum procedures are clearly written in the student worksheet. Unlike the students in the Ex-Class who still asked a lot of questions about the tools and materials that must be prepared and the practical procedures that must be carried out. Most of the students in the Ex-Class seemed confused in doing the practicum because they were not used to designing practicum projects independently. Some students in the Ex-Class also showed an attitude of frequently asking the teacher because they had too much difficulty with the practicum project that had to be done and were very dependent on other students who were considered smarter.

Another factor that can cause no difference in conceptual understanding between students in the C-Class and students in the Ex-Class is the average value of student's initial knowledge of chemistry in the C-Class is higher than the average value of students in the Ex-Class, which is 52.03 > 51.16. Thus, although in terms of t-test analysis, different subjects have the same initial ability, on a numerical average it shows that the initial understanding of chemistry in the C-Class is higher than the Ex-Class.

Another factor that can cause there is no difference in the ability and skills of the scientific process in this study is inseparable from the motivation of the students and the estimations that arise from the students themselves during the learning process. The results of open interviews with students in the Ex-Class showed that some of them realized that they had not been able to follow the instructional well using the new learning model and needed even greater enthusiasm. Though the influence of motivation in learning can have a positive impact. The influence of motivation in learning according to Djamarah (2011) is being able to encourage someone to always want to move forward in learning, have the awareness to carry out learning activities, become fond of learning, and make learning a necessity.

Estimation in learning also greatly affects the psychology of learners in learning. Some negative estimates that arise during students participating in PjBL, for example, students feel that project learning is not too important, students feel it will not be possible to follow independent learning by completing projects designed by themselves, and students feel they do not have sufficient ability to complete a given project (Erdem, 2012). These estimates certainly affect the psychology of students in participating in learning which can cause the results obtained by students to be less than optimal, especially the results of understanding concepts. Furthermore, these estimates can affect students' interest in learning. It should be noted that interest is the main factors that can affect the active behavior of students in learning (Subramaniam in Rosales JR & Sulaiman, 2016). The interest of students in the Ex-Class in this study is not seen maximally. Some students show boredom in participating in PjBL that was carried out.

Overall, the results of this research on PjBL do not have a significant effect on students' understanding of concepts and SPS. This result is similar to the research conducted by Ismail (2018) which shows that the PjBL model does not provide effective results in the learning achievement of students. However, these results do not mean that the PjBL model cannot be used in chemistry learning because the success of this PjBL model can also provide effective results such as research conducted by Sumarni, W; Wijayati & Supanti (2019) which showed that PjBL can improve the cognitive abilities of students by using the STEM approach.

▪ CONCLUSION

The results shows there is no difference in the ability to conceptual understanding and science process skills between students who take lessons using a PjBL model and students who take lessons using the 5M model on Acid-Base materials for Class XI SMA. Referring to these results, it is highly recommended that similar research be carried out using PjBL models for other chemical content besides Acid-Base and by varying learning approaches, to enrich the results of research on the effectiveness of PjBL in chemistry lessons by perfecting the instrument. which will be used.

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