The Implementation of Project-Based Learning Model towards the Ability to Understanding Mathematical Concepts

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Abstract

The ability to understand mathematical concepts is an important part of learning objectives. The provided material is not only to be memorized, but also students need to understand the entire concepts of the material being studied. This research aims to determine the effect of implementing the PjBL model on the ability to understand mathematical concepts and how much students' interest in learning as a response to the application of the PjBL learning model in class VII by using algebra material at SMP Negeri 36 OKU in the academic year 2022/2023. The research used a quantitative research method with a One Group Pretest-Posttest design. The research population was all members of class VII students. The sample used was only 1 class with a saturated sampling technique where all members of the population were used as samples. The techniques in collecting the data were tests, questionnaires, and observations. The data test analysis technique used the Z-Test, the questionnaire was measured using a Likert scale, and observations were measured using the Guttman scale. From the research results, the z table value = -1.95996398454005 and the calculated z = -5.8488123797208 with a sig of 0.00 < 0.05 where the calculated z < -z table concludes that learning with the PjBL model has an effect on the ability to understand mathematical concepts and The response to students' interest in learning shows that the majority are in a good category. However, it is necessary to adapt to this learning process because this learning model is being used for the first time and several meetings are needed to complete the project.

Keywords: Algebraic; Ability to Understand Concepts; Project-Based Learning (PjBL) Model

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Abstrak

Kemampuan pemahaman konsep matematis salah satu bagian penting dalam tujuan pembelajaran. Materi yang diberikan bukan semata-mata untuk dihapalkan, tetapi peserta didik harus mengerti agar dapat memahami konsep materi yang dipelajari. Permasalahan yang dihadapi oleh peserta didik karena mengalami kesulitan dalam membedakan unsur-unsur bentuk aljabar, kesulitan mensubstitusikan persamaan, dan kesulitan dalam operasi hitung bentuk aljabar. Penelitian ini bertujuan untuk mengetahui pengaruh penerapan model pembelajaran PjBL terhadap kemampuan pemahaman konsep matematis dan berapa besar respon minat belajar peserta didik terhadap penerapan model pembelajaran PjBL pada materi bentuk aljabar kelas VII SMP Negeri 36 OKU Tahun 2022/2023. Metode penelitian yang digunakan adalah metode kuantitatif dengan desain *One Group Pretest-Posttest*. Populasi penelitian adalah peserta didik kelas VII. Sampel yang digunakan hanya 1 kelas dengan tehnik *sampling jenuh* yang mana semua anggota populasi digunakan sebagai sampel. Tehnik pengumpulan data yang digunakan adalah tes, angket, dan observasi. Tehnik analisis data tes menggunakan *Uji-Z*, angket diukur dengan skala *Likert,* dan observasi diukur dengan skala *Guttman*. Dari hasil penelitian nilai –z tabel = -1,95996398454005 dan z hitung = -5,8488123797208 dengan sig 0,00 < 0,05 yang mana z hitung < -z tabel disimpulkan bahwa pembelajaran dengan model PjBL berpengaruh terhadap kemampuan pemahaman konsep matematis dan respon minat belajar peserta didik menunjukkan bahwa sebagian besar pada kategori baik. Walaupun, perlu adaptasi dengan proses pembelajaran ini karena model pembelajaran ini baru pertama kali digunakan dan dibutuhkan beberapa pertemuan untuk menyelesaikan proyek.

Kata Kunci: Bentuk Aljabar; Kemampuan Pemahaman Konsep Matematis; Model *Project-Based Learning* (PjBL)

Introduction

Understanding concepts plays an important role in achieving learning goals of teaching learning process, this enables students to solve a question easily if they understand its concepts first. Based on the Minister of National Education's regulations (2006), one of the objectives of mathematics subjects is for students to have the ability to understand mathematical concepts. Based on research results, Kesumawati (2008) stated that understanding mathematical concepts is a very important part of the mathematics learning process and an important basis for solving mathematical and everyday life problems. Then, Warmi (2019) also stated that most students deal with some difficulties in understanding concepts. It is better that the learning process focus more on conceptual understanding because understanding concepts is important and fundamental for further learning. This shows that the ability to understand mathematical concepts is an important part of the learning objectives. The material provided is not just to be memorized, but

students must understand it in order to get a better understanding of the concepts of the subject matter itself.

Even though understanding concepts is very important, in reality, many research results identified the problem of students' low ability to understand concepts. Kartika (2018) stated that students' abilities are still relatively low, especially in algebraic material. Then, Mulyani, et al (2018) stated that students' mathematical understanding abilities in solving algebraic questions were still low. This can be seen from the results of the first test of students' mathematical understanding ability in simple calculations without using formulas and carrying out algorithmic calculations then connecting one concept to another. In accordance to research by Hayati & Marlina (2021) stated that based on test results, students' ability to understand mathematical concepts is relatively low. Students still often make mistakes in determining the elements of algebraic forms. One of the mathematics teachers at SMP N 36 OKU said that students had some difficulties in distinguishing elements in algebraic form, substituting equations, and calculating algebraic operations. Especially in algebraic operations, students are often able to solve it, but some errors might occur. One of the students admitted that it was difficult to complete algebraic operations, especially multiplication operations.

Regarding this phenomenon, it is very necessary to have a learning model that actively involves students in learning. One innovative learning model that enables students actively involved in teaching learning process is the *Project-Based Learning* (PjBL) learning model (Linda, 2015). Minister of Education and Culture Regulation Number 22 of 2016 stated that one of the recommended learning is *Project-Based Learning* (Sisdiana, 2019). The application of this learning model is intended in order to make students able to express their thoughts, exchange ideas, and collaborate with each other. Sitanggang & Pinem (2019) stated that the application of Project-Based Learning (PjBL) can improve students' ability to understand mathematical concepts in algebraic material. This increase occurred because students not only listened, took notes, and memorized the material being explained by the teacher. However, teachers only provide sufficient assistance with the aim that students can complete the project. Students are actively involved and experience firsthand the completion of the project. So that it can provide students with experience in learning and make the process more enjoyable. This can help students to improve memory and more easily understand algebraic material so that students' ability to understand mathematical concepts can increase. This statement is in line with Stives' opinion which states that Project-Based Learning (PjBL) is learning that can create a constructivist learning environment that can condition students to build their own knowledge (Halimah & Marwati, 2022). Project-Based

Learning (PjBL) starts with basic questions, the topics raised are relevant to students and the teacher only acts as a facilitator. Therefore, Project-Based Learning (PjBL) has an influence on understanding concepts, because understanding is the result of the learning process (Susanto, 2013).

Several studies have concluded that Project-Based Learning (PjBL) has an influence on students' understanding of mathematical concepts. The results of previous research, Wahyuni (2019) said that Project-Based Learning had an effect on the ability to understand concepts of students in the FKIP UMSU mathematics education study program. Furthermore, Sari's (2022) research results state that the STEM integrated Project-Based Learning model is effective compared to conventional learning models in improving students' ability to understand concepts and mathematical dispositions in solving problems. Rozali, et al (2015) also stated that the ability to understand mathematical concepts of students who were given the PjBL learning model in class XI IPA 1 MAN 3 Padang experienced good development. Hence, it can be concluded that Project-Based Learning (PjBL) has an influence on students' ability to understand mathematical concepts. Based on the description above, researchers conducted this research to determine the effect of implementing Project-Based Learning (PjBL) on students' ability to understand mathematical concepts and to find out how much students' interest in learning responds to the implementation of Project-Based Learning (PjBL).

Method

In this study, the research method used was quantitative with a pre-experimental design method in the form of a one-group pretest-posttest design. This design can be used if in the research there is a group that is given treatment, then to compare the situation before and after being given treatment (Lestari & Yudhanegara, 2018). The experimental group was given Project-Based Learning (PjBL). The main data in this research were the results of the pretest and posttest of algebra form material, learning interest questionnaires, and observation sheets.

This research was carried out on March 27 – April 4 2023 in class VII at SMP Negeri 36 OKU. The sample determination is saturated sampling, namely a sampling technique where all members of the population are used as samples (Lestari & Yudhanegara, 2018). The class used was only 1 class because in the school there was only 1 class VII which was used as an experimental class with the learning model applied being the Project-Based Learning (PjBL) model. Data collection techniques in this research were tests, observation sheets, and questionnaires. The test used in this research measures the ability to understand mathematical concepts of the

material that has been studied. The researcher used an essay question test instrument where the pretest and posttest were at the same cognitive level but with different numbers and contexts used. After the validity test, the researcher then carried out reliability, distinguishing power, and difficulty index tests. Then, researchers also used a questionnaire to see students' responses to Project-Based Learning (PjBL) which was implemented during the learning process. The questionnaire used is a checklist-type questionnaire in the form of a Likert scale with 5 scales using the options of strongly agree, agree, neutral, disagree, and strongly disagree. Furthermore, the observation sheet is in the form of a checklist that aims to observe students' attitudes during the learning process, measuring the implementation of learning that takes place by implementing Project-Based Learning (PjBL). In addition, there is project assessment observation data which consists of aspects of project planning, implementation, and reporting.

After the data had been obtained, then the data were analyzed. The carried out data test analysis was that the test scores were converted into the concept understanding ability category and a gain normality test was carried out to see the difference between pretest and posttest scores and show an increase in students' concept mastery abilities after the learning was carried out by educators. Gain normality is divided into 3 criteria, namely high, medium, and low. To test the hypothesis, so that the conclusions obtained meet the correct criteria, a prerequisite test analysis was carried out, namely the normality test for this research using the help of the Statistical Program for Social Science (SPSS), namely the Shafiro-Wilk test and homogeneity test with the f-test. Next, the test requirements were analyzed using the normality test and the homogeneity test was met, and then the hypothesis test used in this research was carried out, namely the z test. The data used is pretest and posttest data to see whether there is an influence or not based on the resulting z-table and z-calculation values. There are several indicators of interest in learning, namely feelings of enjoyment, attention, interest, and involvement of students. Then, the percentage of the response data obtained was calculated and converted into 5 categories, namely very good, good, enough, fair, and fail. There are 3 observation data, namely observation data for attitude assessments seen during the learning process.

Results

Data on the results of students' understanding of concepts is obtained from students' grades. The average pretest and posttest scores of class VII students at SMP Negeri 36 OKU are presented in the table below:

Table 1. The Understanding of Mathematical Concepts

Pretest	Posttest	Gain	N-Gain	N-Gain Category
41,84	68,18	26,34	0,40	Medium

Table 1 shows that there is a difference between the pretest and posttest scores. The average posttest score is higher than the average pretest score, which means there is an influence on students' understanding of mathematical concepts. A graph of the categories of values for the ability to understand mathematical concepts can be seen in the image below.
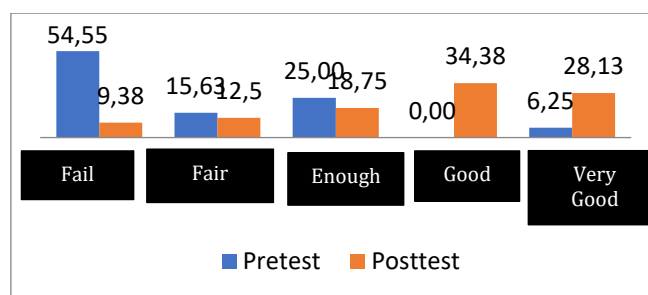

Figure 1. Categories of Students' Mathematical Concept Understanding Ability

From the picture above, there are differences in pretest and posttest scores. During the pretest, most students failed and did not understand mathematical concepts. However, during the posttest, most of the students' understanding of mathematical concepts was good. After the analyzed data results are normal and homogeneous, we proceed to test the research hypothesis. There are 2 hypotheses for this research, namely, H_0 is that there is no influence between the average on students' ability to understand mathematical concepts before and after implementing Project-Based Learning (PjBL). Meanwhile, H1 is that there is an influence between the average on students' ability to understand mathematical concepts before and after Project-Based Learning (PjBL). From the results of the z-test values, it can be concluded that H0 was rejected and H1 was accepted, so there is an influence between the averages on students' ability to understand mathematical concepts after implementing Project-Based Learning (PjBL) which was implemented at SMP Negeri 36 OKU.
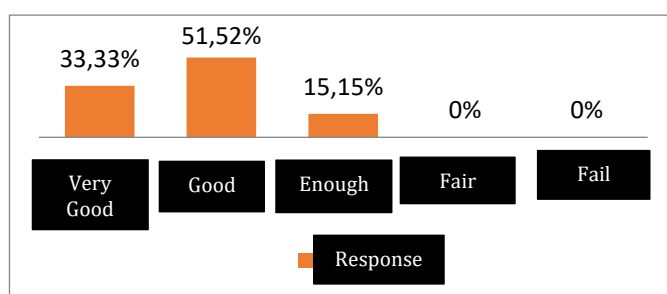
Figure 2. Results of Analysis of Student Learning Interest Responses

Based on the results of the analysis above, it can be concluded that the response of students' interest in learning in participating in Project-Based Learning (PjBL) is partly or 51.52% in the good category. This learning interest response questionnaire consists of indicators of students' feelings of enjoyment, attention, interest, and involvement of students.

Attitude values are obtained from assessments at each meeting. Where students created two projects. The first project was creating a poster with the theme of implementing algebraic forms in everyday life which contains a summary of the material and the application of algebraic forms in everyday life. The second project was making a poster determining the area and perimeter of tiles/ceramics on the terrace of the house which is presented on cardboard. The student attitude scores can be seen in the table below:

Table 2. Student Attitude Values

Number of Students	Category
11	Very Good
11	Good
4	Enough
6	Fair
1	Fail

Based on Table 2, which shows the attitude scores obtained by students, it shows that the implementation of Project-Based Learning (PjBL) has a good impact on students' attitudes. This can be seen from the scores of most students being > 70, which can be seen from many students who are in the very good – fair category. Most of the students' attitude scores are in the good category, which means that students' attitudes are carried out in accordance with the indicators assessed at each meeting with Project-Based Learning (PjBL).

The project value was obtained from project one assessment by creating a poster on the theme of implementing algebraic forms in everyday life which

contains a summary of the material and the application of algebraic forms in everyday life. The second project is making a poster determining the area and perimeter of tiles/ceramics on the terrace of the house which is presented on cardboard. The scores on the two Project-Based Learning (PjBL) projects show an increase and decrease in each group. If all the values of projects one and two are added up, the results in the table below are obtained:

Table 3. Total Value of Group Projects

Group	Mark	Category
1	91.18	Very good
2	94.12	Very good
3	85.29	Very good
4	84.31	Very good
5	90.20	Very good
6	92.16	Very good
7	91.18	Very good

Based on Table 3, shows the total project value obtained by each group, indicating that the implementation of Project-Based Learning (PjBL) has a good impact on students. This can be seen from the project value which is in the very good category. The success of researchers in implementing Project-Based Learning (PjBL) from the results of observations of learning implementation showed that the overall score during the four meetings was in the very good category. So, this shows that every learning process in accordance with the Project-Based Learning (PjBL) syntax has been carried out very good.

Discussion

Project-Based Learning (PjBL) on Students' Ability to Understand Mathematical Concepts

Table 4. Z-Test Results Data on the Ability to Understand Mathematical Concepts

z-Test: Two Sample for Means	*Pretest*	*Posttest*
Hypothesized Mean Difference	0	
Z	-5,84881238	Z- count
P(Z<=z) one-tail	2,47548E-09	
z Critical one-tail	1,644853627	
P(Z<=z) two-tail	4,95095E-09	
z Critical two-tail	1,959963985	Z- table

Based on the results of data analysis in the table 4, it was found that the value, namely calculated z < -z table (-5.8488123797208 <-1.95996398454005), then H0 was rejected and H1 was accepted. So, it can be concluded that there is an average influence on students' ability to understand mathematical concepts after implementing Project-Based learning (PjBL) which was implemented at SMP Negeri 36 OKU.

Project-Based Learning (PjBL) provides students with space to construct their knowledge by introducing students to problems that may occur in real life. This is because Project-Based Learning (PjBL) which is carried out in groups is able to make students express their ideas in solving existing problems. These ideas are expressed in the Project-Based Learning (PjBL) process, such as finding problems, project design, determining schedules, and the methods used to solve problems. Next, present the results of solving the problem in the form of a project. The project was made in the form of a summary and application of algebraic forms in everyday life which was made in the form of a poster using cardboard. This can make students motivated and enthusiastic to solve these problems.

Students' activities after implementing Project-Based Learning (PjBL) have an influence on students' ability to understand mathematical concepts compared to before implementing Project-Based Learning (PjBL). This could be seen from the Project-Based Learning (PjBL) steps.

The first step is basic questions, where at the beginning of learning the teacher asks questions related to the project that can build students' curiosity. The questions given are real in the student's environment. So, students are motivated to solve these problems and carry out project work. Then, students will understand and restate the concepts they have acquired and apply them to the project tasks they carry out. Isrok'atun (2019) stated that Project-Based Learning (PjBL) is a learning design that instills knowledge and skills through project tasks related to students' lives so that they are easy to understand.

Next, the second and third steps are to design a project completion plan and the schedule needed to complete the project. After students understand the problem given, they solve the problem in the form of a project. In accordance with the planning and schedule, they have previously agreed. The project created is a medium that can make it easier for them to understand the material. Project assignments in the form of posters are production projects that involve creation (Rejeki et al., 2022).

Then, the fourth step monitors students and project progress. In this step, the focus is on students' understanding of mathematical concepts in the

development of projects that students have worked on. In the project creation process, students are given the freedom to work at school or other places which can make it easier for students to complete the project. Then, the teacher guides students to deepen their understanding and develop projects so that they can be applied to problems that occur in everyday life. This is in accordance with the indicators of understanding the concept of Regulation of the Director General of Basic Education Number 506/C/Kep/PP/2004 (in Hendriana, et al, 2021).

In the fifth step, students present the results of their projects in front of the class. The process that occurs is reflection on planning and solving problems. When the presenting group has finished giving a presentation, the other groups will provide questions or input to the presenting group. After being answered by the presenting group, students are expected to understand the problem-solving project given. The teacher's task at this step is as a facilitator and guide so that the questions and responses given can be understood. Through this step, students are trained to respect each other's opinions. Then, students will discover for themselves the concepts of the material they study. In line with Short, Harold, Lundsgaard, Morten F V., Krajcik (in Purnomo, 2019) state that Project-Based Learning is like scientific learning which has several basic characteristics, where the learning process goes through several stages, starting with the stages of asking, appreciating, analyzing, associate and conclude.

The final step is to evaluate the experience, students reflect on the activities and results of the projects that have been completed. What is reflected is the difficulties experienced by students in working on projects and finding solutions as well as the feelings felt by students after solving the given problems. The steps of Project-Based Learning (PjBL) show that students are guided to discover and understand concepts so they can solve the problems given. Thus, the application of concept understanding indicators in the Project-Based Learning (PjBL) process has an influence on students' ability to understand mathematical concepts. The research carried out was also seen from the results of observations on the implementation of learning that occurred during four meetings, showing that each learning process was in accordance with the Project-Based Learning (PjBL) syntax which had been implemented in the very good category.

In the learning process, students also found obstacles, namely 1) students needed to adapt to this learning process because this learning model was used for the first time in this class. To overcome this problem, teachers always explain to students the steps that students must take; 2) the time it takes several meetings to complete the project. This is based on the agreement of students and teachers. To overcome this, teachers always review the progress of students' projects at each

meeting. This can support increasing students' ability to understand mathematical concepts, even though there are several obstacles that researchers encounter in the field. Researchers realize that this research is not perfect. However, various efforts have been made to obtain maximum results.

Response of Students' Learning Interests to the Implementation of the Project-Based Learning (Pjbl) Learning Model

Based on the results of questionnaire data analysis, the response to interest in learning by implementing Project-Based Learning (PjBL) was 33.33% of students in the very good category, 51.52% of students in the good category, and 15.15% in the fair category. The student interest in learning questionnaire consists of 23 statements regarding Project-Based Learning (PjBL) given to students. The following is a graph of students' learning interest per indicator.
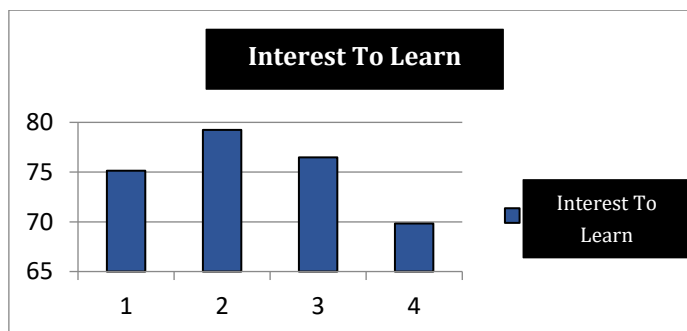

Figure 3. Student Learning Interest Per Indicator

Information:
1 = Feelings of enjoyment
2 = Attention
3 = Interest
4 = Involvement of students

Based on the picture above, it can be seen that students have responded good to mathematics learning that applies Project-Based Learning (PjBL) because during the learning process, students experience directly completing the project. Starting from designing, and creating projects, to presenting project results with the group, so that the learning process does not make students bored. This is in accordance with Stivers' statement which states that Project-Based Learning (PjBL) creates a constructivist theory learning environment where students build their own knowledge (Halimah & Marwati, 2022).

Susanto (2013) also stated that students' interest in certain subjects cannot be separated from the influence of the learning system organized by teachers at school. The indicator of interest in learning according to (Lestari & Yudhanegara, 2018) is students' feelings of enjoyment in the learning process which is different from before, interest in learning appears when students make project plans and scheduling, show attention when learning, and involvement in learning arises from the steps beginning to end, which is in accordance with the opinion of Priansa (2017) who states that Project-Based Learning (PjBL) is an effort to change teacher-centered learning into student-centered learning. In this research, what will be observed is how much interest students have in learning towards Project-Based Learning (PjBL). In line with research by Nugraheni (2018) which stated that almost every statement in the student interest response questionnaire stated that they agreed with the project-based learning provided.

Conclusion

Based on the results and discussion, it can be concluded that the results of research carried out on algebraic material showed that there was an influence on students' ability to understand mathematical concepts after implementing Project-Based Learning (PjBL) which was implemented at SMP Negeri 36 OKU. The implementation of Project-Based Learning (PjBL) showed that the majority of students' attitude scores are in the very good category. According to the indicators assessed at each meeting with Project-Based Learning (PjBL), the total project value obtained by each group shows that the implementation of Project-Based Learning (PjBL) had a good impact on students. This could be seen from the project value which is in the very good category and the overall value of the results of the learning implementation which took place over four meetings is in the very good category. So, this shows that every learning process in accordance with the Project-Based Learning (PjBL) syntax has been carried out very good and the results of students' learning interest responses are included in the good category at 51.52%. This shows that the response to interest in learning with Project-Based Learning (PjBL) is mostly in the good category. Based on the research results and conclusions, there are several suggestions for future researchers, it is hoped that they will provide knowledge to students about what learning models are used, introduce existing learning models, and pay more attention to the time used so that it is not too long, and when making observations it is better to More than 1 observer is used.

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