



The Effectiveness of the STEM-Based Project Based Learning (PjBL) Learning Model on the Critical Thinking Skills of SPLDV Material of Al-Azhar Paron Middle School Students

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Abstract: This study aims to find out whether the STEM-based PjBL learning model is effective on the critical thinking ability of SPLDV material of Al-Azhar Paron Junior High School students. The research used is a quantitative research with a Quasi Experimental design. The population in this study is grade VIII students of Al-Azhar Paron Junior High School. The research sample is the entire population with the number of class VIII A 25 students and class VIII B 21 students. The prerequisite test carried out was a normality test using the Lilliefors formula and a variant homogeneity test was carried out to see the similarity of variants in both groups. Hypothesis testing is carried out using the unpaired T test. The results of the study showed that the average calculation of the post test results of the experimental class that applied the STEM-based PjBL learning model was higher than that of the control class that applied the conventional learning model. If you look at the results of the unpaired t-test, it shows that the t-count (3.601) is greater than the t-table (2.015) at a significance level of 5%, meaning that the null hypothesis is rejected so that it gives us confidence that the research hypothesis is accepted. These results can then be interpreted that the application of the STEM-based PjBL learning model is effective on the critical thinking skills of SPLDV material of Al-Azhar Paron Junior High School students.

Keywords: Effectiveness; Learning Model; PjBL; STEM; Critical Thinking.

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1. INTRODUCTION

The rapid development of the digital era has caused technology to become more commonly used in various fields, including education. The field of education has an important role in the progress of a country, with learning activities being closely related to the progress of the nation in this era. The availability of information and communication sources has made learning more effective and efficient. One of the main focuses of learning in the world of education today is mathematics. Mathematics learning in the 21st century emphasizes the importance of developing aspects of critical thinking, communication, collaboration, and creativity (Fajriyah, 2022). One of the skills that students must have is critical thinking skills. Critical thinking skills are abilities that enable

students to study a problem systematically, face obstacles in an organized way, formulate innovative questions, and design appropriate solutions to the problems faced (Aini et al., 2022).

Critical thinking skills are very important for students, so they must be encouraged and taught in every class, because they are not skills that develop naturally from birth which can be applied through understanding (Syafita et al., 2023). Mathematics learning itself is learning related to the lives and environment around students. In other words, ideal mathematics learning is learning that can be directly learned by students to develop critical thinking skills so that students can find answers through the learning experiences they do.

Based on the results of observations conducted at Al-Azhar Paron Middle School, many students explained that they had difficulty solving questions that contained high-order thinking skills, causing the solutions to these questions to not touch on the substance of critical thinking skills. Students tend to focus on patterns and formulas, but lose understanding in the analysis and testing of the truth of the question which is its essence. In addition, students are less trained in developing their ideas in solving problems. The inability of students to find new ideas or ideas to solve a mathematical problem is the cause of low student thinking skills (Octafiana et al., 2022). Students only see the references given by the teacher. This is evidenced by the results of the 2023 student ANBK which shows that students' competence in thinking using concepts, procedures, facts, and mathematical tools in algebra content to solve everyday problems has decreased from last year by 11.39%. Thus, it means that the critical thinking skills of grade VIII students are still relatively low. So it is necessary to think about ways and strategies to overcome the problems above.

Success in achieving learning objectives is influenced by the choice of learning model used. One option that can facilitate understanding of the subject matter is to use PJBL (Project Based Learning) or a project-based learning model. The application of this model results in students not only learning abstractly, but also being given the opportunity to practice directly. Learning with Project-based learning is an innovation in learning models that foster critical thinking in students and make learning activities more meaningful so that they can be remembered by students (Dewi et al., 2023). This allows students to analyze problems, provide critical responses, and find solutions when they face problems in learning.

The effectiveness of the project-based learning model can be done by integrating the use of technology that is in accordance with the times. One way to achieve this is to combine the Science, Technology, Engineering, and Mathematics (STEM) approach with the project-based learning model. STEM is an approach that integrates four main components in education, namely science,

technology, engineering, and mathematics, which can make students have design, creativity, and innovation skills (Supriyatun, 2019).

Based on research (Lianti et al., 2023) entitled Effectiveness of STEM Integrated Project Based Learning Model on Critical Thinking Skills of Junior High School Students, it shows that the STEM integrated PjBL learning model is effective in helping students improve their critical thinking skills. Based on research conducted by (Priatna & Lorenzia, 2018) STEM integrated PjBL is theoretically able to optimize critical thinking skills. The collaboration of the PjBL-STEM learning model is said to be sufficient to improve two essential aspects of critical thinking skills. In line with this premise, (Pramasdyahsari et al., 2022) also showed that PjBL-STEM positively and significantly affects students' critical thinking skills at all levels of education (elementary, junior high, and high school).

Based on previous research, the difference in this study is the material studied and based on the results of the t-test which showed that the average critical thinking test results of control class students were lower than the average experimental class. With the existing background, the researcher conducted research related to the Effectiveness of the STEM-Based Project Based Learning (PjBL) Learning Model on the Critical Thinking Skills of SPLDV Material of Al-Azhar Paron Middle School Students.

2. METHOD

This research was conducted at SMP Al-Azhar Paron in the even semester of 2023/2024. The research method used in this study is a quantitative research method with a Quasi-experimental design. The research methodology used in this study is a non-equivalent control group design, almost identical to the pretest-posttest design with the exception that this design does not randomly select experimental and control groups (Sugiyono, 2009). This design is used because it is in accordance with the conditions of the research sample, where the sample studied has a comparison group or control group and an experimental group. Both groups will later be tested using the same instrument and analyze which treatment is more optimal. The population in this study were all students of class VIII of SMP Al-Azhar Paron totaling 46 students divided into two classes. Sampling in this study used a saturated sample technique. It is said to be a saturated sample because the entire population, namely class VIII of SMP Al-Azhar Paron as many as 46 students, was used as a sample. The 46 students were divided into two groups, namely class VIII B as an experimental class consisting of 21 students and class VIII A as a control class consisting of 25 students, according to the researcher's considerations, the experimental class consisting of 21 students was given

treatment using STEM-based PjBL learning and the control consisting of 25 students was given treatment using conventional learning.

The instrument used in this study was a test. The critical thinking ability test given to students was in the form of an essay test as a measuring tool for students' critical thinking abilities. The test was compiled based on indicators of critical thinking abilities. Before the test questions were used to measure students in the sample class, the test questions were first tested. The trial was intended to determine the validity, reliability, level of difficulty and discrimination of the test items. From the results of the trial, the questions that would be used to measure the level of students' critical thinking abilities in learning mathematics on the SPLDV material were selected. This study used an unpaired T-test analysis. Before conducting the t-test, the researcher began by conducting a normality test to determine whether the data from the critical thinking ability test were normal or not and a homogeneity test to determine whether the two data results were homogeneous or not as a prerequisite for testing the hypothesis.

3. RESULTS AND DISCUSSION

Before conducting the prerequisite test, the research instrument was first tested through validity, reliability, difficulty level, and discriminatory power tests. The validity test was conducted using product moment correlation calculated manually and with the help of Microsoft Excel, where 10 questions were tested on 15 students. From the results of the validity test, it was found that 6 out of 10 questions met the validity requirements with an r -count value greater than r -table, which was 0.514. The reliability test was conducted to ensure the consistency of the instrument in measuring students' critical thinking skills, using the Cronbach Alpha formula. The calculation results showed an r_{11} value of 0.72, which indicated that the instrument had a high level of reliability. The difficulty level test revealed that 3 questions were classified as easy, while the other 7 questions were classified as moderate. For the discriminatory power test, it was found that 8 questions had moderate discriminatory power, and 2 other questions had poor discriminatory power. Based on the results of this trial, it was concluded that out of 10 questions, 6 could be used because they met the criteria for validity, reliability, discriminatory power, and adequate difficulty level.

Next, the prerequisite test is carried out by testing the normality and homogeneity of the data. The normality test uses the Lilliefors technique, and the results show that the data in the control class and the experimental class are normally distributed, with the L count value smaller

than the L_{table} . The homogeneity test of variance is carried out using the F test, where the results show that the variance of the post-test scores in both classes is homogeneous, with the F_{count} value smaller than the F_{table} . With the fulfillment of the normality and homogeneity prerequisites, further analysis can be carried out to test the effectiveness of the applied learning model.

At the hypothesis testing stage, testing is carried out using the t test to see the difference in effectiveness between the STEM-based PjBL learning model and the conventional learning model on students' critical thinking skills. The results of the t test show that the t count value of 3.601 is greater than the t table of 2.015, so H_0 is rejected and H_1 is accepted. This means that the STEM-based PjBL learning model is more effective than the conventional learning model in improving students' critical thinking skills. These results indicate that a more innovative and integrated learning approach with STEM can have a significant impact on students' academic achievement, especially in developing critical thinking skills.

4. CONCLUSION

This study is based on the results of the ANBK of Al-Azhar Paron Middle School students in 2023 which showed that students' competence in thinking using concepts, procedures, facts, and mathematical tools in algebra content to solve everyday problems had decreased from last year by 11.39%. This means that the critical thinking skills of class VIII students are still relatively low. So it is necessary to think about ways and strategies to overcome these problems. In this study, the researcher aims to determine the effectiveness of the STEM-based PjBL learning model on students' critical thinking skills in SPLDV material at Al-Azhar Paron Middle School. This research was conducted in class VIII of Al-Azhar Paron Middle School. The sample of this study was class VIII A as a control class using the conventional model and class VIII B as an experimental class using the STEM-based PjBL model. Before the data analysis test was carried out, a prerequisite test was first carried out using the Lilliefors normality test and the homogeneity test. The results of the normality test of the control class with $L_{hitung} (0.131) < L_{tabel} (0.173)$ indicate that H_0 is accepted or it can be said that the data is normally distributed. While the results of the normality test in the experimental class with $L_{hitung} (0.116) < L_{tabel} (0.19)$ also indicate that the data is normally distributed. The results of the homogeneity test with $F_{hitung} (2.047) < F_{tabel} (2.082)$ indicate that H_0 is accepted or the data is homogeneous. After knowing that the data is normal and homogeneous, an unpaired t-test analysis was carried out with a significance level of 5%. The summary results of the unpaired t-test show the hypothesis decision. The t-count = 3.601 was obtained while the t-table = 2.015

because the $t\text{-count} \geq t\text{-table}$, then H_0 is rejected. This means that the STEM-based PjBL model is more effective than the conventional model on students' critical thinking skills in SPLDV material. The STEM-based Project Based Learning model provides interest, enthusiasm and activeness in students. Strengthened by the average results of the experimental posttest which showed values above the KKM. By using this model, students not only learn abstractly, but are also given the opportunity to practice directly. Thus triggering effectiveness and comfort in learning.

Based on research (Lianti et al., 2023) entitled The Effectiveness of the STEM Integrated Project Based Learning Model on the Critical Thinking Skills of Junior High School Students, with the independent sample t-test used for data analysis. The research findings were 1) the critical thinking skills of students in the PjBL-STEM class and the PjBL class were different, 2) the critical thinking skills of PjBL-STEM students were superior to PjBL students, 3) based on the regression equation $\hat{Y} = 6.996 + 0.841X$, the influence of PjBL-STEM learning had an impact of 75.5% on students' critical thinking skills. Critical thinking (Y) increased by 0.841 for each unit of the PjBL-STEM learning model (X). This shows that the STEM-integrated PjBL learning model is effective in helping students improve their critical thinking skills. The difference between this study and previous studies is the material studied and based on the results of the t-test which showed that the average critical thinking test results of control class students were lower than the average experimental class. Based on this, it can be concluded that the STEM-based Project Based Learning learning model is effective for the critical thinking skills of SPLDV material for Al-Azhar Middle School students.

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