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# THE EFFECTIVENESS OF PROJECT-BASED LEARNING TO IMPROVE HIGHER ORDER THINKING SKILLS (HOTS) AND MATHEMATICAL RESILIENCE OF STUDENTS AT THE GALANG DEVELOPMENT PRIVATE HIGH SCHOOL

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*ABSTRACT*

This research aims to determine the increase in students' high-level thinking abilities and increase students' mathematical resilience abilities by implementing project-based learning and to determine the effectiveness of the project-based learning model for high-level thinking (HOTS) and the resilience abilities of class XI students at the Development Private High School in Galang. The method used in the research is quantitative research. The location of the research was at the Galang Development Private High School, Jl. Neighborhood Farmers VII Galang City, Galang District, Deli Serdang Regency. The research was conducted in class XI in the even semester 2023-2024. The research subject is class XI, where class XI-1 is an experimental class with a project-based learning model and class XI-2 is a control class with a direct (conventional) learning model. The achievement and improvement of high-level thinking skills of students who receive project-based learning is better than students who receive direct learning. And the achievement and increase in mathematical resilience of students who receive project-based learning is better than students who receive direct learning.

**Keywords**: Effectiveness of Project Based Learning, High-level thinking skills (HOTS), Mathematical literacy.

## INTRODUCTION

Education is an effort to create conditions and learning processes that enable students to actively develop religious spiritual strength, self-control, personality, intelligence, morals, and skills necessary for themselves and society (Octiviani Pulungan et al., 2024). Many schools still use a teacher-centered learning system. In this system, students only receive information from the teacher, and collaborative skills do not appear in learning activities (Suratno et al., 2020). So far, mathematics learning has been given to students in an informative manner, which means students only get information from the teacher, so their level of attachment is low (Fauzi & Arisetyawan, 2020). Mathematics is a science that is very

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important for improving intellectual abilities and skills (Siagian et al., 2022). Mathematics is a subject that must be taught from elementary to secondary levels because it is a basic competency that everyone must have. As a result, mathematics requires more hours of study than other subjects (Santoso & Nurjamil, 2024). In the twenty-first century, humans will be faced with increasingly complex problems in various aspects of life. The 21st century is a modern century where almost all aspects of social life continue to develop very quickly. This development makes it easier for everyone to communicate and connect globally or without being bound by regional boundaries (Oktaviya, 2023). It cannot be denied that globalization has positive and negative impacts. One way to reduce the negative impact is to educate the younger generation to be able to overcome any problems they encounter in the field. The young generation, who is qualified and competitive and in tune with developments in the 21st century, must have the various skills needed. They must be able to handle problems, think creatively, work together, and create innovation. This ability can be trained by studying it. If mathematics learning is successful, students will have effective communication skills, reasoning, problem solving, understanding, and other abilities. They will also have the ability to use mathematics in their lives (Anisa, 2014). As an educator, it is very important to be able to create a learning atmosphere that involves student participation. It also involves paying special attention to students who are less active during the learning process. Additionally, it is important to identify the problems students face when they receive low grades and find ways to solve them. As a result, a learning model that can activate students all the time is needed. Learning can be said to be good if it goes well. Apart from that, using methods that are appropriate to the material being taught, which ultimately produces results that meet expectations (Nurhaliza et al., 2024).

Based on the results of a field study at the Galang Development Private High School regarding students' interest in learning mathematics, it turns out that the majority of mathematics subjects are less popular and are considered a scourge that needs to be avoided. Due to students' initial beliefs that mathematics is a difficult subject, the learning atmosphere makes it tense. As a result, they become anxious, which will affect their ability to understand information during the teaching and learning process (Kholil & Zulfiani, 2020). The results show that this has a negative impact on students' difficulties in solving mathematical problems and makes them feel burdened by these problems. Student internal and external factors can influence learning difficulties (Fauzi & Arisetyawan, 2020). Learning difficulties are various disorders related to listening, speaking, reading, writing, and arithmetic, which are caused by the individual's internal components, namely minimal brain function disorders (Suryani, 2010). Some students tend not to try to solve problems but ask their friends or teachers. The consequences are students' lack of knowledge, lack of enthusiasm for learning, and lack of optimism. If this is left without treatment, it will affect student learning outcomes. The learning process in class

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can help students improve their thinking abilities. Learning must enable students to discover meaningful and activity-based ideas (Hanifah, 2019). Efforts that teachers can make are implementing an innovative learning model, one of which is the project-based learning model. According to (Suherman et al., 2020). To improve high-level thinking skills, the project-based learning model (PjBL) is the right approach. The project-based learning model (PJBL) uses projects or activities as goals and focuses on student activities that focus on gathering information and utilizing it to produce results that are beneficial to students and others (Nurhadiyati et al., 2020). To face feelings of anxiety and fear in facing challenges or difficulties, students need to develop a persistent and tough attitude. This positive attitude is contained in mathematical resilience (Rahmmatiya & Miatun, 2020).

Academic resilience is an important component related to a person's ability to adapt to the educational environment. Because high resilience in students can enable them to fulfill academic demands well and reduce the risk of stress. Learning outcomes must also be improved to attract children's interest in school. Students who have low academic resilience tend to be stressed and show poor learning outcomes (Ramadanti & Sofah, 2022). According to (Azizah & Abadi, 2022) Resilience is a very important student ability. One of the important soft skills for students to have is mathematical resilience. Resilience means a quality attitude in learning mathematics. That is, confidence consists of believing in oneself that one can ultimately succeed through hard work, persistence in solving problems, and having the desire to discuss, reflect, and investigate (Ansori, 2020). Resilience can be influenced by many things. More specifically, the review divides the sources of resilience into three, namely: 1) Personality includes openness, extraversion, and friendliness; internal locus of control; self-efficacy, self-esteem, cognitive appraisal, optimism, intellectualism, cognitive flexibility; social engagement; positive self-concept; emotion regulation; positive emotions; religious; adaptability; strength or fortitude; and demographic factors such as age, gender, and race. 2) Research shows that harsh early conditions can impact the development of neurobiological systems, function, and brain structure. Brain size, neural tissue, receptor sensitivity, and the synthesis and reuptake of neurotransmitters can all change and influence the development of resilience. 3) Environment. At the micro level, resilience is influenced by social support, such as friends and family relationships (Sujadi et al., 2021).

To live in the 21st century, various abilities are needed, one of which is thinking skills. There are two types of thinking skills, namely low or low level thinking skills and high or high level thinking skills. Students are not used to working on HOTS-based questions, which have their own logic and reasoning. The questions that students work on and solve are very similar to what the teacher exemplifies in class. So students' knowledge is only limited to the teacher's lessons (Rahmawati et al., 2022). Students have different higher-order thinking abilities based on their ability to accept and solve

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mathematical problems. Human abilities vary because their nature is different from each other (Khairunnisa et al., 2023)

## METHODS

This research uses a quantitative research approach method. The data analysis technique used in this research is quantitative data analysis using the Normality Test, Homogeneity Test, N-Gain Test, Hypothesis Test. Quantitative Research Methods, as stated by Sugiyono, can be interpreted as research methods that are based on the philosophy of positivism, used to research certain populations/samples, sampling techniques are generally carried out randomly, data collection uses research instruments, data analysis is quantitative/statistical with The aim is to test the established hypothesis. This research was conducted at the Galang Development Private High School Jl. Neighborhood Farmers VII Galang City, Galang District, Deli Serdang Regency. The research was conducted in class XI in the even semester 2023-2024. The population in this research activity is all students at the Galang Development Private High School in the 2023-2024 academic year in the even semester. The sample used in this research was class XI. The instruments used were high-level thinking ability test questions (HOTS), resilience questionnaires, and interview guidelines.

## FINDINGS

High-level thinking skills data was collected and analyzed to determine students' abilities before and after treatment. Descriptive statistics of students' high-level thinking skills data are presented in Table 1 below.

**Table 1.** Descriptive Statistics of High-Order Thinking Skills Data

| Experimental Class | | | | | Control Class | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***N*** | **Stat.** | **Pretes** | **Postes** | **<g>** | ***n*** | **Stat.** | **Pretes** | **Postes** | **<g>** |
| 25 | $\bar{x}$ | 21,72 | 42,12 | 0,71 | 25 | $\bar{x}$ | 23,24 | 37,88 | 0,54 |
| | S | 4,82 | 2,74 | 0,10 | | *S* | 4,33 | 2,07 | 0,09 |

In the table above, it can be seen that students who received project based learning showed a greater post-test average and n-gain than students who received direct learning. The post-test and n-gain averages of students who received project based learning were 42.12 and 0.71, while students who received direct learning were 37.88 and 0.54. This means that overall students who received project based learning showed higher achievement and improvement in higher order thinking skills than students who received direct learning. Before carrying out the mean difference test, a data normality test and a homogeneity of variance test for the two groups of data are first carried out. The normality test uses the Kolmogorov-Smirnov (K-S) test, while the variance homogeneity test uses the Levene test. The normality test is used to determine whether the data testing uses parametric or non-

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parametric statistical analysis. The parametric statistical analysis used is the t-test or t^' test, while the non-parametric statistical analysis used is the Mann-Whitney U test. A summary of the results of the normality test for high-level thinking skills pre-test data is presented in Table 2 below.

**Table 2.** Normality Test of Pretest Data for Higher Order Thinking Skills

| **Learning** | ***N*** | **K-S** | ***Sig.*** | **$H_0$** |
|---|---|---|---|---|
| Pjbl | 25 | 0,159 | 0,101 | Accepted |
| Direct | 25 | 0,107 | 0,200* | Accepted |

Overall, in the table above it can be seen that the probability value (sig.) of the pretest data for high-level thinking skills in the experimental class and control class is greater than the significance level = 0.05, which means H0 is accepted. This means that the overall high-level thinking skills pre-test data for each lesson comes from a normally distributed population so that it can be continued with the homogeneity of variance test. A summary of the results of the homogeneity test of high-level thinking skills pre-test data is presented in Table 3 below.

**Table 3.** Data Variance Homogeneity Test

| Statistik Levene (F) | dk1 | dk2 | *Sig.* | $H_0$ |
|---|---|---|---|---|
| 1,231 | 1 | 48 | 0,273 | Accepted |

The results in the table above show that the probability value (sig.) in the high-level thinking skills pretest is greater than the significance level = 0.05, so that the null hypothesis is accepted, in other words, the population variance of the high-level thinking skills pretest data is homogeneous. Next, to find out whether there is a difference in the means of the two sample groups, a test of differences in the means of data on improving higher order thinking skills was carried out using the t-test. A summary of the results of the mean difference test can be seen in Table 4 below.

**Table 4** Test of Differences in Mean Data for Increasing Higher Order Thinking Skills

| **Learning** | **Mean Difference** | ***T*** | ***Sig.* (2-*tailed*)** | ***Sig.* (*1-tailed*)** | **$H_0$** |
|---|---|---|---|---|---|
| Pjbl | 0,715 | 6,389 | 0,000 | 0,000 | Rejected |
| Direct | 0,537 | | | | |

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By looking at the summary of the analysis results in Table 4 above, the probability t value (sig.) for both studies is smaller than the specified significance level = 0.05, so the null hypothesis is rejected. In other words, there is a significant difference between the mean data for increasing high-level thinking skills in the experimental class and the control class. These results provide the conclusion that there is a significant difference between data on improving high-level thinking skills for students who received project-based learning and students who received direct learning. These results are supported by research conducted by (Ruddin, 2024) where the influence of the PjBL learning model on student learning outcomes at SMK 7 Makassar with the t value for PjBL is 2.431 with a significance level (Sig.) of 0.018, which shows that PjBL is statistically significant in influencing the dependent variable at the 95% confidence level. This indicates that there is a strong and significant relationship with PjBL.

## CONCLUSION

Overall, the effectiveness of the project based learning model on high level thinking abilities (HOTS) shows that there is an increase in students' high level thinking abilities and also students' resilience abilities. There is a significant difference between the mathematical resilience of students who receive project based learning and students who receive direct learning.

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