


## **Analysis of Students' Mathematical Communication Skills in Review of Self-Efficacy in The Project-Based Learning Model Using Project Assessment**

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### **ABSTRACT**

This study aims to analyze the quality of mathematics learning after applying PjBL with project assessment on students' mathematical communication skills (KKM) and students' KKM in terms of self-efficacy in PjBL learning with project assessment. The type of research is a mix method with a sequential explanatory design. In this study, 6 research subjects were taken based on the level of self-efficacy in students of grade X-8 SMAN 6 Cirebon. The results showed that (1) the PjBL learning model with project assessment improved the quality of mathematics learning for KKM students, and (2) research subjects with high self-efficacy categories are able to meet all KKM indicators, namely stating problems into written mathematical ideas, stating mathematical problems in the form of drawings or mathematical models, presenting written mathematical problem solving in an organized and structured manner, and evaluating mathematical ideas in writing. Subjects with moderate self-efficacy categories were only able to meet the KKM indicators, namely expressing problems into written mathematical ideas and expressing mathematical problems into images or mathematical models. Subjects with a low self-efficacy category were only able to meet the KKM indicators, namely presenting written mathematical problem solving in an organized and structured manner, and evaluating mathematical ideas in writing.

**Keywords:** Mathematical communication skills, self-efficacy, PjBL, project assessment

### **ABSTRAK**

Penelitian ini bertujuan menganalisis kualitas pembelajaran matematika setelah menerapkan PjBL dengan asesmen proyek terhadap kemampuan komunikasi matematis (KKM) peserta didik dan KKM peserta didik ditinjau dari self-efficacy dalam pembelajaran PjBL dengan asesmen proyek. Jenis penelitian adalah mix method dengan desain sequential explanatory. Dalam penelitian ini diambil 6 subjek penelitian berdasarkan tingkat self-efficacy pada peserta didik kelas X-8 SMAN 6 Cirebon. Hasil penelitian menunjukkan bahwa (1) model pembelajaran PjBL dengan asesmen proyek meningkatkan kualitas pembelajaran matematika terhadap KKM peserta didik, dan (2) subjek penelitian dengan kategori self-efficacy tinggi mampu memenuhi semua indikator KKM, yaitu menyatakan masalah ke dalam ide matematika tertulis, menyatakan masalah matematika ke dalam bentuk gambar atau model matematika, menyajikan pemecahan masalah matematika tertulis secara terorganisir dan terstruktur, dan mengevaluasi gagasan matematika dalam tulisan. Subjek dengan kategori self-efficacy sedang hanya mampu memenuhi indikator KKM, yaitu menyatakan masalah ke dalam ide matematika tertulis dan menyatakan masalah matematika ke dalam bentuk gambar atau model matematika. Subjek dengan kategori self-efficacy rendah hanya mampu memenuhi indikator KKM, yaitu menyajikan pemecahan masalah matematika tertulis secara terorganisir dan terstruktur, dan mengevaluasi gagasan matematika dalam tulisan.

**Kata kunci:** Kemampuan komunikasi matematika, *self-efficacy*, PjBL, asesmen proyek

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## Introduction

Communication, mathematics, representation, reasoning and formulating solving strategies, using symbolic, formal, and technical language and operations, and using mathematical teaching aids are the seven basic mathematical abilities that underpin the occurrence of mathematical processes, according to the OECD's 2018 International Student Assessment Program (PISA) (2023). Communication skills, based on these seven abilities, are one of the mathematical abilities that play a critical role in achieving mathematics learning objectives. However, students with low communication skills may struggle to understand and use specialized mathematical vocabulary, hindering their ability to express ideas clearly. Bakić-Tomić et al., (2015) Revealing that mathematical ability is one of the life skills, so the ability to process and produce new knowledge needs to be developed in learning. Mathematical communication is a crucial skill, although Indonesian students still do poorly in this area. Mathematical communication is a crucial skill, particularly for explaining reasoning, justifying solutions, and collaborating on problems. Unfortunately, Indonesian students still show weaknesses in this area. Dewi et al., (2020) According to findings from the Trend in International Mathematics and Science Study (TIMSS) 2021, the results of a survey conducted by PISA organized by the OECD in 2022 Indonesia obtained an average score of 366 and ranked 73rd out of 79 countries. This gain has decreased when compared to the PISA results in 2018 which ranked 77th out of 79 countries with an average score of 379. Meanwhile, the data obtained from the 2021 TIMSS analysis carried out by IEA Indonesia ranks 44th out of 49 countries.

Students at SMAN 6 Cirebon were given beginning ability test questions as part of a preliminary investigation, and the findings showed that while the students could solve the questions, their responses only included the computation results. applying the relevant ideas. Additionally, students don't clearly provide their justifications for answering the questions. One of the results of the work of students who show low mathematical communication skills states that indicators of mathematical communication skills, namely changing the shape of the problem into pictures, using mathematical symbols correctly, using formulas appropriately, giving arguments in solving problems, writing answers correctly and systematically and writing conclusions from statements in their own language are still lacking.. There are still many students who have not been able to change the form of the problem into pictures, use mathematical symbols correctly, use formulas correctly, give arguments in solving problems, write answers correctly and systematically and write conclusions from statements in their own language that has been done.

The mathematical ability of students is not only influenced by mathematical communication as a cognitive aspect, but also influenced by self-confidence or self-

efficacy as one of the affective aspects. According to Ordun & Akün, (2017); Peechapol et al., (2018); and Waddington, (2023) Self-efficacy is the dynamic and multifaceted individual belief in one's ability to successfully navigate and master challenges, tasks, and situations. It encompasses the confidence in our mental, motivational, emotional, and behavioral resources to execute the necessary effort towards achieving specific goals or fulfilling demanding requests, particularly in the context of online learning. Put simply, it's the conviction that we "can do it," within a specific context or domain. In addition, according to Bellemans & Devos, (2023) Self-efficacy is a perceived assessment that a person has the ability to perform actions that bring the desired results. The same is stated by Tus (2020) Self-efficacy is an individual's assessment of actions based on the situation. Moreover, Kurnia and Mulyani (2020) Provide information that self-efficacy affects the ability of oral and written mathematical communication and academic success of students. This can be seen from the contribution given by learning independence and self-efficacy to mathematical communication by 51.55%. Other studies say there is a relationship between mathematical communication skills and self-efficacy specifically in mathematics learning (Salgado et al., 2018; Taştan et al., 2018). Research Gulistan et al., (2017) dan Perera & John, (2020) It also mentions that the contribution of self-efficacy and mathematical communication skills has a significant impact on learning achievement. Research results Klassen & Klassen (2018) It also states that self-efficacy has a positive influence on learners' mathematical communication skills.

This research suggests that learning activities that might help students strengthen their mathematical reasoning skills should be given careful consideration. Choosing the appropriate learning model can have an impact on how well educational activities go. Project-Based Learning (PjBL) is one of the available learning paradigms. PjBL is a learning model that involves students directly according to their experience and ability in building mathematical solving processes through real projects (Beier et al., 2018; Craig & Marshall, 2019). Students are assigned assignments that are realistic, comprehensive, and challenging, and they may get adequate support to finish them (Berhita et al., 2020). In addition, PjBL is a learning model that has many benefits for students (Kokotsaki et al., 2016). PjBL can help learners develop critical thinking, problem-solving, communication, cooperation, creativity, and innovation skills. In addition, PjBL can also encourage students to become independent and autonomous learners (Becerra-Posada et al., 2022; Häkkinen et al., 2017; Loyens S. M. et al., 2015).

According to the Anggraena et al. (2022) learning guidelines and independent curriculum assessment, learning implementation must not only give students high-quality, engaging, and contextualized learning experiences, but it must also be evaluated continuously to ascertain the degree to which students have met learning

objectives. Project assessment is one of the evaluations that aligns with PjBL learning. According to Masrukan (2017) Emphasize that a project assessment is an evaluation of a work that needs to be finished in a specific amount of time. The use of this project assessment is intended to improve the ability of students, one of which is communication skills. In addition to improving students' communication skills, the application of this project assessment is intended to be able to increase student creativity, because in project assessment learning there are goals and understandings that have to do with the development of students' self-concept.

Based on the above problems, the researcher is interested in taking the title "The mathematical communication ability of students in terms of self-efficacy in the project-based learning model using project assessment".

### **Research Methods**

Research is conducted using a mixed methodology, where quantitative research serves as the primary approach and qualitative research as a secondary approach. Prettest-Posttest Control Group Design was the type of sequential explanatory study design that was employed. Two classes were taken for this study: the experimental class and the control class. Project assessment will be used to apply the Project-Based Learning model to the experimental class, and Project-Based Learning will be administered to the control class. All grade X pupils at SMAN 6 Cirebon made up the study's population. The sample of this study consisted of 72 students of grade X. Cluster random sampling technique was used for sampling. Class X-4 (Control class) and class X-8 (Experimental class) are classes used for research. Data analysis techniques used in the study are normality test, Variance difference test, Classic Due Diligence, Average Difference Test, and Proportion Difference Test. The research instruments used include self-efficacy questionnaires, mathematical communication skills test questions, response questionnaires, interview guidelines.

### **Result and Discussions**

Self-efficacy classification was carried out on 36 experimental class learners (X-8) using self-efficacy measures validated by experts and assessed for validity and reliability. The self-efficacy scale contains 15 statements. The following is a detailed scale of efficacy obtained by students ranging from high level to low level.

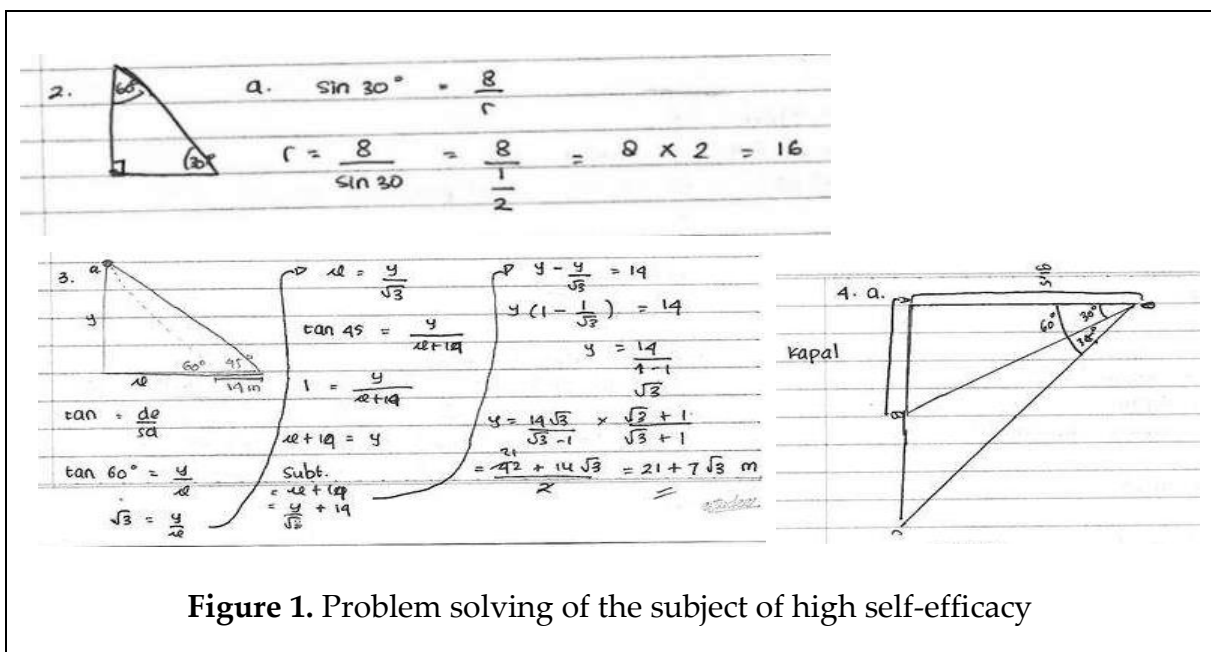
Based on the [Table 1](#), there are 5 students with a high level of self-efficacy, 25 with moderate self-efficacy, and 6 with low self-efficacy. Six students were selected as interview subjects to describe the mathematical communication skills of students in the experimental class in terms of self-efficacy.

**Table 1.** Exposure of the results of students' communication skills with self-efficacy

Student	Self-Efficacy Scale	Information
5	>156	High
25	$107 < x < 156$	Currently
6	<107	Low

**Communication skills at high self-efficacy**

The subject's answer has demonstrated mathematical communication skills, based on the results of working on students' mathematical communication skills. This is demonstrated by the subject's ability to understand and effectively solve challenges. In addition, it is demonstrated the fact that learners who have a high level of self-efficacy are able to meet all requirements for mathematical communication skills, including the capacity to translate problems into written mathematical ideas, to express mathematical problems as mathematical images or models, to present solutions to written mathematical problems in an orderly and structured manner, and to assess mathematical ideas in an orderly and structured manner. Here is one of the students who get communication skills with high self-efficacy (Figure 1).



**Figure 1.** Problem solving of the subject of high self-efficacy

It was found that students with high self-efficacy were able to respond to questions quite effectively, based on the results of students' tests of mathematical communication skills and examination of interview transcripts. This is demonstrated by the fact that students who have a high level of self-efficacy are able to meet all requirements for mathematical communication skills, including the capacity to translate problems into written mathematical ideas, to express mathematical problems



models. These findings are based on the results of learners' tests of mathematical communication skills and analysis of interview results (Figure 2).

### Communication skills at low self-efficacy

Based on the results of the students' test questions on mathematical communication skills and analysis of interview results. Learners with low self-efficacy find that they have little difficulty solving problems by meeting only the indicators of mathematical communication skills, which include the ability to present written mathematical problem solving in an organized and structured manner and the ability to evaluate mathematical ideas in writing (Figure 3).

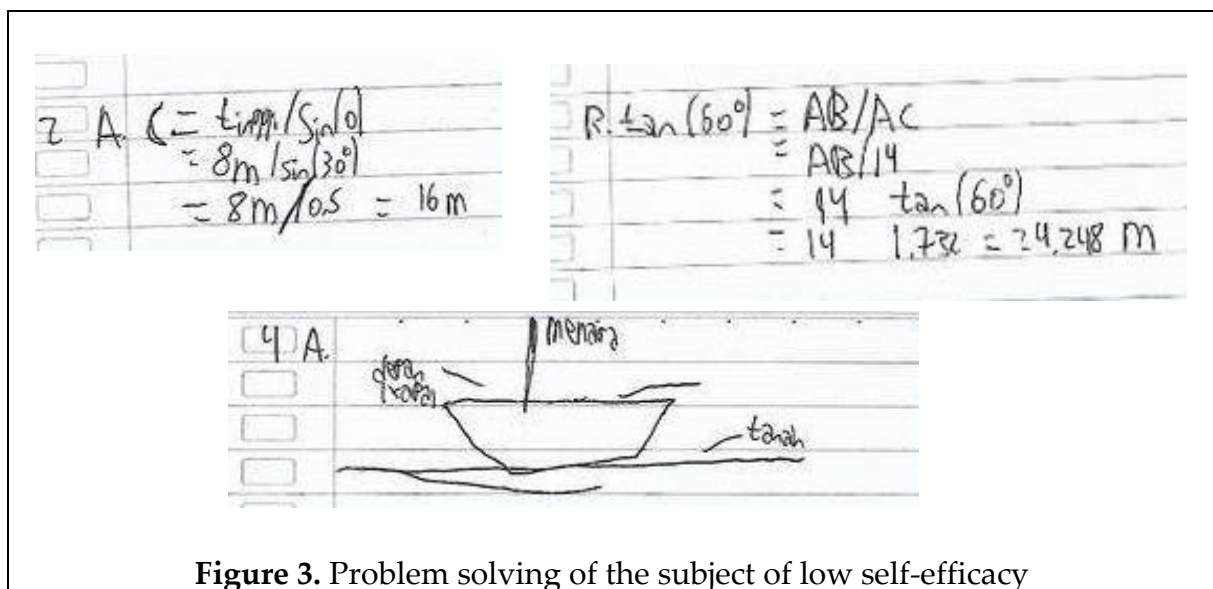


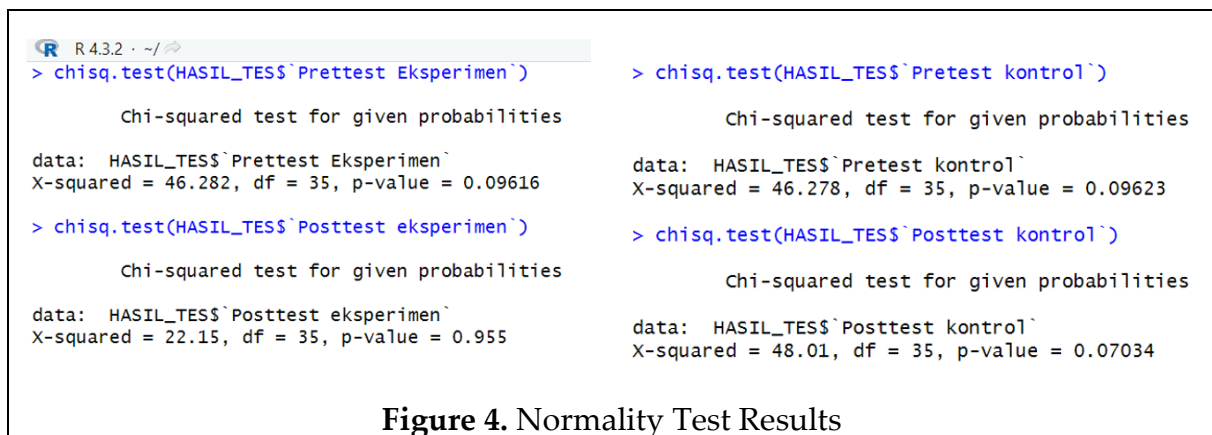
Figure 3. Problem solving of the subject of low self-efficacy

### The effectiveness of the project-based learning model using project assessment in improving students' mathematical communication skills

If the PjBL Learning Model with project evaluation passes three specified hypothesis tests, it is claimed to be beneficial for students' mathematical communication skills. Prior to evaluating the hypothesis, it is important to perform precursor tests, namely the normalcy test with the Chi-Square Test and the difference variant test with the Lavene Test, using Rstudio as follows.

#### Normality Test

The RStudio application can be used to test for normalcy. If the value is significant, it indicates that the data is regularly distributed, and vice versa  $>0.05$ . Figure 4 depicts the significant values in the experimental (X-8) and control (X-4) classes. As a result, the experimental and control classes' data can be assumed to be regularly distributed.  $0.9550 > 0.09623 > 0.05$



### Variance difference test

The homogeneity test determines whether or not the variation of the original sample value is homogeneous. Lavene test for data homogeneity with the RStudio program. If the value is significant, it means that the data originates from a population with homogeneous variance, and vice versa  $>0.05$ .

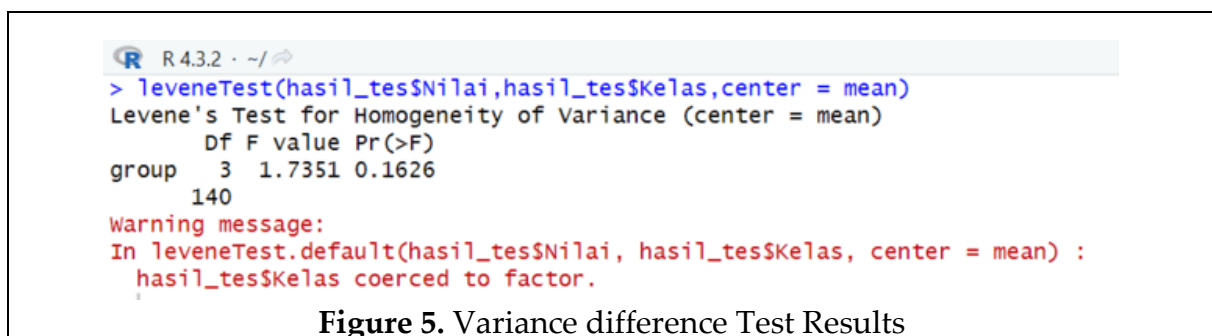


Figure 5 shows the significant value of the lavender test. As a result, we may conclude that the sample was taken from a population with a homogeneous variance of 0.1626  $> 0.05$ .

### Classic Due Diligence

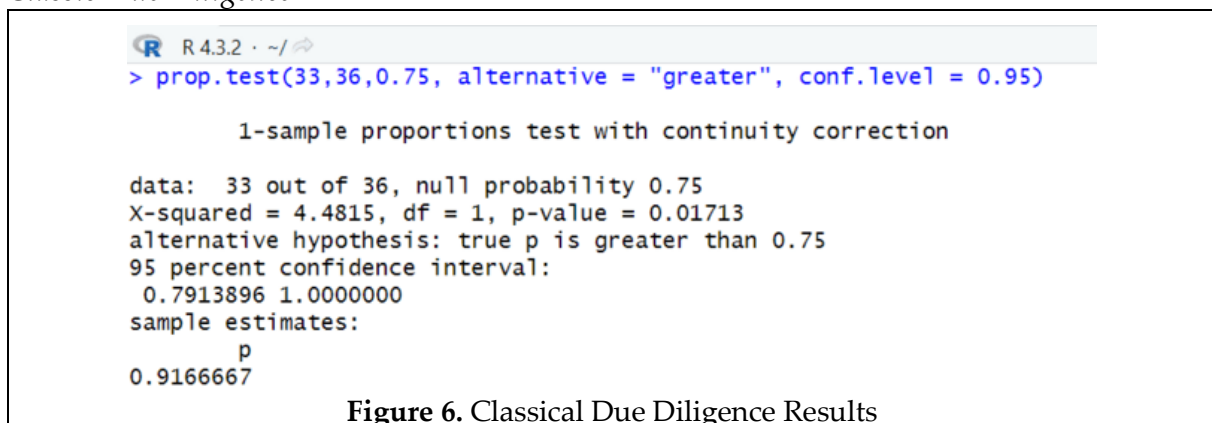


Figure 6 shows the p-value is 0.017130.05 based on the data output, hence the  $H_0$  is rejected. This signifies that students in PjBL learning with project evaluation are more than 75% complete.

#### Average Difference Test

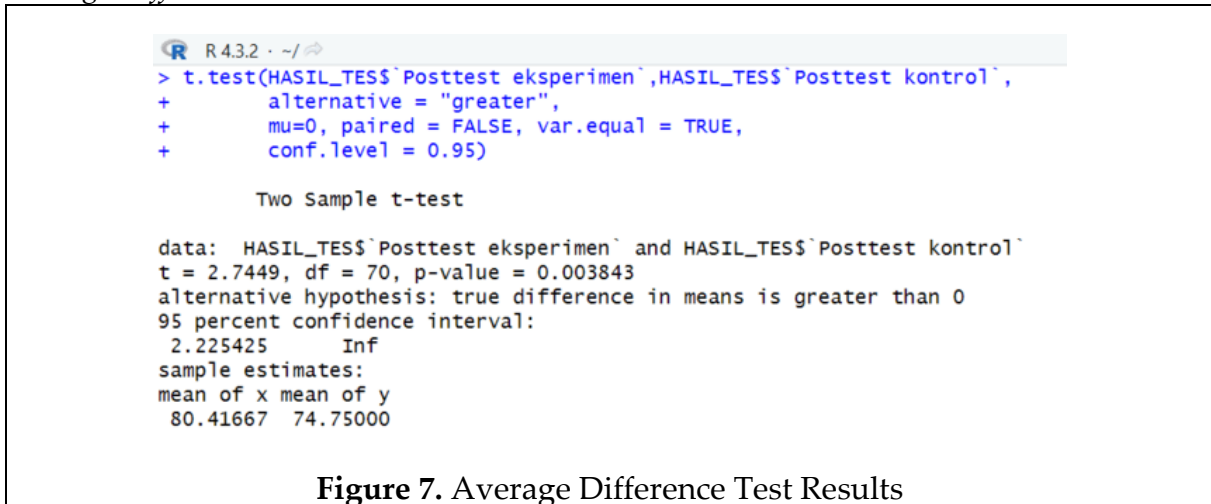


Figure 7 shows  $H_0$  was rejected because the data output yielded a sig value of 0.0038430.05. This suggests that the average mathematical communication ability of students using PjBL learning with project assessment is higher than the average mathematical communication ability of students using PjBL learning.

#### Proportion Difference Test

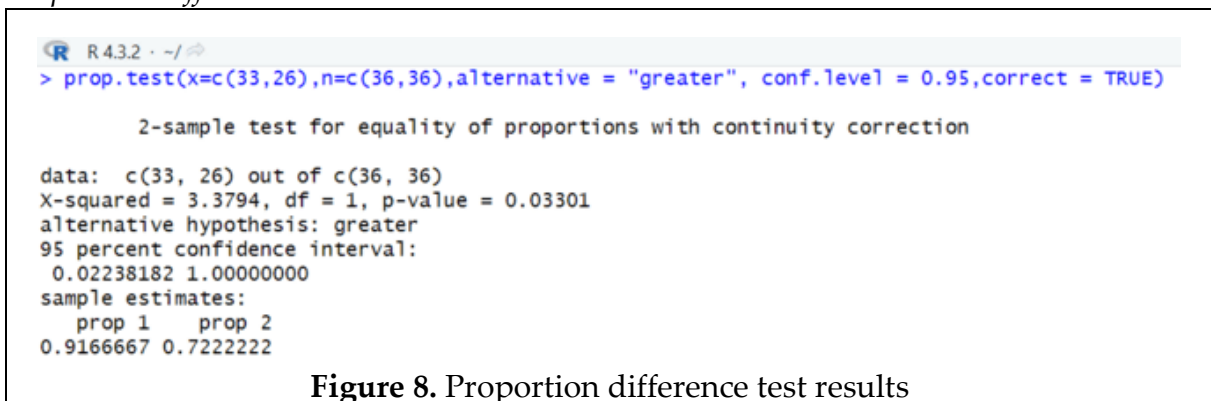


Figure 8 shows  $H_0$  was rejected since the data output yielded a p-value of 0.03301<0.05. This suggests that the proportion of students' mathematical communication skills developed through PjBL with project assessment is higher than the proportion of students' mathematical communication skills developed through PjBL learning.

Learners' mathematical communication skills are examined from three categories. High self-efficacy category, medium self-efficacy category, and low self-efficacy category. based on research findings. Based on the high category, it can be said that the mathematical communication ability of learners is positively influenced by self-efficacy. Compared to learners with low self-efficacy, those with high self-efficacy have superior mathematical communication skills. Self-efficacy can be defined as a person's belief in his capacity to complete a job or realize a goal.

The challenge of mathematical communication skills is considered solvable by learners who have strong self-efficacy. Their perseverance and determination are supported by this idea. Higher learning motivation is another benefit of self-efficacy learners. Learners are more encouraged to acquire mathematical knowledge and hone their communication skills in the subject. Self-efficacy positively affected learners in a moderate self-efficacy category capacity for mathematical communication, according to moderate category findings.

Mathematical communication skills were superior among learners who had modest levels of self-efficacy compared to those who lacked them. Self-efficacy is defined as an individual's confidence in their capacity to complete a job or achieve a goal. When it comes to solving problems involving mathematical communication skills, learners with moderate self-efficacy have slightly lower self-confidence than those with high self-efficacy. They are inspired by this idea to work harder and persevere through setbacks.

In addition, compared to learners with low self-efficacy, those with moderate self-efficacy also showed better learning motivation. They have a stronger desire to understand mathematical concepts and hone their mathematical communication skills. The inability to write solutions to mathematical problems regularly and systematically persists even in learners with reasonable levels of self-efficacy. This is due to their inability to identify the right solution to any difficulties contained in the problem. It can be said that learners in the low self-efficacy category have lower mathematical communication skills due to their poor self-efficacy. Compared to learners with high or moderate self-efficacy, those with low self-efficacy had poorer mathematical communication skills.

Self-efficacy can be defined as a person's belief in his capacity to complete a job or realize a goal. Low self-efficacy: Learners think they cannot overcome challenges using mathematical communication skills. They can't try and refuse to give up easily because of this mindset. In addition, learners who have low self-efficacy also show decreased motivation to learn compared to learners who have high or medium self-efficacy. They

lack the will to acquire mathematical knowledge and hone their mathematical communication skills.

### **Conclusion**

Based on the results and discussion, this study has two key findings with practical implications for mathematics education : (1) The PjBL learning model with project assessment is effective in improving the quality of mathematics learning for students who previously struggled to meet minimum competency standards (KKM). This suggests that PjBL can be a valuable tool for educators aiming to support students with diverse learning needs. (2) Students with high self-efficacy were more likely to achieve all KKM indicators, demonstrating a broader understanding of mathematical problem-solving. This highlights the importance of fostering student self-efficacy alongside content knowledge. Further research could explore: How PjBL can be adapted to specifically address the needs of students with varying levels of self-efficacy. The long-term impact of PjBL on student achievement and self-efficacy in mathematics.

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