
The Effect Of Self-Efficacy And Creative Thinking Skills On Achievement In Mathematics Using Structural Equation Modeling (Sem)

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Abstract

The background of this study is grounded in the importance of strengthening students' internal factors that contribute to success in mathematics learning, particularly self-efficacy and creative thinking skills. These variables foster students' confidence, encourage them to explore diverse problem-solving strategies, and improve mathematics learning achievement. Employing a quantitative approach with Structural Equation Modeling (SEM) using IBM SPSS AMOS software, this study examined the effects of self-efficacy and creative thinking skills on mathematics learning achievement. The participants consisted of 200 students from SMKN 1 Purwokerto. The model evaluation indicated an excellent fit with the observed data, reflected by a CMIN/DF value of 1.086 with a probability of 0.325, a Comparative Fit Index (CFI) of 0.995, and a Root Mean Square Error of Approximation (RMSEA) of 0.022. Creative thinking skills significantly influenced mathematics learning achievement, with an estimated coefficient of 0.324 ($p = 0.002$). Furthermore, self-efficacy also had a significant positive effect on mathematics learning achievement (estimate = 1.247, $p = 0.020$). These findings confirm that strengthening students' self-efficacy and creative thinking skills can optimize mathematics learning achievement and provide practical implications for vocational school teachers in designing more effective mathematics learning.

Keywords: self-efficacy, creative thinking, mathematics learning outcomes, SEM, CFA

1. Introduction

Mathematics education contributes significantly to the development of higher-order thinking skills. At the Vocational High School (SMK) level, mathematics learning not only aims to master mathematical concepts, but also serves as a reference in supporting the mastery of skill competencies according to the vocational field. Therefore, mathematics learning outcomes are one of the important indicators that reflect students' learning outcomes in understanding and applying concepts, as well as solving various problems faced both in learning and in real-life contexts.

Although mathematics has an important role, in reality it is still a challenge. At the vocational level, some students still have difficulty understanding concepts, determining ideas, and applying them in problem-solving. Learning math is not only about finding answers to given

problems, but also about how the process of solving them is. So far, there is still a lot of learning in the classroom that has not encouraged students to be more active and interactive in learning.

Self-efficacy is one of the factors that is suspected to affect students' mathematics learning achievement. In this case, self-efficacy helps students feel more confident in their abilities. To understand concepts, solve problems, and achieve learning goals, a student must have self-efficacy. In facing problems and challenges, students who have high self-efficacy tend to be more confident, persistent, and do not give up easily when experiencing difficulties. Strong confidence in one's abilities can help improve mathematics learning outcomes and encourage creative thinking in students (Fitriani & Pujiastuti, 2021; Livia et al., 2021; Suherman, 2024; Suherman & Vidákovich, 2025).

In addition to psychological factors in the form of self-confidence, creative thinking skills are another thing that is suspected to affect student learning outcomes. Creative thinking skills allow students to discover new and different ways of solving problems. In addition, creative thinking skills in mathematics help students better understand and solve real-life problems (Firdaus et al., 2024; Komarudin et al., 2023). This has the potential to improve achievement in mathematics. Self-efficacy not only plays a role in improving learning outcomes, but also contributes to improving students' ability to think creatively. Students' confidence in their abilities makes them more courageous to explore various ideas, try different solution strategies, and come up with more diverse solutions in solving mathematical problems (Rahyuningsih et al., 2022; Umam et al., 2023).

Although the relationship between self-efficacy, creative thinking skills, and mathematical learning outcomes has been extensively researched, most studies still test the relationships between variables separately using regression or correlation analysis so that they have not been able to describe the more complex structural relationships between the three constructs simultaneously. In addition, most of the research was conducted on public school students so empirical evidence on vocational school students is still very limited. The characteristics of mathematics learning in vocational schools are different from high schools because mathematics plays a role in supporting skill competencies, so the relationship between psychological factors, cognitive skills, and mathematical achievement is thought to have different characteristics.

In terms of methodology, most previous studies still use correlation or regression analysis so that they have not been able to model the relationship between latent constructs simultaneously. Although some recent studies have utilized Structural Equation Modeling (SEM) to test the relationship between various psychological factors that affect mathematical achievement (Dong et al., 2023; Tak et al., 2025), the research generally only focuses on the relationship between two constructs, for example between self-efficacy and the ability to think creatively (Lestari et al., 2025; Levinta et al., 2024), so that research that integrates self-efficacy, creative thinking skills, and mathematical achievement in one structural model in the context of vocational school

students is still very limited. Therefore, this study uses SEM to build a more comprehensive relationship model. The novelty of this research lies in the integration of these three variables in one structural model in the context of mathematics learning in vocational schools so that it is expected to be the basis for the development of more effective mathematics learning strategies in vocational education.

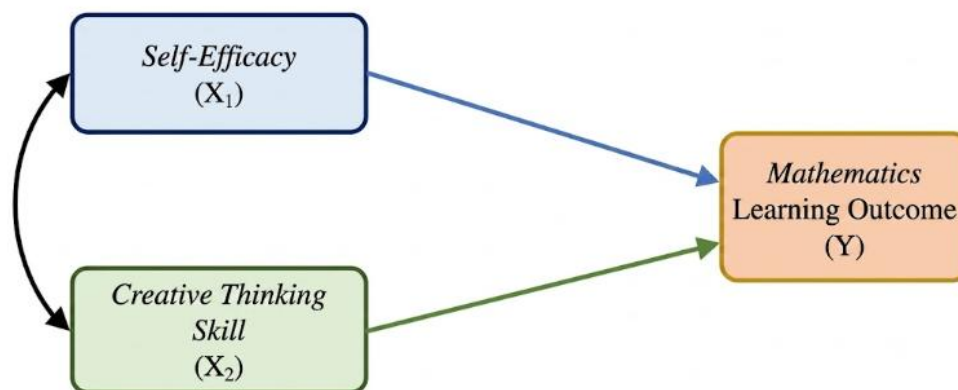
2. Method

This study examines the influence of self-efficacy and creative thinking skills on students' mathematics learning achievement. The research methods used are quantitative approach methods and ex post facto design. The structural relationships between variables were analyzed using the IBM SPSS AMOS software with the help of the Structural Equation Modeling Approach. SEM was chosen because it is able to analyze the relationships between latent constructs simultaneously, take into account measurement errors, and evaluate measurement models and structural models in one analysis (Hidayat & Wulandari, 2022). The subjects of the study were 200 students of SMKN 1 Purwokerto majoring in Software and Game Development, Visual Communication Design, and Pharmacy with an age range of 15-16 years with the material of the Two-Variable Linear Equation System (SPLDV). The sample size of 200 respondents met the minimum recommendations for SEM analysis so that it was considered adequate to produce a stable model estimate (Hidayat & Wulandari, 2022). With *the proportional random sampling technique*, every student has an equal opportunity to become a research respondent. The research instruments include *self-efficacy questionnaires*, mathematical creative thinking ability tests, and mathematics learning outcome tests.

Self-efficacy was measured using a five-point Likert-scale questionnaire consisting of 10 items based on the dimensions of magnitude, strength, and generality. One example of his statement is "I believe I can solve the problem of the System of Two-Variable Linear Equations (SPLDV) despite the high level of difficulty." Creative thinking ability was measured using two open-ended questions based on fluency, flexibility, originality, and elaboration indicators. Mathematics learning achievement was measured using eight multiple-choice questions through Google Form. To verify the answers, students are also asked to write down the completion steps on the answer sheet. The learning outcome test is prepared based on the SPLDV material competency indicator. Prior to the analysis, the measurement model was evaluated using Confirmatory Factor Analysis (CFA). The validity of the construct was assessed based on factor loading (>0.50), Average Variance Extracted (AVE) (>0.50), and Composite Reliability (CR) (>0.70), while discriminant validity was evaluated using Fornell–Larcker criteria. The model is declared feasible if all criteria for validity and reliability are met

The relationship between variables in this study can be explained through the following conceptual framework:

Figure 1.
Conceptual Framework

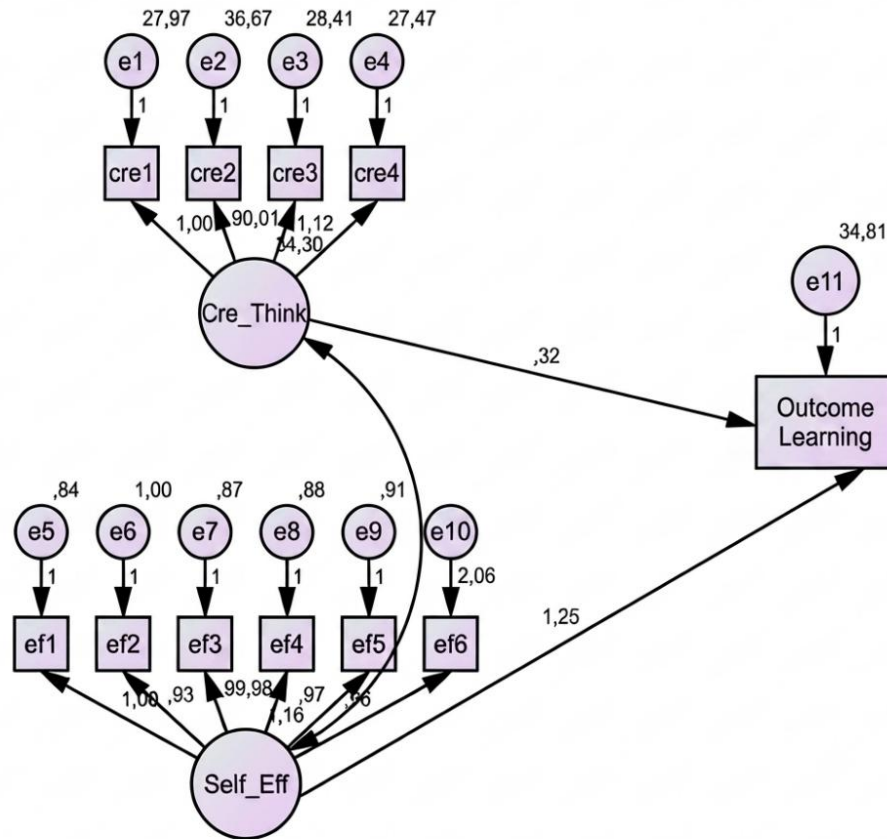


The conceptual framework as shown in Figure 1 places *self-efficacy* and creative thinking ability as exogenous variables that are thought to have a direct influence on mathematical achievement as endogenous variables. The Structural Equation Modeling (SEM) approach assisted by the IBM SPSS AMOS software was used to determine the strength and significance of the influence of each variable. Some of the stages carried out in data analysis techniques are descriptive statistical analysis, SEM assumption test, *measurement model testing*, and *structural model testing*. Before testing the model, a *multivariate normality test* was carried out based on the critical ratio (CR) values of skewness and kurtosis as well as the detection of *multivariate outliers* using *Mahalanobis Distance*. Several suitability indices such as Chi-Square, CMIN/DF, CFI, TLI, and RMSEA are used to evaluate the feasibility of the model. Through *path coefficient analysis*, the hypothesis is declared acceptable if the probability value (p-value) is less than 0.05 which indicates that the influence between variables is statistically significant. This shows that *self-efficacy* and creative thinking skills affect math achievement.

3. Result and Discussion

The Confirmatory Factor Analysis (CFA) approach, supported by the IBM SPSS AMOS software, was used to test the measurement model in order to check the validity of each research variable's latent construct. Self-efficacy is measured using six indicators, while creative thinking ability is measured using four indicators. All the indicators are stated to be valid in representing the latent construct found in the research. This is shown by all indicators that have a standard factor loading value above the minimum threshold of 0.50..

Figure 2.
Output Confirmatory Factor Analysis (CFA) Research Model



So, the measurement model is considered ready to continue testing the structural model. The analysis results indicate that all indicators adequately represent the latent constructs, indicating that the measurement model is valid and appropriate for subsequent structural analysis. This shows that the research instrument is able to validly measure the construct of self-efficacy and creative thinking ability, so that it is ready to be used for the next part of the analysis. After the measurement model is declared valid, the next stage is to evaluate the feasibility of the model (*goodness of fit*) to determine the level of suitability of the research model with empirical data. The test results show that the developed model performs well in terms of consistency.

Table 1.*Goodness of Fit Mode Test Results*

Goodness of Fit Index	Cut-off Value	Empirical Result	Remark
Probability	> 0.05	0.325	Fit
CMIN/DF	< 2.00	1.086	Fit
GFI	> 0.90	0.955	Fit
AGFI	> 0.90	0.929	Fit
CFI	> 0.90	0.995	Fit
TLI	> 0.90	0.994	Fit
RMSEA	< 0.08	0.022	Fit

Based on Table 1, all conformity indices show that the research model has met the eligibility criteria. A CMIN/DF value of 1.086 indicates that this model has an excellent fit rate. CFI and TLI values close to 1 indicate that this structural model has a good ability to explain the relationships between research variables. In addition, an RMSEA value of 0.022 also indicates a low model estimation error rate, which indicates that the model meets the eligibility criteria for use in hypothesis testing. The analysis of path coefficients in structural models is used to test the research hypothesis and identify the direct influence between the research variables.

Table 2.*Hypothesis Testing Results*

Relationship Between Variables	Estimate	C.R.	P	Remark
Creative Thinking Ability → Learning Outcomes	0.324	3.151	0.002	Significant
Self-Efficacy → Learning Outcomes	1.247	2.328	0.02	Significant

Based on Table 2, creative thinking skills have been shown to have a positive and significant influence on achievement in mathematics. This shows that students who have good creative thinking skills tend to be able to solve mathematical problems more effectively so that they obtain more optimal learning outcomes. They are able to generate ideas or strategies to solve problems flexibly, innovatively, and effectively. This influence can be explained because creative thinking skills encourage students to produce various alternative solution strategies, choose the most appropriate solutions, and adjust strategies when facing different problems. In mathematics learning, this ability helps students understand concepts more deeply so that they not only memorize procedures, but also be able to apply them to varied situations. These findings are supported by (Rizkayati et al., 2024) and (Marzuki1 et al., 2020) who explain that creative thinking skills have a positive correlation with success in learning mathematics.

In addition, the results of the analysis show that self-efficacy also has a positive and significant influence on achievement in mathematics. Theoretically, students who have high self-efficacy will set higher learning goals, show perseverance when facing difficulties, and view failure as part of the learning process. This condition affects the improvement of student learning outcomes, especially in the Two-Variable Linear Equation System (SPLDV) material. This is in line with the research of (Özcan & Kültür, 2021) and (Hermanto, 2024) who stated that self-efficacy has a positive and significant relationship with achievement in mathematics.

In addition to the direct influence on mathematics learning outcomes, the results of the model analysis also showed a positive correlation between self-efficacy and students' creative thinking skills. This is shown by the standard estimated value of 0.206 with a probability value of 0.020 ($p < 0.05$), so that the relationship between variables is statistically significant. These findings show that the higher the self-efficacy of students, the higher their creative thinking skills. This happens because confidence in one's own abilities encourages students to be more courageous in expressing ideas, trying various solution strategies, and persevering when facing difficulties. This condition provides an opportunity for students to explore various alternative solutions so that creative thinking skills develop optimally. This is in line with research by (Herianto et al., 2024) which revealed that self-efficacy contributes to the development of students' creative thinking skills. The results of this study also reinforce the findings of (Umam et al., 2023) that self-efficacy plays a role in improving mathematical creative thinking skills and learning achievement through interrelated structural relationships. Thus, students' mathematics learning achievement is influenced by both self-efficacy and creative thinking skills.

4. Conclusion

The integration of cognitive and psychological factors, namely self-efficacy and creative thinking skills, has been shown to play an important role in improving students' mathematics learning achievement. The results of the study show that these two variables have a positive and significant influence on mathematics achievement so that they need to be considered in learning design. Therefore, mathematics teachers are encouraged to design learning activities that promote students' active participation, strengthen their self-efficacy, and provide opportunities to explore diverse problem-solving strategies in order to foster creative thinking skills and improve mathematics learning achievement.

This research has limitations because it only involves students from one vocational school with the material of the Two-Variable Linear Equation System (SPLDV), so that the results of the research cannot be generalized to the educational level and other mathematical materials. Further research is suggested to involve a wider sample, test different math material, and consider other variables, such as learning interests and the use of digital technology, that have the potential to affect math learning achievement.

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