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The Effects of STEM Learning Model and Self-efficacy on Students' Learning Outcome

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Abstract: The purpose of this study is to examine if and how students' sense of self-efficacy correlates with their performance in STEM-related courses. Descriptive verification is the primary research strategy used in this quantitative investigation. All of the students from Banten Health Polytechnic took part in this study. A random sample strategy was used in this study. The sample size for this study was 100 students. Information was gathered via questionnaires for this investigation. Descriptive statistics and inferential statistics, namely PATH analysis with Smart PLS 3.0 software, are used in this investigation. Student learning outcomes were found to be affected by the STEM learning model ($p<0.05$), self-efficacy was found to be affected by the STEM learning model ($p<0.05$), and the STEM learning model was found to be affected by the self-efficacy of its students ($p<0.05$). It is hoped that further study would yield a STEM education approach that will enable all kids to flourish.

Keywords: Learning Outcomes, Self-efficacy, STEM

A. Introduction

Education researchers have long been interested in the correlation between exposure to STEM subjects in the classroom and positive academic outcomes for students. However, there is no single definition of STEM education (Baran et al., 2016; Bybee, 2013; Hsu et al., 2017; Wahono et al., 2020). Learning outcomes are the results of teaching and studying, and they can be either cognitive, emotional, or psychomotor (Hidayat & Suryadi, 2023; Novita & Sundari, 2020).

Teacher management of the learning process is very important to achieve learning outcomes that focus on social communication exchanges. The importance of creative and innovative methods in learning is emphasized (Lai et al., 2018). Teachers are at the forefront of education, and as such, they are responsible for developing and implementing lesson plans, assessing students' progress towards learning goals, and reflecting on the effectiveness of their teaching. Likewise, a teacher needs skills to choose an effective learning model for his students, considering that they all have unique qualities (Tjabolo & Herwin, 2020). Today, STEM education has become one of the most popular pedagogical approaches. The goal of STEM education is to equip students with the knowledge and abilities to apply scientific, technological, mathematical, and engineering principles to the solution of real-world issues. Indeed, STEM programmes place a premium on practical training (Yıldırım & Sidekli, 2018).

Students are encouraged to explore ill-defined tasks that make use of STEM in a constrained context. It is widely agreed that effective STEM education must include student-cantered approaches, hands-on activities, and the encouragement of teamwork, team communication, knowledge expansion, and formative assessment. Exposure to STEM subjects can increase students' self. The confidence gained by participation in STEM-related activities is invaluable. Students should develop a growth mindset by viewing their homework as a challenge, and then working diligently to complete it by using their analytical and problem-solving skills (Samsudin et al., 2020). Students who believe in their own abilities to do tasks successfully have high self-efficacy (Jamali et al., 2015). Students who believe in their own abilities are more likely to keep working until they succeed. The belief in one's own abilities is also a key indicator of academic success (Doordinejad & Afshar, 2014).

Observations conducted by researchers at the Banten Health Polytechnic revealed that students still lacked confidence in conducting practical learning and struggled to complete practical assignments assigned by instructors in all courses, resulting in poor student learning outcomes. This study investigates the relationship between the STEM learning model and student learning outcomes. The STEM learning model and student self-efficacy are intended to improve student learning outcomes. Previous research has demonstrated the significant impact that a mastery-based approach to STEM education may have on students' outcomes (Çevik & Bakioğlu, 2022). Students who are already proficient in English tend to have higher self-efficacy scores, and this correlation is statistically significant (Chen, 2020).

This research aims to clarify the connection between STEM learning model and self-efficacy on student learning outcomes. This research differs from previous studies in that it exploits the STEM learning model and student self-efficacy to enhance student learning outcomes. Consequently, this study is aimed at addressing the following issues:

1. Does the STEM learning model affect the learning outcomes of students?
2. Does student self-efficacy have any influence on student learning outcomes?
3. Does the STEM learning model and student self-efficacy effect on students learning outcomes?

B. Methods

This study uses a quantitative method. All participants in this research were students at Banten Health Polytechnic. In this investigation, sampling was conducted via random sampling. The sample size for this study is one hundred students. The first independent variable in this study is the STEM learning model (X1), which consists of four indicators (Torlakson, 2014), (1) representative science regarding the laws and concepts that apply to nature; (2) technology is a skill or system used in managing society, organization, knowledge, or designing and using an artificial tool that can facilitate work; (3) engineering or engineering is the knowledge to operate or design a procedure to solve a problem; and (4) mathematics is the knowledge to operate or design a procedure to solve a mathematical problem. If incorporated into the learning process, each of these components can make knowledge more meaningful.

This study's second independent variable is self-efficacy (X2), which is comprised of four indicators (Lunenburg, 2011), (1) achievement of accomplishment. Because it is founded on authentic experience, the experience of accomplishment is the most influential factor on an individual's sense of self-efficacy. Success increases a person's self-efficacy, whereas repeated failure decreases self-efficacy. (2) The experiences of others, including Similarly, an individual's self-efficacy in a given field will increase after observing the success of others in the same field. Individuals persuade themselves by asserting that other people have accomplished the task satisfactorily. (3) Verbal persuasion, specifically verbal persuasion, is used to persuade individuals that they are capable of achieving their goals. Existing in this dimension are the teacher's attitude and communication towards the students. (4) Physiological state influences, in part, an individual's perception of his capacity to perform a task. Individuals' emotional turmoil and physiological states serve as a precursor to the occurrence of something undesirable, so stressful situations are generally avoided. The dependent variable (Y) is the learning outcomes, which include intellectual skills, cognitive strategies, attitudes, verbal knowledge, and motor skills (Nasution, 2018).

For this study, a questionnaire was employed for data collection. Researchers often use questionnaires to get information and data from participants. Information for this study was gathered with the help of a Likert scale. Respondents are asked to assess their level of agreement from one to five on a Likert scale. To facilitate a range of responses to numerous questions, the Likert scale was developed. A 5-point Likert scale was used in this analysis. Descriptive statistics and inferential statistics, specifically PATH analysis with Smart PLS 3.0 software, are used to examine the data in this study. Researchers examine not only how much of an impact X1 has on Y or X2 has on Y, but also how much of an impact X1 has on Y that is mediated by X2 (indirect effect). The overall structure of the analytical model is shown in Figure 1. Validity and reliability indicators for each latent variable are calculated during the administration of the test. The least reliability value that can be accepted is r = 0.300. Items on an instrument are declared invalid if their total correlation score is below 0.300 (Sugiyono, 2022). In the meantime, testing for dependability was conducted using the split-half method. The more consistent an instrument is, the higher the reliability coefficient of its linked variables needs to be (above 0.700 or 70%) (Wibisono, 2022).

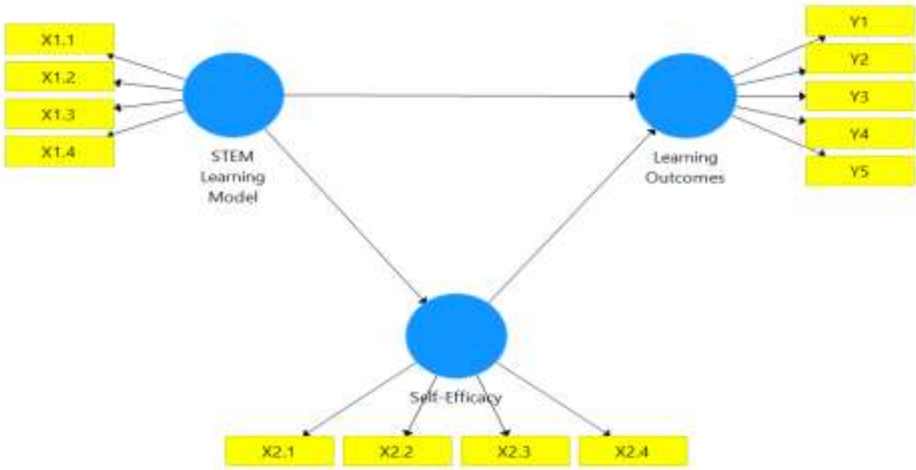

Figure 1. Theoretical Research Framework Model

C. Results and Discussion

During instrument testing, researchers check the validity and reliability of the indicators researchers employ to rate each hidden variable. The minimum validity threshold is R = 0.300. In other words, the instrument's components are deemed invalid if their correlation is less than or equal to 0.300 (Sugiyono, 2022). The split-half method was also used during this time period to assess reliability. If the coefficient of reliability for a given instrument variable is more than 0.700, we say the variable may be relied upon, and the greater the dependability, the more consistent the instrument (Wibisono, 2022). Table 1. lays out the specifics of the instrument's validity and reliability.

Table 1. Validity and Reliability Analysis Results

Item	STEM		Self-Efficacy		Learning outcomes	
	Validity	Reliability	Validity	Reliability	Validity	Reliability
1	0,650		0,660		0,672	
2	0,817		0,742		0,744	
3	0,536		0,686		0,600	
4	0,741	0,777	0,686		0,829	0,793
5	0,459		0,551	0,746	0,853	
6	0,578		0,536		0,810	
7	0,527		0,586		0,787	
8	0,442		0,613		0,751	
9	0,479		0,596		0,708	
10	0,671		0,553		0,695	
11	0,376		0,420		0,746	
12	0,224		0,369		0,579	
13	0,243		0,343		0,585	

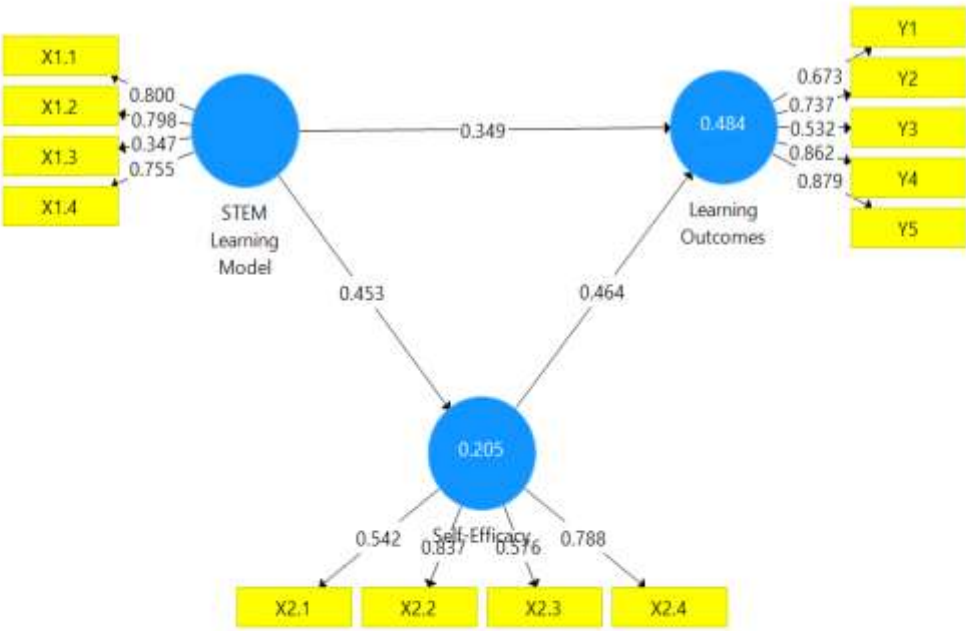

Figure 2. Path Analysis Model Path

Table 2. Test the Significance of Direct and Indirect Effects

Variable	Kind of effects	Mean	Standard deviation	T Statistic	p
X1→Y	Direct	0.358	0.099	3.534	0.000
X2→Y		0.470	0.083	5.478	0.000
X1→X2→Y	Indirect	0.461	0.084	5.506	0.000

The validity of the STEM learning model and self-efficacy on student learning outcomes is greater than the crucial value (r = 0.195), as shown in Table 1. The Cronbach's alpha value used to determine the reliability is also quite high. The applied instrument thus appears to be legitimate and reliable according to the predetermined standards. The next step, following the validity and reliability analysis of the instrument, is to do a path analysis using the framework model presented in Figure 1. The theoretical connection between the variables is depicted here using a graph. Using the path coefficient value, smart PLS version 3.0 calculates the path test. Figure 2 shows how strongly several constructions or variables are related to one another. Path coefficients characterise these relationships.

Table 3. demonstrates that X1 has a substantial direct effect ($p<0.05$) on Y. The manner in which students learn the STEM model has a significant impact on their learning outcomes. STEM education positively affects critical thinking skills, particularly the "truth-seeking and open-mindedness" subscale. In other words, the STEM activities utilised in this study increased students' critical thinking dispositions (Hacioglu & Gulhan, 2021). STEM education is essential for students to acquire 21st century abilities such as problem-solving, innovation, creativity, communication, and collaboration (Cooper & Heaverlo, 2013; Sari et al., 2020). Students in STEM education pursue solutions to real-world problems. Real-world problems are interdisciplinary and cannot be solved with the knowledge and skills of a single discipline. Therefore, in order to solve this problem, students must employ an interdisciplinary approach to knowledge and skills from various disciplines, based on the essence of the problem (Wang et al., 2011). The indirect effect of self-efficacy on student learning outcomes is illustrated in Table 3. This indirect effect has a significant statistical impact ($p< 0.05$). Self-efficacy mediates the relationship between the STEM learning model and student learning outcomes. This is corroborated (Samsudin et al., 2020) STEM Method to Improve Students' Ability to Solve Problems.

D. Conclusion

The study and debate lead us to the conclusion that the STEM learning model and student self-efficacy significantly impact students' ability to learn. The STEM learning model, combined with high levels of student self-efficacy, can be used to provide better academic outcomes for students. This squares with the fact that a person's physiological state and, to some extent, their own estimation of their own abilities both have a role in their performance. Stressful circumstances are typically avoided since they tend to predispose individuals to mental and physiological states that can lead to negative outcomes. Few STEM indicators, student self-efficacy, and learning outcomes have been studied so far.

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