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The Relationship between Academic Self-Efficacy and Cognitive Learning Outcomes of High School Students in Biology Subjects through Problem-Based Learning Model

Gamar Shamdas[1]

[1] Department of MIPA Education, Faculty of Teacher Training and Education, Tadulako University, Palu, Indonesia.

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Corresponding Author:
Gamar Shamdas
gamar.shamdas@gmail.com

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Abstract: Self-efficacy in the classroom is the belief that one can successfully complete any academic task.. Pre-experimental research with a quantitative approach aims to describe the connection between secondary school understudy's academic self-efficacy and cognitive learning outcomes in biology lessons and to describe gender associations with academic self-efficacy. The One-Shot Case Study research design was carried out in a high school in Palu City for Class XI students, a population of 7 classes totaling 200 students. One class sample consists of 32 students, determined completely randomly. Academic self-efficacy data were acquired through questionnaires, and outcomes of cognitive learning from multiple-choice tests. Information investigation of the connection between academic self-efficacy and cognitive learning outcomes used a simple linear regression test. The association of gender with academic self-efficacy used the Point-Bivariate Correlation test. The result of the research is that there is a relationship between academic self-efficacy and cognitive learning outcomes, and students' cognitive learning outcomes can be predicted through the regression equation y = 25.651 + 1.733x, meaning that an increase in academic self-efficacy scores of 1 point will increase students' cognitive learning outcomes scores of 1.733. Gender significantly correlates with academic self-efficacy, r = 0.841, p = 0.001. This means that the closeness of the gender relationship with the academic self-efficacy of high school students is in the very strong category at 1% significance.

Keywords: Academic achievement; Academic self-efficacy; Cognitive learning outcomes; Gender

Introduction

Cognitive and noncognitive aspects influence student academic success. Self-efficacy is a cognitive predictor (Stankov, 2013), and noncognitive (Jung et al., 2017) is defined as a person's perception and belief in his ability to organize, carry out and complete certain tasks needed to achieve a goal (Bandura, 1989; Capron Puozzo & Audrin, 2021). These beliefs are multilevel and multifaceted that influence a person to feel, think, motivate himself, and behave in various tasks (Dishman et al., 2005; Tsang et al., 2012) as well as playing an important role in student motivation in activities, effort and persistence and emotional reactions in the independent learning process which can mediate academic achievement (Zimmerman, 2000). In addition, self-efficacy also influences student enthusiasm and the frequency of participating in discussions (Mahler et al., 2017) and daring to make changes and make decisions (Alfayez, 2022; Duffy et al., 2015). Academic self-efficacy includes learning skills, time management, critical and creative thinking, and involvement in learning (Yuen & Datu, 2021).

Each student has different academic self-efficacy. Students who have high self-efficacy demonstrate the ability to encourage and self-regulate, can survive in the face of difficulties (Komarraju & Nadler, 2013), and can solve problems complex problems (Ahmad & Safaria,

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2013), and have responsibility for mastering skills and experience (Bryant, 2017), so they often use many strategies in learning (Siew & Wong, 2016). In addition, they also tend to perform well academically because they are more confident, perform better, are not afraid to face new challenges, work easily with others, are less anxious, and suffer less stress (Siriparp, 2015). The characteristics of students with high self-efficacy are supported by Bandura's theory (Bandura, 1997) that those with high self-efficacy expectations tend to be able to achieve what they do in a healthier, more effective, and more successful manner because they can direct themselves through control. On their thought processes, motivations and actions, have greater goals for themselves, demonstrate greater strategic adaptability in finding arrangements, accomplish higher scholarly performance, and are more precise in determining the level of quality performance. This specific component of academic self-efficacy causes the way students think and act from one another to be different.

Vasile et al. (2011) explained that academic self-efficacy could be implemented through feelings and actions. Therefore academic self-efficacy can moderate the connection between cognitive interest and test dread (Lei et al., 2021; Nie et al., 2011), mediate past learning experiences and current learning engagement (Chen et al., 2022), mediates between resilience and student academic achievement (Supervía et al., 2022), predicts academic motivation (Ahmadi et al., 2021) and predicts academic performance (Schunk, 2016; Shane-Simpson et al., 2022). One part of academic performance is cognitive learning outcomes, namely the level of students' ability to understand and manage the knowledge obtained and store it in their memory. Although cognitive learning outcomes are inseparable from the involvement of their level of self-efficacy, these learning outcomes need serious attention, especially from external factors that can trigger their cognitive activity. Students need to be conditioned in quality learning related to their daily living environment to create fun learning that makes it easy for them to understand concepts. This learning can be realized by applying innovative learning models that can move students to be more creative (Chang et al., 2021; Mierdel & Bogner, 2019; Tsai et al., 2015) and trigger active students (Kwangmuang et al., 2021; S.Shieh, 2012; Shala & Shatri, 2022) motivate students in learning (Ardhaoui et al., 2021; Mendoza et al., 2023) and increase their academic self-efficacy (Mulyadi et al., 2016).

The problem-based learning model (PBL) is a novel method of learning that has the potential to generate academic self-efficacy and improve students' cognitive learning outcomes because the specific strategies used in PBL can involve students in complex, open, and thematic real-world problems that have the potential to stimulate students to be actively involved in learning. Facilitating students to awaken their ability to solve problems, empowering them to think critically and creatively as well as negotiating and collaborating in groups to make decisions (Amena, 2021) and this situation becomes integrated as a catalyst to increase student self-efficacy (Dunlap, 2005). The effectiveness of PBL in learning has been informed by many different results, as reported by several studies, namely PBL affected the interest of science teachers and 6th-grade students at a school in Indiana (Ottenbreit-Leftwich et al., 2021), increased learning achievement, problem-solving skills and classroom interaction among university students in the eastern province of Turkey (Aslan, 2021), improving the learning process of students at two comprehensive universities (UWO and UW-L), USA (Wallace et al., 2020) improve the communication skills of high school students (Shamdas et al., 2023), have a significant effect on student self-regulated learning (Shamdas, 2023) and enhancing metacognitive abilities in solving problems in class VIII students of West Mataram City MTs, Indonesia (Sutarto et al., 2022).

PBL learning has also been implemented in schools in Palu, Central Sulawesi, Indonesia. Still, there has been no report on the connection between academic self-efficacy and outcomes of high school students' cognitive learning in Biology. Therefore it is important to conduct research on academic self-efficacy and mental learning results of secondary school understudies in biology through PBL learning because the consequences of this research can offer information regarding the benefits of the PBL learning model related to students' belief in academic abilities, especially cognitive learning outcomes. In addition, the findings obtained can be used as a basis for development research in Biology learning. The results can also be used by teachers in designing Biology lessons that can generate interest and motivation in student learning. Therefore, the study's objective was to the connection between high school student's academic self-efficacy and cognitive learning outcomes in biology lessons through PBL learning and the associations of gender with academic self-efficacy.

Method

The pre-experimental study used a One-Shot Case Study design with a quantitative approach. One-Shot Case Study is a design that involves the exposure of a group to a treatment followed by measurement. At the same time, the quantitative approach is a set of propositions or hypotheses about the relationship between variables made up of constructs or variables

(Creswell, 2014). The independent variable in this study is academic self-efficacy, and the dependent variable is cognitive learning outcomes.

The research was conducted at a high school in Palu City for Class XI students. The population is all Class XI totaling 7 classes with 200 students. The sample used one class of 32 students who were treated with the Problem-Based Learning (PBL) model. The determination of the sample is completely random, assuming that all population members have the same opportunity to be sampled.

Learning uses the PBL model by applying the five stages of PBL adopted by Arends (2012). The conclusion of the learning series, students were given a cognitive learning results test which contained 10 various decision questions, and an academic self-efficacy questionnaire containing 10 statement items developed and modified from five indicators of academic self-efficacy by Van Zyl et al. (2022). All instruments were validated internally by two senior lecturers who are experts in educational evaluation at the FKIP Tadulako University, Biology Education Study Program, Indonesia. The analysis results show that 10 statement items on the questionnaire instrument and 10 item numbers on the test instrument are included in the valid criteria. In addition, all the questionnaire's items were scored on a 5-point Likert scale from strongly disagree to strongly agree.

Analysis of data on the connection between academic self-efficacy and cognitive learning outcomes used a simple linear regression test and gender association data with academic self-efficacy using the Point-Bivariate Correlation test. All data were analyzed using SPPS version 25.0. The research scheme is shown in Figure 1.

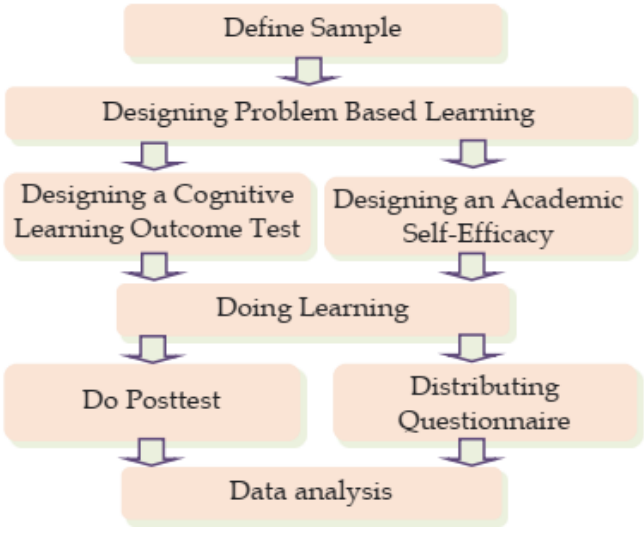

Figure 1. Research scheme

Result and Discussion

The results and discussion of academic self-efficacy and cognitive learning outcomes in Biology are presented following the pattern of (a) the relationship between academic self-efficacy and cognitive learning outcomes and (b) gender associations with academic self-efficacy.

There's a connection between academic self-efficacy and outcomes of high school students' cognitive learning in Biology. The outcomes of the data normality analysis are presented in Table 1, the Simple Linear Regression analysis results are introduced in Table 2, and the outcomes of the Regression Coefficient Analysis are shown in Table 3.

Relationship between Academic Self-Efficacy and Cognitive Learning Outcomes

Table 1. Results of Data Normality Analysis

Tests of Normality

		Statistic	df	Sig.
Unstandardized Residual	Kolmogorov-Smirnov[a]	.138	32	.129
	Shapiro-Wilk	.961	32	.296

a. Correction of Lilliefor's Significance

The Shapiro-Wilk test and the Kolmogorov-Smirnov test both found normal distribution of the residual data $D(32) = 0.138$, $p = 0.129$ and [$W(32) = 0.961$, $p = 0.296$].

Table 2. Results of a Simple Linear Regression Analysis

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	853.963	1	853.963	69.704	.000
	Residual	367.537	30	12.251		
	Total	1221.500	31			

Model Summary

Model	R	R Square	Adjusted R Square	Std. An error in the Estimate	Durbin-Watson
1	0.836	0.699	0.689	3.50018	.848

A simple linear regression test (Table 2) was performed to predict students' cognitive learning outcomes based on their academic self-efficacy scores. A significant regression equation was obtained [$F(1.30) = 69.704$ $p < 0.001$], with $R^2 = 0.699$. The obtained results show that there is a connection between academic self-efficacy and cognitive learning outcomes of students in Biology through PBL learning. The role of a fun learning process that triggers students to be active in teaching and learning activities helps students strengthen their

confidence in learning. Real problems are used as the basis for learning in the PBL model, followed by communication and collaboration with friends in groups to explore problems and look for causes and solutions to problems causing students to easily understand the concepts being studied so that knowledge that is firmly embedded in the minds of students makes them more confident. With academic ability. This finding is supported by Bandura's (Bandura, 1997) explanation that human accomplishment relies upon the communication between between behavior, individual elements, and ecological circumstances, allowing them to assess their self-efficacy from actual appearance, experience, the influence of others and their physiological reactions. In addition, students with a strong sense of self-efficacy tend to be involved in challenging tasks, are more diligent and more involved in the effort, and show excellent academic performance compared to students who lack self-confidence (Bong, 2010). This finding is in accordance with the consequences of different examinations which report that academic self-efficacy is significant relationship with academic success (Adeyemo, 2016; Carroll et al., 2009; Elias et al., 2009; Honicke & Broadbent, 2016; Manzano-Sanchez et al., 2018; Meral et al., 2012; Motlagh et al., 2011), academic self-efficacy has a significant positive impact on student learning engagement (Wu & Ma, 2022), and academic self-efficacy is a better agent and predictor of academic success (Ferla et al., 2009; Shams et al., 2011). This finding is corroborated by the outcomes of the regression coefficient analysis, as depicted in Table 3.

Table 3. Regression Coefficient Analysis Results

Coefficients						
Model		Unstandardized Coefficients		Standardize Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	25.651	6.405		4.005	.000
	Academic Self-Efficacy	1.733	.208	.836	8.349	.000

a. Dependent Variable: Cognitive Learning Outcomes

The data in Table 3 informs that students' cognitive learning outcomes can be predicted using the regression equation y = 25.651 + 1.733x. The regression coefficient (B = 1.733) indicates that an increase in the academic self-efficacy score of 1 point will increase the score of students' cognitive learning outcomes by 1.733.

Prior knowledge, experience, and skills possessed by students have strengthened their confidence and confidence to complete each academic task successfully. This is supported by Wahab's explanation (Wahab, 2010) that self-efficacy encourages a person to formulate specific learning strategies to expedite his cognitive processes, behavioral activities, and emotions which can facilitate self-management to achieve the desired results. This finding corresponds to the results of other research that self-efficacy beliefs significantly increase the achievement of learning outcomes (Yusuf, 2011) and self-efficacy has a positive relationship and is an indicator in deciding scholarly accomplishment as indicated by every increase in academic self-efficacy will be accompanied by an increase academic achievement (Basith et al., 2020).

Association of Gender with Academic Self-Efficacy

Gender has a significant relationship with students' academic self-efficacy. The aftereffects of the information ordinariness examination are introduced in Table 4 and the consequences of the Point-Biserial connection test examination are displayed in Table 5.

Table 4. Results of Data Normality Analysis

Tests of Normality							
Gender		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Man	Academic Self-Efficacy	.213	11	.176	.934	11	.449
Woman	Academic Self-Efficacy	.162	21	.155	.944	21	.259

*. This is the true significance's lower bound
a. Lilliefors Importance Rectification

The aftereffects of the Shapiro-Wilk test and the Kolmogorov-Smirnov test inform that the academic self-efficacy data for men and women are normally distributed, namely the results of the Kolmogorov-Smirnov test for men are [D(11) = 0.213, p = 0.176] and for women [D (21) = 0.162, p = 0.155] while the results of the Shapiro-Wilk test for men were [W(11) = 0.934, p = 0.449] and for women [W(21) = 0.944, p = 0.259].

Table 5. Results of Point-Biserial correlation test analysis

Correlations			
		Gender	Academic Self-Efficacy
Gender	Pearson Correlation	1	.841**
	Sig. (2-tailed)		.000
	N	32	32
Academic Self-Efficacy	Pearson Correlation	.841**	1
	Sig. (2-tailed)	.000	
	N	32	32

**. Correlation is significant at the 0.01 level (2-tailed).

The consequences of the Point-Biserial correlation test show that gender has a significant relationship with students' academic self-efficacy, r = 0.841, p = 0.001, N =

32. The aftereffects of this review are supported by the opinion of Pajares et al. (2007) that self-efficacy is one of the determinants of success in learning for male and female students because this belief will help determine what can be done with the knowledge and skills they have. Even this finding has similarities with the results of other studies, which report that there is a significant positive relationship between self-efficacy and academic achievement between male and female students, although anxiety is greater in female students than male students (Mohammadyari, 2012), there is a correlation between female as well as male students enrolled in classes VIII A and VIII B's attitudes and self-efficacy toward science subjects (Ernawati et al., 2021).

Conclusion

In this study, academic self-efficacy and results of secondary school understudies' cognitive learning in Biology subject through a problem-based learning model were studied. The consequences of the review show that a exists relationship between academic self-efficacy and students' cognitive learning outcomes in Biology through PBL learning. Students' cognitive learning outcomes can be predicted using the regression equation y = 25.651 + 1.733x. The regression coefficient (B = 1.733) means an increase in self-efficacy score academic score of 1 point will increase the score of students' cognitive learning outcomes by 1.733. In addition, gender has a significant relationship with students' academic self-efficacy, r = 0.841, p = 0.001. This means that the closeness of the gender relationship with the academic self-efficacy of high school students is in the very strong category at 1% significance.

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Author Contributions
The role of the author in this study is the owner of the idea, designer and research implementer.

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Conflicts of Interest
The author declares no conflict of interest.

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