Investigating the Correlation Between Scientific Literacy and Self-Efficacy in Pre-Service Science Education Teachers

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Abstract. This study investigates the correlation between self-efficacy and scientific literacy among pre-service science education teachers. Scientific literacy is a core competency in science education, essential for promoting informed decision-making in a democratic society. Self-efficacy, a component of student agency, has been suggested to support scientific literacy by fostering resilience and engagement in student-centered learning. This quantitative study employed a correlational research design with a sample of 25 third-year pre-service science teachers from Universitas Lambung Mangkurat. Data were collected through a 20-item scientific literacy test and a 20-item self-efficacy questionnaire, each using a 5-point Likert scale. Analysis using Spearman's rank correlation showed a statistically significant but weak positive correlation between self-efficacy and scientific literacy ($\rho = 0.351$, $p = 0.042$). This finding aligns with some existing research but highlights inconsistencies in prior studies on the relationship between self-efficacy and scientific literacy. Further research with broader samples is needed to clarify this relationship.

Keywords: scientific literacy, self-efficacy, pre-service teachers, science education, correlational research design

1 Introduction

Scientific literacy has become the focus of science education in the world, especially in the last two decades. This trend might have been driven by PISA, the OECD's four-year assessment on 15 years old students' competences, which includes scientific literacy. The interest in scientific literacy could be attributed to the importance of having scientifically literate citizen in a democratic society [1], [2] including in making personal, or collective decision toward achieving the sustainable development goals [3]. According to PISA's 2015 scientific literacy framework, there were three competences of scientifically literate person: 1) explain phenomena scientifically, 2) evaluate and design scientific enquiry, and 3) interpret data and evidence scientifically [4]. For these competences, only 34% of Indonesian students from the PISA sample who can attain Level 2 or higher (OECD average: 76%) [5]. This means that more than half of Indonesian students are having

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difficulties in recognizing the correct explanation for familiar scientific phenomena nor using the knowledge to identify, whether a conclusion is valid based on the data provided.

Understanding what might be related to students' scientific literacy is imperative to improve this situation. Recent research on scientific literacy mostly discussed scientific knowledge, skill and the teaching models used to improve scientific literacy. Studies have been conducted to investigate what might affect students' scientific literacy such as developing a certain teaching approach or relevant learning materials [6], [7], [8]. Other than that, previous study based on PISA's result reported that students' attitude, specifically students' general interest in science positively related to students' scientific literacy [9]. Besides that, other studies found that attitude towards learning outcomes and learning activities are positively correlated with scientific literacy skills [10]. Another study by Bakar reported that motivation and self-efficacy, attitude toward science, constructivist learning environment could affect students' scientific literacy [11].

Moreover, research that seeks to find what could affect scientific literacy during learning activities found that teaching models such as inquiry-based learning and problem-based learning were able to improve students' scientific literacy [12], [13], [14]. These models were student-centered models, where students are expected to be an autonomous learner who can navigate their own learning. However, for a student to be able to direct their own learning, the student would need to have agency: the ability to intentionally direct own life decision and to choose one reaction to it [15]. Human agency is exercised through several core human capacities, namely capability to generate new thoughts, capacity to think about the future, capacity of self-reaction, and capacity for reflective self-consciousness [16], [17].

The capacity for reflective self-consciousness. This is the capacity to examine own thoughts, feelings and actions to influence future thoughts and behaviors. This means someone should evaluate and judge oneself, including one's ability to achieve desired attainments. This is called self-efficacy, considered as one of the most influential aspects in capacity for reflective self-consciousness [17]. Previous study found that someone with higher self-efficacy tends to persevere when faced with difficulty, and able to think more positively. However, low self-efficacy tends to be more pessimistic and give up when facing issues [18].

It could be assumed that when someone with high self-efficacy is faced with scientific problem, if they have high self-efficacy, they could be expected to be more involved in student-centered learning, hence, have better scientific literacy performance compared to those with lesser self-efficacy. This study investigates whether there is a relationship between self-efficacy and scientific literacy. The result of this study could contribute to furthering the discussion on how to improve students' scientific literacy by considering factors other than the content of the school curricula.

2 Methods

This study employs quantitative research methodology with correlational research design. Two types of data were collected: (1) scientific literacy, assessed through 20 multiple-choice test questions, and (2) self-efficacy, measured using a 20-item questionnaire on a 5-point Likert scale. The participants in this study were 25 pre-service science education teachers in their third year of a four-year bachelor's program in the Faculty of Teacher Training and Education at Universitas

Lambung Mangkurat. Spearman's rank correlation analysis was conducted to analyze the data using IBM SPSS Statistics 25. This statistical analysis was used because the scientific literacy data were not normally distributed, hence the use of the non-parametric analysis.

3 Results and Discussion

The Spearman's rank analysis indicated a significant positive correlation between self-efficacy and scientific literacy among the 25 pre-service science education teachers, with a correlation coefficient of 0.351 ($p = 0.042$, one-tailed). This suggests that as teachers' self-efficacy increases, there is a tendency for their scientific literacy to increase as well, although the relationship is considered weak. However, the correlation is statistically significant, indicating that this association is unlikely to be due to random chance.

Table1. Correlation Between Scientific Literacy and Self-Efficacy Analyzed using Spearman Rank's Analysis using IBM SPSS Statistic 25

			Scientific literacy	**Self-efficacy**
Spearman's rho	Scientific literacy	Correlation Coefficient	1.000	.351*
		Sig. (1-tailed)	.	.042
		N	25	25
	Self-efficacy	Correlation Coefficient	.351*	1.000
		Sig. (1-tailed)	.042	.
		N	25	25

*. Correlation is significant at the 0.05 level (1-tailed).

Previous study on this topic has also reported similar results. A study by Latifah et al [19] reported that there is a strong correlation between self-efficacy and scientific literacy in prospective physics teachers. The study used Pearson correlation that is a stronger statistical test compared to Spearman's rank. However, the article did not report on the sample size nor whether the assumption of the data has been met. Another study on this topic has also been conducted by Juniarso et al. [20] on elementary school level. They reported that elementary school students' self-efficacy highly affects students' scientific literacy. Meanwhile another study by Arifiyyati et al [21] found that there is no relationship between self-efficacy and scientific literacy in high-school students during biology learning. These mixed results should be considered as basis for future research to explore further and in a more rigid way on the relationship between self-efficacy and scientific literacy.

4 Conclusions

Scientific literacy is necessary for democratic society. Educators need to understand what is necessary to foster scientific literacy. Recent research on scientific literacy mostly discussed scientific knowledge, skill and the teaching models used to improve scientific literacy. On the other

hand, less discussion was found on the affective aspects and other aspects that could accelerate the implementation of those models, such as students' agency, specifically on self-efficacy. This study found that a weak relationship between self-efficacy and scientific literacy can be found in pre-service science education teachers. This result contributes to the discourse on the relationship between scientific literacy and self-efficacy that still are not concluded, considering previous studies also reported mixed results, with varying methods and sampling. Further study on the relationship between scientific literacy and self-efficacy that reported larger and varied samples across educational levels is needed.

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