



Science Self-Efficacy (SSE) Relationship on Cognitive Learning Outcomes amongst The Ecology Concept

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ABSTRACT

Purpose of the study: Science Self-Efficacy (SSE) is important for students because it is directly related to their belief in their ability to learn and complete science tasks. Students with high SSE tend to be more confident, do not give up easily when faced with difficulties, and have greater motivation and involvement in the science learning process. This study aims to determine the effect of SSE on students' cognitive learning outcomes in the Ecology concept, focusing solely on identifying the relationship between these two variables.

Methodology: This research utilized a quantitative ex post facto correlational design with Simple Random Sampling. The instruments used were a 30-item Science Self-Efficacy (SSE) questionnaire and a cognitive learning test. Data were analyzed using descriptive statistics and Spearman's rank correlation in SPSS version 27 to determine relationships among variables.

Main Findings: The study revealed that students' Science Self-Efficacy (SSE) was predominantly categorized as High, with 60% of participants reaching this level. The Spearman correlation coefficient of 0.623 and the significance value of 0.001 indicated a positive, significant relationship between SSE and cognitive learning outcomes. These findings confirm that higher levels of SSE strongly contribute to improved cognitive performance in learning the Ecology concept.

Novelty/Originality of this study: This studies rarely examine Science Self-Efficacy (SSE) as a domain-specific construct related to higher-order cognitive outcomes in Ecology, its dimensions (magnitude, strength, and generality), or evidence from multicultural contexts such as Indonesian schools abroad.

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1. INTRODUCTION

Education plays an important role in advancing a nation's progress and success, especially in today's era of globalization. Based on the Law (UU) on the National Education System (*SISDIKNAS*) Number 20 of 2003, Article 1, Paragraph 1, which states that education is a conscious and planned effort that aims to create a learning environment that encourages students to be active in developing their potential [1]. The process includes strengthening spiritual values, self-control, and character development, as well as developing skills applicable to individuals, communities, nations, and countries [2]. Thus, education is the primary factor to be considered in supporting the development and progress of the Indonesian Nation.

To support the development and progress of the Nation, the Indonesian government has implemented this through the Independent Curriculum [3]. One subject in the Independent Curriculum that requires special attention is Natural Sciences. Natural Science learning can be defined as a field of science that studies nature and the phenomena that occur in it [4]. Natural Science learning serves as a basis for other disciplines and as a foundation for the application of science and technology [5]. Science teaching itself assesses student success based on the achievement of learning objectives, which is reflected in learning outcomes [6]. Learning outcomes serve as a benchmark for assessing the effectiveness of a learning implementation [7]. Learning outcomes are changes in student behavior that can be observed and measured through various indicators that are visible in real terms, namely, in the aspects of knowledge, attitudes, and skills [8]. One of them is learning outcomes in the cognitive realm, which focuses on intellectual aspects, such as knowledge and thinking skills [9]. The cognitive realm includes six main aspects, namely knowledge or memory, understanding, application, analysis, synthesis, and evaluation [10].

The achievement of cognitive learning outcomes depends not only on students' intellectual abilities but also on internal and external factors [11]. Internal factors include physiological aspects, intelligence, talents, interests, self-perception, motivation, and attitude [12]. Meanwhile, external factors are sourced from outside the student, such as the influence of family, school, and social environment [13]. These two factors play an important role in determining learning success. Thus, student learning outcomes are greatly influenced by students' ability to manage the learning process, including confidence in their ability to achieve learning goals [9]. In other words, the learning process must be supported by confidence in students' abilities [14]. Belief in the student's own abilities is called Self-efficacy. Self-efficacy is a person's belief in their ability to perform a specific task [15]. Self-efficacy can develop through observing others' successes in similar situations [16]. For example, when students see that their peers have completed a task or achieved high exam scores. So, Self-efficacy not only depends on the cognitive abilities of students, but also affects other psychological aspects that play a role in learning [13].

Science learning that requires Self-efficacy, the student's confidence in their ability to complete tasks or activities related to the field of Science learning, is called Science Self-Efficacy (SSE) [17]. Individuals with Science Self-Efficacy (SSE) are more likely to achieve better results and are more likely to achieve high achievement in science evaluation in the classroom [18]. This is because students will be better able to cope with difficulties, have aspirations, and be more actively involved in the science learning process [19]. One subject in the field of science that requires Science Self-Efficacy (SSE) is the Ecology concept. Ecology has abstract and concrete concepts, which can be accounted for through learning methods such as practicum and simulation [20]. Learning about Ecology concept plays an important role because, through Ecology concept education, students can be formed into individuals with environmental awareness, so that environmentally friendly behavior is achieved [21]. Learning objectives in the concept of Ecology can be achieved if students understand the concept of Ecology well, which is reflected in the improvement of learning outcomes [22].

Facts in the field show that, based on pre-research through observations on direct learning, and interviews with students of Sekolah Indonesia Jeddah (SIJ) in Jeddah, Kingdom of Saudi Arabia (KSA), especially grade VII Junior High School students in the 2024/2025 school year, it can be seen that students still look less confident in asking questions and tend to be incapable of answering questions from teachers. This relates to the results of interviews with several students, who stated that students are more likely to enjoy learning in a social context and are more often inclined to view science learning as "difficult" and not "for them". In this case, students at Sekolah Indonesia Jeddah (SIJ) face external factors, including diverse social backgrounds, varying cultures, languages, and prior learning experiences. Based on field findings, previous research also shows a relationship consistent with this research. Students with Self-efficacy have a percentage of 18.9% and 81.1% in influencing science learning outcomes [23]. The subsequent research states that the study's results show that Self-efficacy is positively related to post-test science learning outcomes, with an average effect size significantly greater than 0.23 ($p < 0.001$) [24]. Other previous research states that the influence of Self-efficacy on science learning outcomes is a good category at the student level [25].

Although previous studies have consistently reported a positive relationship between self-efficacy and science achievement, several critical gaps remain. First, limited research has specifically examined Science Self-Efficacy (SSE) as a domain-specific construct in relation to higher-order cognitive outcomes within the Ecology concept. Second, empirical evidence from multicultural educational settings, particularly in Indonesian schools abroad, remains scarce. Third, prior studies have rarely analyzed Science Self-Efficacy (SSE) dimensions (magnitude, strength, and generality) in relation to cognitive performance in complex ecological systems. Therefore, this study addresses these gaps by investigating the relationship between Science Self-Efficacy (SSE) and students' cognitive learning outcomes in Ecology within a multicultural educational context. Thus, this study focuses on further examining Science Self-Efficacy (SSE) in relation to students' cognitive learning outcomes, especially in science learning on the concept of Ecology.

2. RESEARCH METHOD

This research is a quantitative study using an ex-post facto design. Method ex-post facto with a research design in the form of a correlation test, which is a study of events that have occurred to identify factors that are suspected to be the cause or influence of the events being studied [26]. The variables in this study include two: the independent variable (X), Science Self-Efficacy (SSE), and the dependent variable (Y), students' cognitive learning outcomes. The following is an overview of the research design in Figure 1.



Figure 1. Research Design

The study population was Junior High School grade VII students at *Sekolah Indonesia Jeddah* (SIJ) in Jeddah, Kingdom of Saudi Arabia (KSA). Sampling was carried out using Simple random sampling, yielding a sample of 48 students from classes VII A and VII B. In this study, data collection techniques included test and non-test instruments. The non-test instrument was a questionnaire adapted from an instrument developed by Harpison [27], with a Cronbach's Alpha value of 0.7, which is classified as Very Good. Furthermore, the questionnaire instrument was adapted to the Science-task level of Secondary School and the Self-efficacy dimension by Bandura [28], that is, Magnitude (Level), Strength, and Generality. The questionnaire consisted of 30 questions, 15 positive and 15 negative, using a 4-point Likert scale. Here is the questionnaire grid Science Self-Efficacy (SSE) in Table 1.

Table 1. Excerpts of a *Science Self-Efficacy* (SSE) Questionnaire

Dimensi	Indicators	Samples of Questionnaire Item	Item Number	
			Positiv e	Negativ e
Magnit ude/ Level	Self-confidence in completing tasks and overcoming obstacles	I will definitely do every science assignment in the concept of Ecology given by the teacher.	1, 4, 5,	2, 3, 8, 9,
		I always have an idea to be able to do science assignments, especially in the concept of Ecology.	6,7, 11, 16	10, 14
Strength	Commitment to completing tasks consistently and not being easily discouraged	I always try to use other methods when I cannot find the answer to a science question.	13, 15,	12,1 8,
		I never procrastinate to do the science assignment of the Ecology concept given by the teacher.	17, 19, 22	20, 30
Generali ty	A positive attitude in facing different situations to achieve success	I did not give up before trying to do science questions, no matter how difficult they were.	24, 25,	21, 23,
		When my grades are good, I am more eager to study so that my grades are even better.	26, 28	27, 29
Total			15	15

The data collection technique on students' cognitive learning outcomes was obtained from an instrument consisting of 5 multiple-choice questions and five questions describing the concept of Ecology. The following is a grid of learning outcome tests in Table 2.

Table 2. Learning Outcome Test Guidelines

Learning Objectives	Question Indicator	Cognitive Level	Question Number
Students can <i>classify</i> abiotic and biotic factors (C3)	Presented with pictures, students can <i>classify</i> the biotic and abiotic factors they contain.	C3	1, 6
Students can <i>analyze</i> the influence of the biotic and abiotic environment on organisms (C4)	When presented with follow-up questions, students were able to <i>discern</i> the relationships between biotic and abiotic factors in the environment.	C4	7
	When presented with abiotic environmental	C5	2

Learning Objectives	Question Indicator	Cognitive Level	Question Number
Students can <i>analyze</i> the interaction of ecosystem components (C4)	change events, students can <i>evaluate</i> their impact on the ecosystem's balance. When presented with follow-up questions, students can <i>analyze</i> environmental conditions when only one biotic or abiotic factor is present.	C4	8
	Presented with an example of an interaction between organisms, students can <i>analyze</i> the types of symbiosis, including mutualism.	C4	3
	Presented with images, students can <i>analyze</i> the impact of population extinction on the food chain and the interactions among ecosystem components.	C4	9
Students can <i>structure</i> the food chain (C6)	Presented with advanced instructions, students were able to <i>design</i> the entire food chain of the forest ecosystem based on a video depicting forest destruction that led to animal extinction.	C6	10
Students can <i>classify</i> individual roles in the food chain (C3)	Presented with several organisms, students can <i>evaluate</i> the correct order of energy transfer.	C5	4
	Presented with an image, students can <i>classify</i> individual role organisms in the food chain	C3	5

Questionnaire data on Science Self-Efficacy (SSE) were analyzed and classified into five categories to facilitate data interpretation. Science Self-Efficacy (SSE) students who comply with the guidelines by Widoyoko [29] In Table 3.

Table 3. Science Self-Efficacy (SSE) Categorization Criteria Based On Intervals

Guidelines	Criteria
$X > 102$	Very High
$84 < X \leq 102$	High
$66 < X \leq 83$	Medium
$48 < X \leq 65$	Low
$0 < X \leq 47$	Very Low

The data scale in this study includes cognitive learning outcomes as interval data, whereas the Science Self-Efficacy (SSE) data are ordinal. The data analysis techniques used in this study are descriptive statistics and Spearman's rank correlation tests to assess the direction and strength of the relationship between the two variables, using SPSS Version 27. Furthermore, from the results of the calculations that have been carried out, it is then seen that the level of strength of the relationship between the variables using the correlation coefficient interpretation guidelines proposed by De Vaus [30]. The interpretation guidelines for the correlation coefficient are shown in Table 4.

Table 4. Guidelines for The Interpretation of Correlation Coefficients

Correlation Coefficients	Relationship Strength Levels
0.00 – 0.199	Very low
0.20 – 0.399	Low
0.40 – 0.599	Medium
0.60 – 0.799	Strong
0.80 – 1.00	Very Strong

The hypothesis proposed in this study consists of H_0 = There is no relationship between Science Self-Efficacy (SSE) (X) and students' cognitive learning outcomes (Y). At the same time, H_1 = There is a relationship between the variables of Science Self-Efficacy (SSE) (X) and students' cognitive learning outcomes (Y). Decision-making is based on significance values, with the provision that if $\text{sig} < 0.05$, then H_0 is rejected or a relationship exists between variables X and Y.

3. RESULTS AND DISCUSSION

The results of the analysis of the Science Self-Efficacy (SSE) questionnaire, carried out on 48 students in grades VII A and VII B at Sekolah Indonesia Jeddah (SIJ) in Jeddah, Kingdom of Saudi Arabia (KSA), provide an overview of the frequency of responses in the Science Self-Efficacy (SSE) category for each student. The results of the questionnaire processing are presented in Table 5.

Table 5. Category of Science Self-Efficacy (SSE) Students

Value Interval	Category	Frequency	Percentage (%)
$X > 102$	Very High	0	0
$84 < X \leq 102$	High	29	60
$66 < X \leq 84$	Medium	18	38
$48 < X \leq 66$	Low	1	2
$0 < X \leq 48$	Very Low	0	0

Based on Table 5, the level of Science Self-Efficacy (SSE) among students at Sekolah Indonesia Jeddah (SIJ) is predominantly in the High category, with 60% (29 students) in that category. The data is visualized in a graph shown in Figure 2.

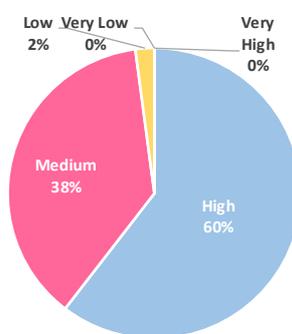


Figure 2. Graph of the Science Self-Efficacy (SSE) category

These results show that most students have high confidence in their ability to learn science. However, two students still have low Science Self-Efficacy (SSE). Furthermore, the data are analyzed along three dimensions of Self-Efficacy, as defined by Bandura (1997): Magnitude, Strength, and Generality. The results of the categories in the three dimensions are presented in Table 6.

Table 6. Recap per Self-Efficacy dimension indicator

Aspects	Dimensions of Self-Efficacy				Me
	Magnit	Str	Gen	an	
Average Score	ude	ength	erality	an	71
Dimension (%)	74%	%	67	73%	
Categories By Interval	Mediu	dium	Me	ium	Med %

Table 6 shows that the average score per indicator for 48 students was 71%, indicating that the level of Self-Efficacy in science learning is in the Medium category. Furthermore, a recapitulation of data on the two variables, namely Science Self-Efficacy (SSE) and students' science learning outcomes, is presented in Table 7.

Table 7. Descriptive statistics

Student	X (SSE)	Y (Learning Outcomes)	Student	X (SSE)	Y (Learning Outcomes)
1	93	100	25	86	90
2	90	94	26	88	90
3	92	96	27	84	86
4	84	86	28	84	80
5	73	74	29	89	86
6	86	85	30	81	80
7	89	90	31	85	86

8	78	80	32	66	80
9	98	96	33	89	90
10	75	80	34	74	86
11	75	80	35	100	100
12	95	100	36	83	86
13	92	86	37	79	84
14	79	86	38	89	90
15	87	96	39	95	80
16	92	90	40	84	100
17	93	90	41	96	90
18	86	96	42	102	100
19	77	90	43	92	80
20	85	90	44	87	90
21	86	86	45	75	84
22	102	100	46	82	84
23	75	80	47	88	100
24	80	90	48	89	84

The data from the two variables in Table 7 were then analyzed using descriptive statistics to provide a statistical overview of the Science Self-Efficacy (SSE) questionnaire data and science learning outcomes, as shown in Table 8.

Table 8. Descriptive statistics

	Mean	Standard deviation	Minimum score	Maximum score
Science Self-Efficacy (SSE)	86.02	7.951	66	102
Cognitive learning outcomes	88.48	6.870	74	100

Table 8 shows that both variables have relatively high average values, with cognitive learning outcomes at 88.48. This indicates that students' cognitive achievement is generally high. The next step is to analyze the data using statistical techniques to determine the relationship between variables using a nonparametric Spearman's Rank test. The results of the analysis are presented in Table 9.

Table 9. Spearman's Rank Correlation Test Results

		Science Self-Efficacy (SSE)	Science Learning Outcomes
Science Self-Efficacy (SSE)	Correlation Coefficient	1	0,623**
	Sig. (2-tailed)		0,001
	N	48	48
Science Learning Outcomes	Correlation Coefficient	0,623**	1
	Sig. (2-tailed)	0,001	
	N	48	48

Based on the results of the correlation test (Spearman's Rank) at Table 9, the correlation coefficient was 0.623, indicating a strong relationship between Science Self-Efficacy (SSE) and students' cognitive learning outcomes. [30]. In addition, the significance value of 0.001 is smaller than the significance level ($\alpha = 0,05$). Thus, this study rejects H0 and accepts H1, indicating a significant relationship between the two variables.

Based on the results of the analysis of Science Self-Efficacy (SSE) students in grades VII A and VII B at Sekolah Indonesia Jeddah (SIJ), it was found that the level of Science Self-Efficacy (SSE) was in the high category, with a percentage of 60%. This value is obtained from three dimensions of Self-efficacy: the Magnitude aspect at 74%, the Strength aspect at 67%, and the Generality aspect at 73%. Meanwhile, the profile of students' cognitive learning outcomes includes behavioral changes related to the intellectual realm or knowledge (Pertiwi et al., 2019). Based on descriptive statistical analysis of science learning outcomes, the minimum score for students is 74. In contrast, the maximum score for students in the cognitive domain is 100, measured by student achievement in learning the concept of Ecology.

The findings of this study demonstrate a relationship between Science Self-Efficacy (SSE) and students' science learning outcomes. The relationship is evident from the significance value of 0.000, which is smaller

than the significance level ($\alpha = 0.05$), thus showing a significant relationship between Science Self-Efficacy (SSE) and students' science learning outcomes. In addition, the correlation coefficient was 0.623, indicating that Science Self-Efficacy (SSE) strongly contributes to student achievement in learning outcomes related to the concept of Ecology. The results of the analysis align with Dalyono's [31] View that family, surroundings, and school environments can also influence learning outcomes. This shows that students' self-confidence has an important role in the science learning process. Students who have Science Self-Efficacy (SSE) will be more confident in exploring and solving scientific problems [32].

Science Self-Efficacy (SSE) can be seen and measured through its dimensions, which reflect how individuals assess and apply their beliefs in their ability to complete specific tasks or goals [24]. In the Magnitude dimension, students are classified as moderate, demonstrating confidence in solving complex problems that require high-level thinking [33]. Students with a high magnitude tend to achieve good learning outcomes because they are confident that they can handle complex analytical problems [34]. This dimension confirms that Science Self-Efficacy (SSE) encourages students to learn and overcome obstacles in science learning. This aligns with Bandura's Theory [28] Self-efficacy is an individual's evaluation of their ability to complete tasks, achieve goals, or face challenges.

On the dimension Strength, students are classified in the medium category, indicating that some students have confidence in consistently completing tasks optimally [28]. Students with strengths tend to be better able to face and solve challenges in learning, thereby contributing to improved learning outcomes [35]. In terms of Generality, students are in the moderate category, indicating their ability to use learning experiences as a source of motivation for further learning. Learning motivation plays an important role because it directly affects student learning outcomes [36]. Students with high Generality tend to actively evaluate their understanding, apply various strategies in completing complex tasks, and develop independent learning skills [37]. Thus, the three dimensions of Science Self-Efficacy (SSE) have an important role in determining the achievement of cognitive learning outcomes of science [38].

Science Self-Efficacy (SSE) in individual students is seen in a positive attitude, such as completing assignments on time, liking challenges in learning, and always being active in the classroom [39]. A positive attitude plays an important role in supporting the achievement of learning objectives and learning outcomes [40]. An attitude based on a supportive feeling towards a subject encourages students to study more diligently so that they obtain more satisfactory results [41]. Encouraging a positive attitude in students will also result in different science learning achievements compared to other students, because it motivates students to always complete their assignments as well as possible without cheating off their friends' work [42]. This condition is because students are better able to survive when facing difficulties and have aspirations to complete assignments in science learning [19]. One example is asking students to analyze the relationship between biotic and abiotic factors. Students with Science Self-Efficacy (SSE) in the High category can analyze the relationships between biotic and abiotic factors. Students can explain that the absence of abiotic factors, such as sunlight, water, and carbon dioxide (CO_2), will inhibit photosynthesis in plants, demonstrating a good understanding of the role of abiotic factors in the lives of living beings.

Students with low Science Self-Efficacy (SSE) have not been able to explain how the absence of abiotic factors affects biotic factors in the context of plant growth. These results indicate that students who have low Science Self-Efficacy (SSE) tend to face obstacles in the learning process, both at school and in the surrounding environment, due to fear, shame, low confidence, and doubts about their abilities and skills [20]. This analysis confirms that the concept of Ecology belongs to a complex and dynamic field that can be comprehensively understood only if students analyze the interactions among biotic, abiotic, and ecosystem factors [43]. Therefore, understanding the concept of Ecology requires that Science Self-Efficacy (SSE) be adequate so that students can relate the concept to real phenomena in their environment.

The above explanation shows a positive correlation between Science Self-Efficacy (SSE) and science learning outcomes. Firdausy supports this [13], who found that Self-efficacy significantly contributes to science learning outcomes. Students with high Self-efficacy are needed to achieve good learning outcomes. Bandura's Theory holds that Self-efficacy significantly influences learning success because it is directly related to an individual's belief in their ability to achieve academic goals [28]. Athia reported similar findings [44], indicating that students with high Self-efficacy perform better in learning than those with low Self-efficacy. Moreover, individuals with high Self-efficacy tend to organize and complete tasks effectively, achieving optimal results regardless of task difficulty [45].

Thus, to improve Science Self-Efficacy (SSE), students and teachers need to foster an active, fun classroom atmosphere that helps students consistently develop self-confidence and positive motivation [46]. Science learning should emphasize direct experience so that students can explore and understand the environment scientifically, in accordance with the Essence of Science [47]. Science not only emphasizes epistemological aspects in the acquisition of knowledge but also fosters self-confidence in the process of developing knowledge [48]. This perspective aligns with the theory of learning behaviorism by Watson (1878–1958), which provides a framework in which changes in behavior characterize learning as a result of the

interaction of stimuli and responses [49]. In science learning, contextual problems serve as stimuli, while students' responses are reflected in analytical skills and mastery of concepts [50]. Science Self-Efficacy (SSE) is a factor that strengthens this response because high self-confidence makes students better prepared to respond positively to learning stimuli [51].

4. CONCLUSION

The study's results show that (SSE) is significantly correlated with students' cognitive learning outcomes in the Ecology concept. The study's results show that Science Self-Efficacy (SSE) has a positive, significant relationship with students' cognitive learning outcomes in Ecology concepts. Based on the Spearman's Rank correlation test, a coefficient of 0.623 ($p = 0.001$; <0.05) was obtained, indicating a strong relationship between students' Science Self-Efficacy (SSE) and achievement of science learning outcomes. It also shows that Science Self-Efficacy (SSE) contributes to a relatively strong category of students' cognitive learning outcomes. These findings confirm that strengthening Science Self-Efficacy (SSE) is indispensable for supporting analytical skills, mastery of concepts, and meaningful student involvement in learning Ecology concepts.

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AUTHOR CONTRIBUTIONS

Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Data Curation, Writing-Original Draft Preparation, & Visualization, MHP and NI; Writing – Review & Editing, MS and RNR; Supervision & Project Administration, MHP, NI, MS and RNR.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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