



The Relationship between Self-Efficacy and Science Anxiety with Science Literacy Among Senior High School Students in Biology Learning

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Article Information	ABSTRAK
Submitted: 02 – 09 – 2025 Accepted: 25 – 09 – 2025 Published: 30 – 09 – 2025	Literasi sains merupakan kemampuan penting di abad ke-21, terutama dalam memahami isu-isu sains, menilai risiko dan manfaatnya, serta mengambil keputusan berdasarkan pertimbangan ilmiah. Namun, literasi sains siswa di Indonesia, termasuk di SMAN 6 Semarang, masih tergolong rendah. Dua faktor psikologis yang diduga memengaruhi kondisi ini adalah <i>self-efficacy</i> dan <i>science anxiety</i>. Penelitian ini bertujuan mengetahui hubungan antara <i>self-efficacy</i> dan <i>science anxiety</i> dengan literasi sains siswa. Pendekatan yang digunakan adalah kuantitatif non-eksperimental jenis korelasional. Sampel dipilih menggunakan teknik <i>purposive sampling</i> dengan kriteria memiliki kemampuan akademik yang setara. Data diperoleh melalui tes dan angket, yakni angket <i>self-efficacy</i> berdasarkan indikator Bosscher dan Smit (1998), angket <i>science anxiety</i> dari <i>The Abbreviated Science Anxiety Scale</i> (ASAS) oleh Megreya et al. (2021), serta soal literasi sains yang disusun berdasarkan indikator PISA 2025. Analisis data menggunakan uji korelasi Pearson, korelasi ganda, dan regresi linier ganda. Hasil menunjukkan <i>self-efficacy</i> berhubungan signifikan dengan literasi sains ($p = 0,027$; $r = 0,174$; kontribusi 3%). <i>Science anxiety</i> juga berhubungan signifikan ($p = 0,027$; $r = 0,173$; kontribusi 3%). Secara simultan, keduanya signifikan terhadap literasi sains ($p = 0,001$; $R = 0,281$) dengan kontribusi 6,7%, meskipun kekuatan hubungan tergolong lemah. Kata kunci: literasi sains; <i>science anxiety</i>; <i>self-efficacy</i>
Publisher	ABSTRACT
Program Studi Pendidikan Biologi, Fakultas Sains dan Teknologi, UIN Walisongo Semarang	<i>Scientific literacy is a crucial competency in the 21st century, particularly in understanding scientific issues, evaluating associated risks and benefits, and making decisions based on scientific reasoning. However, the level of scientific literacy among students in Indonesia, including those at SMAN 6 Semarang, remains relatively low. Two psychological factors hypothesized to influence this condition are self-efficacy and science anxiety. This study aims to investigate the relationship between self-efficacy, science anxiety, and students' scientific literacy. The research employed a non-experimental quantitative approach with a correlational design. Participants were selected through purposive sampling based on the criterion of possessing comparable academic abilities. Data were collected through tests and questionnaires. The self-efficacy questionnaire was developed based on indicators by Bosscher dan Smit (1998). The science anxiety questionnaire was adapted from the</i>

Abbreviated Science Anxiety Scale (ASAS) by Megreya et al. (2021). The scientific literacy test items were constructed based on the 2025 PISA indicators. Data analysis included Pearson correlation, multiple correlation, and multiple linear regression. The results showed a significant relationship between self-efficacy and scientific literacy ($p = 0.027$; $r = 0.174$; contribution = 3%). Science anxiety also showed a significant relationship ($p = 0.027$; $r = 0.173$; contribution = 3%). Simultaneously, both variables significantly correlated with scientific literacy ($p = 0.001$; $R = 0.281$), contributing 6.7%, although the strength of the relationship was weak.

Keywords: science anxiety, self-efficacy, science literacy

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INTRODUCTION

Scientific literacy is the ability to understand, apply, and critically evaluate scientific information for decision-making and solving everyday problems (Alfiah et al., 2024; Permanasari et al., 2021; Utamirohmahsari, 2024). In an era of rapid scientific and technological advancement, this literacy is crucial in shaping a generation that is prepared to face global challenges (Fensham, 2008; Sutrisna, 2021). Despite its importance, the level of scientific literacy in Indonesia remains low. The 2022 PISA results show that Indonesia ranked 67th out of 81 countries, with an average score of 383 (OECD, 2023b). Studies across various educational levels—from elementary school (Astria et al., 2022; Dwiwulandari et al., 2024; Harahap et al., 2022; Utami et al., 2022), junior high school (Juwita et al., 2022; Muliani et al., 2023; Pratama et al., 2024; Tillah & Subekti, 2025), to senior high school (Bungawati, 2024; Rahmadani et al., 2022; Tulaiya, 2020; Yfandi et al., 2024; Zulanwari et al., 2023)—consistently indicate that Indonesian students' level of scientific literacy needs significant improvement.

This low level of scientific literacy is also evident in the results of scientific literacy assessments at the senior high school level, as found among Grade X students at SMAN 6 Semarang. Based on the results of an initial science literacy ability test, the average score of Grade X students at SMAN 6 Semarang in answering science literacy questions adapted from Suryani (2022) was only 42. This score is considered low, highlighting the need to identify factors contributing to the lack of scientific literacy in the school. One of the influencing factors is psychological, such as self-efficacy (Wiarsana, 2020; Yulita & Defrinal, 2025). Self-efficacy is defined by Bandura (1997) as an individual's belief in their ability to achieve specific goals, which influences their emotions, thoughts, motivation, and behavior. Studies by Lestari et al. (2020) and Nursa'ban and Ewisahrani (2021) show that students with high self-efficacy tend to demonstrate better scientific literacy. They are more capable of solving problems, remaining patient throughout the process, and independently overcoming challenges (Hayat et al., 2021), thus achieving optimal learning outcomes. Conversely, Sahin et al. (2024) argue that students with low self-efficacy are more likely to give up easily and lack motivation.

In addition to self-efficacy, another intrinsic factor influencing scientific literacy is science anxiety. This refers to feelings of fear, anxiety, or discomfort when dealing with science-related subjects (Özbuğutu, 2021). Such anxiety may hinder concentration, memory, and task completion (Hakim et al., 2024). It can also disrupt attention and information processing, thereby impeding comprehension (Al Majali, 2020; Dalimunthe & Lesmana, 2024). Furthermore, anxiety interferes with critical thinking skills (Hakim et al., 2024), which are essential for developing scientific literacy (Sanjiartha et al., 2024). Classroom evidence supports these findings. Interviews with biology teacher and Grade X students at SMAN 6 Semarang, along with classroom observations, revealed low self-efficacy and the presence of anxiety. This was indicated by excessive worry, difficulty completing tasks (Grotan et al., 2019), lack of focus, and reluctance to actively participate in learning (Putri, 2016). Students also showed avoidance behaviors (Saraswati et al., 2021), such as avoiding academic challenges due to fear of failure or negative judgment (Arya & Aujla, 2024).

Based on the aforementioned issues, this study aims to investigate “The Relationship Between Self-Efficacy and Science Anxiety with Science Literacy Among Grade X Students in Biology Learning at SMAN 6 Semarang.” This research focuses on three main aspects: the relationship between self-efficacy and students’ scientific literacy, the relationship between science anxiety and scientific literacy, and the simultaneous relationship of both factors with students’ scientific literacy. The findings of this study are expected to provide insights for biology teachers in designing more effective and responsive learning strategies, thereby enhancing students’ ability to understand, apply, and evaluate scientific information in everyday life.

METHODS

This study employed a non-experimental quantitative design with a correlational approach, aiming to examine the relationship between self-efficacy and science anxiety variables on scientific literacy. The research was conducted at SMAN 6 Semarang from May 5 to May 23, 2025. The study population consisted of 251 tenth-grade students, with a sample of 163 students selected from five classes using purposive sampling techniques. The selected sample were determined based on the criterion of possessing comparable academic abilities.

Data were collected through tests and questionnaires, including a self-efficacy questionnaire consisting of 12 statements developed based on indicators by Bosscher & Smit (1998), a science anxiety questionnaire containing 8 statements adapted from the Abbreviated Science Anxiety Scale (ASAS) by Megreya et al. (2021), and a scientific literacy test consisting of 21 items constructed based on the 2025 PISA indicators. All three instruments underwent both content validation and empirical validation prior to use. The instruments also indicated acceptable reliability, with Cronbach’s alpha values of 0.701 for self-efficacy, 0.741 for science anxiety, and 0.872 for scientific literacy.

Responses to the self-efficacy questionnaire were scored on a 4-point Likert scale, with positive items rated from 1 (Strongly Disagree) to 4 (Strongly Agree) and negative items reverse-scored (Widodo et al., 2023). The science anxiety questionnaire used a 5-point scale, with responses scored from 1 to 5 according to the selected option. The scientific literacy test was scored dichotomously, awarding 1 point for each correct answer and 0 points for incorrect answers.

Data were analyzed using Pearson product-moment correlation, multiple correlation, and multiple linear regression tests with IBM SPSS. The interpretation of correlation coefficients referred to Sugiyono's (2014) guidelines, where values between 0.00–0.199 indicated a very weak relationship, 0.20–0.399 a weak relationship, 0.40–0.599 a moderate relationship, 0.60–0.799 a strong relationship, and 0.80–1.00 a very strong relationship. Hypothesis testing was based on the significance value, where $\text{Sig} \leq 0.05$ indicated rejection of H_0 and acceptance of H_a , while $\text{Sig} > 0.05$ indicated acceptance of H_0 (Zahriyah et al., 2021).

RESULTS AND DISCUSSIONS

The Relationship Between Self-Efficacy and Scientific Literacy

Based on the results of the Pearson product-moment correlation test, a significance value of 0.027 ($p < .05$) was obtained, indicating a statistically significant relationship between self-efficacy and scientific literacy. The correlation coefficient (r) was 0.174, suggesting a positive but very weak relationship. This means that the higher the students' self-efficacy, the more likely their scientific literacy will increase, although the influence is relatively small. This finding is consistent with the studies of Juniarso and Sulistyawati (2022), Said et al. (2018), and Tiyuri et al. (2018), which reported similar patterns of correlation. It is also in line with research by Aurah (2017), Latifah et al. (2019), and Lestari et al. (2020), which likewise found a positive relationship between self-efficacy and scientific literacy, though with stronger correlations.

Self-efficacy comprises three main aspects: initiative, effort, and persistence (Bosscher & Smit, 1998). In the learning process, these aspects are reflected in how students manage and complete tasks, achieve goals, and take appropriate actions to meet expectations. In terms of initiative, individuals with high self-efficacy not only respond passively to information but actively seek, interpret, and use it to make informed decisions. Regarding effort, self-efficacy determines how much energy is devoted to facing challenges (Juan et al., 2018). Students with high self-efficacy will continue to strive to complete assignments even when faced with difficulties, because they believe in their ability to perform well (Wiarsana, 2020).

In the aspect of persistence, self-efficacy helps students sustain their efforts when facing obstacles. Such students tend not to give up easily, are able to defend their viewpoints, and remain steadfast in their beliefs (Wiarsana, 2020). Furthermore, self-efficacy also affects perseverance when encountering barriers and resilience in difficult situations (Juan et al., 2018). Students who believe in their own abilities are

generally more inclined to enjoy challenges rather than avoid difficult tasks or problems (Riyadi et al., 2018).

The findings of this study revealed that although Grade X students at SMAN 6 Semarang generally exhibited high levels of self-efficacy, their scientific literacy remained significantly low. This may be attributed to a tendency among some students to overestimate their abilities, leading to inadequate preparation and ultimately, failure. Conversely, students who underestimate their abilities are also at risk of missing important opportunities that could impact their future (Razavi et al., 2017). These findings are supported by interviews with biology teachers at SMAN 6 Semarang, who noted that students who considered themselves more intelligent often felt no need for preparation or well-planned study strategies. In contrast, students who adopted deliberate study strategies and engaged in deep thinking achieved better outcomes. This suggests that self-confidence, without appropriate preparation and strategy, does not guarantee academic success.

The analysis of the coefficient of determination showed that self-efficacy contributed only 3% to scientific literacy, indicating that many other influencing factors remain unexplored. The low level of scientific literacy may also be due to the lack of laboratory activities, the dominance of rote memorization over understanding and application, limited practice in analytical and critical thinking tasks, and low interest in reading as well as in answering discourse-, graph-, and image-based questions (Fu'adah et al., 2017; Huryah et al., 2017). Moreover, students' attitudes and interest in learning science also play a crucial role in determining their level of scientific literacy (Sukowati & Rusilowati, 2017).

The Relationship Between Science Anxiety and Scientific Literacy

Science anxiety among students is often caused by limited learning facilities, a lack of hands-on laboratory activities, complex and abstract material, and monotonous or unengaging teaching methods (Fia et al., 2022; Özbuğutu, 2021). Anxiety also arises when students are required to participate in discussions or take exams, often triggered by fear of negative evaluation and social pressure (Downing et al., 2020; Özbuğutu, 2021). In this study, the majority of students experienced science anxiety at varying levels. Learning-related science anxiety typically emerged when completing worksheets, starting a new topic, or listening to lengthy explanations due to fear of not understanding the material. However, science evaluation anxiety was found to be more dominant, especially during exams, which triggered worry about failure (Apostolidis and Tsiatsos, 2021; Azrai et al., 2016; Downing et al., 2020).

Nevertheless, not all effects of anxiety are negative. Based on the Pearson product-moment correlation test, a significance value of 0.027 ($p < .05$) was obtained, indicating a statistically significant relationship between science anxiety and scientific literacy. The correlation coefficient of 0.173 suggests a positive, albeit very weak, relationship. This means that as students' science anxiety increases, their scientific literacy tends to increase as well, though the contribution is minimal. These findings

support the notion that anxiety does not always hinder performance; in fact, within a reasonable range, it can enhance learning outcomes. This is further supported by interviews with biology teachers and Grade X students at SMAN 6 Semarang, which revealed that students with high academic targets still experienced anxiety, but were motivated to study more seriously as a result.

Theoretically, mild to moderate levels of anxiety can be adaptive and serve as a signal for students to better prepare themselves (Sakarti, 2018; Zainuddin & Fuad, 2024). This form of anxiety encourages more consistent and serious study efforts. If managed properly, this emotional response can even enhance memory retention, focus, and motivation (Apostolidis and Tsiatsos, 2021; Lacosta and Sarajar, 2024). Each student has an “optimal” threshold of anxiety that can support the achievement of the best learning outcomes. Conversely, too little anxiety may result in a lack of focus, while excessive anxiety can significantly interfere with the learning process (Wardani et al., 2024).

The results of this study are consistent with findings by Sausan and Wibowo (2024), who reported that moderate anxiety levels improved literacy, and with Kaur and Vadhera (2020), who found a low but positive correlation between science anxiety and science achievement. This can be explained through intrinsic motivation: students with high expectations feel pressured to maintain performance, resulting in anxiety that drives them to study harder. On the other hand, students with low academic achievement tend to be more relaxed, as they have fewer academic expectations (Prodromou & Frederiksen, 2018).

However, the findings of this study differ from several others that reported a negative correlation between anxiety and learning outcomes. For example, von der Embse et al. (2018) found that higher test anxiety was associated with lower academic performance. Similarly, studies by Harefa et al. (2023), Mangkuwibawa et al. (2024), and Nur et al. (2024) demonstrated that high levels of anxiety can significantly reduce scientific literacy. These differences can be explained by the psychological and individual context of the students. Anxiety tends to arise when students feel incapable of meeting academic standards or learning targets, especially when they perceive the learning activity as important but doubt their own abilities (Downing et al., 2020). This condition reflects feelings of inadequacy, insecurity, and dissatisfaction with oneself (Özbuğutu, 2021). Therefore, how students interpret the learning situation largely determines the impact of anxiety itself.

Based on these findings, it can be concluded that science anxiety is not always an obstacle in the learning process. As long as it remains within a reasonable range and is accompanied by emotional regulation skills, anxiety can function as a valuable source of motivation. Thus, it is important for students to possess emotional intelligence to effectively manage their emotions during learning activities (Arias et al., 2022; Sánchez-Álvarez et al., 2020). Accordingly, manageable science anxiety should not be viewed as a barrier but rather as a natural part of the learning process that can drive students to engage more seriously with academic challenges.

The Relationship Between Self-Efficacy and Science Anxiety with Scientific Literacy

The results of the multiple correlation test indicated a significant simultaneous relationship between self-efficacy and science anxiety on scientific literacy, with an F-change significance value of 0.001 ($p < .05$). The correlation coefficient (R) of 0.281 suggests that the relationship between these variables is positive but weak. This means that although the contribution of self-efficacy and science anxiety to scientific literacy is relatively small, an increase in both variables tends to be associated with an increase in students' scientific literacy. These findings are consistent with Roebianto (2020), who reported that students' attitudes toward science and self-efficacy have a significant direct influence on their academic achievement in science subjects. Similarly, research by Fadhila et al. (2020) supports this by showing that students' attitudes toward science and self-efficacy together have a positive, albeit low, yet significant correlation with scientific literacy.

This is related to the concept of self-efficacy, which refers to students' beliefs about their abilities in science—whether they perceive themselves as capable or not. This belief is interconnected with students' attitudes and behaviors based on their knowledge, experiences, and feelings toward events around them (İnce, 2023). If students perceive their science ability as low (i.e., low self-efficacy), it can reduce their enthusiasm for science, leading them to avoid the subject (Roebianto, 2020). Conversely, high self-efficacy plays an important role in fostering positive attitudes, such as a strong drive to continuously improve academic performance (Trisnawati et al., 2020) and supporting the development of critical skills like problem-solving (Budiarti et al., 2022). Self-efficacy also promotes students' interest in becoming more scientifically literate (Roebianto, 2020), which ultimately strengthens curiosity and engagement in the learning process. Interest that develops during learning greatly influences the quality of students' knowledge (Hidayati et al., 2024). However, a positive relationship between self-efficacy and scientific literacy does not necessarily translate into automatic improvement in literacy.

Previous studies indeed show that higher self-efficacy tends to increase scientific literacy (Aurah, 2017; Latifah et al., 2019; Lestari et al., 2020), but the findings of this study indicate that despite high self-efficacy among students, their scientific literacy remains low. This suggests that excessively high self-efficacy can become counterproductive. Roebianto (2020) warned about conditions where students occasionally have an erroneous perception that their abilities or knowledge are much higher than in reality, resulting in an illusion that they have mastered everything and can do anything, whereas this is not the case. This view aligns with Lackner et al. (2023), who explained that individuals lacking skills often fail to recognize their deficits, although not all unskilled individuals are unaware of their limitations. In this study, it appears that high self-efficacy among students is not accompanied by effective study efforts, possibly due to the mistaken belief that they are sufficiently capable, leading to a lack of thorough engagement with the material, practice, discussion, or other adequate learning strategies. Consequently, students'

scientific literacy does not develop optimally because there is no real drive to improve or deepen their understanding.

On the other hand, based on statements by Sakarti (2018), Wardani et al. (2024), and Zainuddin and Fuad (2024), anxiety at mild to moderate levels can motivate students and serve as a signal to prepare better. This concept aligns with the Yerkes-Dodson Law, which posits that performance improves with increased mental arousal (stress and anxiety) up to an optimal point, after which further anxiety leads to performance decline Cooper et al. (2018). Burns et al. (2020) found that the effect of anxiety on students depends on their self-efficacy levels. Students with low self-efficacy and low anxiety tend to interpret their anxiety as evidence of inability, leading to demotivation, loss of interest, and avoidance of science learning. Conversely, students with low self-efficacy but higher anxiety perceive it not as a weakness but as a motivating signal that activates effort, enhances focus, and encourages more serious engagement with science learning.

However, this study found that although students' science anxiety was at a moderate level, their scientific literacy remained low. This indicates that anxiety alone is insufficient to produce good literacy outcomes. In this context, anxiety, which should act as a trigger for more diligent study, seems not to be followed by adequate learning strategies. Students may feel worried but do not know how to manage their anxiety, so moderate anxiety remains merely a feeling of concern rather than a genuine impetus to improve understanding. Therefore, the anxiety experienced by students has yet to function as a significant motivator for enhancing scientific literacy. This is supported by the adjusted R-squared value of 0.067, showing that self-efficacy and science anxiety together explain only 6.7% of the variance in scientific literacy. Most of the variance, 93.3%, is accounted for by other factors not examined in this study.

Factors influencing scientific literacy encompass various internal and external aspects. Internally, misconceptions contribute to low mastery of basic scientific concepts (Suparya et al., 2022). Students often do not fully understand the concepts taught, hesitate to ask questions, and struggle to interpret data in tables or graphs (Yusmar & Fadilah, 2023). A lack of reading interest, rote memorization without understanding context, and neglecting the importance of literacy in reading and writing also contribute to low scientific literacy (Sutrisna, 2021). However, these cognitive factors are intertwined with affective characteristics such as learning motivation, which also play a crucial role in academic achievement (Ince, 2023; Yanti et al., 2021). Furthermore, attitudes toward science, such as enjoyment and interest in learning science, make students more active and engaged (Setyowati et al., 2022).

Externally, factors such as the crucial role of teachers in guiding students and designing learning that encourages exploration and contextual connection with everyday life (Suparya et al., 2022), the use of active learning strategies like group discussions and problem-solving (Hsu & Goldsmith, 2021), and appropriate media and teaching materials (Setyowati et al., 2022) are vital. Teachers who seldom train students to solve scientific literacy problems leave them unaccustomed to handling

complex issues (Huryah et al., 2017). Additionally, teachers are often pressured to complete the curriculum, resulting in conceptual misconceptions where science is memorized rather than understood contextually and is easily forgotten (Fuadi et al., 2020). Supportive facilities, such as complete laboratories or observation tools, are also essential for optimal learning (Mayasari, 2022). Beyond school, parental attitudes at home affect learning, for instance, by providing enjoyable educational activities like nature walks to observe natural phenomena (Yusmar & Fadilah, 2023).

CONCLUSION AND RECOMENDATION

The analysis results indicate a significant relationship between self-efficacy and scientific literacy among tenth-grade students at SMAN 6 Semarang, although the strength of this relationship is very weak, with a correlation coefficient of 0.174 and a contribution of only 3%. A similar pattern was found in the relationship between science anxiety and scientific literacy, which, despite being significant with a p-value of 0.027, showed a very low correlation strength of 0.173 and contributed 3% to the variability in scientific literacy. The combined analysis of both variables demonstrated a significant simultaneous relationship with scientific literacy, with a combined correlation coefficient of 0.281 and a joint contribution of 6.7%. This positive relationship indicates that increases in self-efficacy and science anxiety are associated with improvements in students' scientific literacy. However, most of the variation in students' scientific literacy is influenced by other factors not included in this study.

Based on these conclusions, it is necessary to design learning strategies that not only enhance students' self-efficacy but also positively manage science anxiety, for example, through contextual approaches or project-based learning. Additionally, it is important to explore other more dominant factors influencing scientific literacy, such as critical thinking skills or learning motivation.

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