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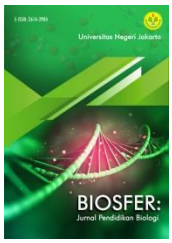

The relationship between self-efficacy and problem-solving ability in biology learning at the senior high school

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ABSTRACT

This study aims to examine the relationship between self-efficacy and problem-solving ability in the topic of the human reproductive system at the senior high school level (SMA). The research employed a quantitative correlational design. A total of 65 students were selected using purposive sampling. Data were collected through a self-efficacy questionnaire and an open-ended test to measure problem-solving skills. The data were analyzed using regression analysis, preceded by a Pearson product-moment correlation test at a significance level of α = 0.01, with prerequisite tests applied. The results showed that the self-efficacy of Grade XI students at senior high school in the human reproductive system topic fell within the moderate category as much as 37%, while their problem-solving ability was in the adequate category in 45%. Statistical analysis yielded a significance value (2-tailed) of 0.00<0.01 and a calculated correlation coefficient as much as 0.700> 0.244 this indicates a positive and highly significant relationship between self-efficacy and problem-solving ability, with a strong correlation strength. In conclusion, there was a significant positive relationship between students' self-efficacy and their problem-solving abilities in biology learning, specifically concerning the human reproductive system material.

INTRODUCTION

The current focus of learning demands active participation of students in the learning process. The role of the teacher is only as a facilitator of students' learning to build their knowledge (Öztürk, 2023). Students are required to be able to gain understanding independently, this aims to hone their cognitive skills (AbuKhousa et al., 2023; Öztürk, 2023; Thornhill-Miller et al., 2023). The cognitive skills that are expected to be able to overcome demands in the world of education have been socialized and included in the guidebook for implementing 21st century skills in the 2013 curriculum as 4C, namely: creative thinking, communication, collaboration and critical thinking skills & problem solving abilities (Ardianti et al., 2024; Mahanal et al., 2022).

One of the 21st century skills that students need to have is the ability to solve problems (Norman E & Jack R, 2011; Wu et al., 2024). Problem solving ability is the ability to apply previously owned knowledge to new situations that involve high-level thinking processes (Daryanes et al., 2023a). However, in reality, the preview research results show that most students experience difficulty in applying the concepts they have learned so they are unable to solve problems in the questions (Daryanes et al., 2023b; Pimdee et al., 2024). Sometimes students are only able to reach the stage of understanding the problem, but are unable to understand the subsequent stages. Problem-solving is essential in biology education as it helps students apply scientific knowledge to real-world issues, fostering critical thinking and scientific literacy. However, traditional teaching often emphasizes memorization, highlighting the need for more inquiry-based and problem-based learning approaches to enhance student engagement and understanding (Thakur et al., 2018).

Apart from problem-solving abilities, there are affective aspects that also influence students' success in achieving learning goals (Daryanes et al., 2023b; Pimdee et al., 2024). The importance of affective aspects in learning is outlined in the curriculum objectives that affective aspects are one of the competencies for achievement in learning activities (Wahyudin et al., 2024). One of these affective aspects is self-efficacy (Hamedi et al., 2021). Self-efficacy is a person's ability to self-assess their competence to successfully complete certain tasks (Bandura et al., 2006; Bhati & Sethy, 2022) The PISA results state that Indonesia ranks sixth from the bottom of the 72 PISA participating countries (Bybee et al., 2009; Khasan et al., 2021; OECD, 2019), which shows that the level of self-efficacy in Indonesia is still very low. PISA data show that students with high self-efficacy tend to achieve higher scores in reading, mathematics, and science (Bakdoolot & Dangin, 2024; Khasan et al., 2021; Tasha, 2023). It is thought that students' low level of self-efficacy can influence problem-solving abilities.

The results of interviews conducted with biology teachers in Bandar Lampung City in March 2022 indicate that the practice and test questions provided to students generally only reach the C3 level (application) of Bloom's Taxonomy and rarely include items designed to develop students' problem-solving skills. Although the Discovery Learning model is applied in the classroom, students tend not to use textbooks as learning resources (Warlinda et al., 2022). Instead, they often seek answers from online platforms such as the Brainly app, frequently copying and pasting responses. While many of these answers are technically correct, they are often identical in wording, suggesting a lack of critical thinking and personal engagement with the material.

Furthermore, students' unfamiliarity with structured problem-solving processes—such as identifying the problem, analyzing the relevant information, and evaluating the possible solutions—has contributed to their weak problem-solving abilities. Another issue identified by teachers is the tendency of students to procrastinate in completing and submitting assignments. This behaviour is influenced by the ongoing uncertainty caused by the COVID-19 pandemic, which has also negatively affected students' affective engagement and motivation in the learning process (González-Pérez & Ramírez-Montoya, 2022; Maulina et al., 2022).

The material used in this research focuses on the human reproductive system for Grade XI Biology in the even semester. This topic is part of Basic Competence 3.12, which involves analyzing the relationship between the structure of the tissues forming the reproductive organs and their functions within the human reproductive system. Issues or cases related to the human reproductive system are commonly encountered in daily life, providing opportunities for students to build meaningful connections between scientific concepts and real-world situations. However, students' ability to engage effectively with such problems is often influenced by their level of self-efficacy. Many students lack confidence in their scientific abilities, which hinders their willingness to explore complex biological issues or to persist in problem-solving tasks. Nowadays, recent research on biology learning has only

revealed students' problem-solving abilities (Ardianti et al., 2024; Daryanes et al., 2023a; Mahanal et al., 2022) through the implementation of various models and improved learning strategies. To the best of our knowledge, there is little evidence linking successful learning outcomes to self-efficacy. Therefore, strengthening self-efficacy is essential to support deeper learning and critical thinking, particularly when dealing with sensitive and application-based topics like human reproduction. Based on the description above, this research is expected to examine the relationship between self-efficacy and problem-solving ability in the topic of the human reproductive system at the senior high school level (SMA). Moreover, it can be used to determine appropriate learning so that these problems can be overcome.

METHODS

Research Design

The type of research used is quantitative research with a correlational research design (Creswell & Poth, 1990). This type of research aims to determine the relationship and level of relationship between two or more variables without any attempt to influence the variables, thus eliminating variable manipulation (Norman E & Jack R, 2011). The research sample was given problem-solving ability tests and a self-efficacy questionnaire after students had completed the human reproductive system material taught by the teacher.

Population and Samples

The population of this study was all students in class XI SMA Muhammadiyah 2 Bandar Lampung, Indonesia, totaling 130 students. The sample in this research was 65 students using the purposive sampling technique (Norman & Jack, 2011). The population in this study was all 130 students in grade XI Science at SMA Muhammadiyah 2 Bandar Lampung, Indonesia, divided into four classes. The researcher used a purposive sampling technique to obtain sample classes that met the specified criteria. These criteria were determined based on interviews with Biology teachers at SMA Muhammadiyah 2 Bandar Lampung, Indonesia. The criteria for selecting sample classes in this study were grade XI Science, based on classes with homogeneous cognitive abilities, class activity, and student responsiveness in learning. Based on the aforementioned criteria, two classes, class XI Science 3 and class XI Science 4, with 65 students, were selected for this study.

Instrument

The research data that has been taken is self-efficacy from the questionnaire and problem-solving ability from the cognitive test. Self-efficacy of the students is measured using a likert scale (Bandura et al., 2006; Linge et al., 2021) questionnaire consisting of 9 questions (Table 1), which cover three main aspects: level (the degree of confidence in one's abilities), strength (the strength of that confidence), and generality (the overall application of that confidence in various situations).

Table 1.
Self-efficacy Questionnaire Grid

Aspect	Indicator	Question Item Number	
		Positif Statment	Negative Statement
Level (the degree of confidence in one's abilities)	How interested are you in the lessons and assignments	1	-
	Optimistic about completing assignments.	2	-
Strength (the strength of that confidence)	Commitment to achieving your goals as a student	3	-
	Belief in and recognition of your strengths	4	-
	Persistence in completing assignments	-	5
	Not easily influenced by others' answers	-	6
Generality	Mastery of learning materials	-	7
	Responding well to different situations and thinking positively	8	-
	Able to handle all situations effectively	9	-

Problem-solving ability of the students is obtained from a test in the form of essay questions on

the topic of the human reproductive system, consisting of 12 questions designed to assess the students' ability to solve problems related to the topic (Table 2).

Table 2.
The Relationship Between the Problem-Solving Ability Test and the Self-Efficacy Questionnaire

Indicator Problem-Solving	Question Items			Self-efficacy Dimension
	Case A	Case B	Case C	
Understanding the problem	1	5	9	Level, Generality
Planning a solution	2	6	10	Level, Strength
Implementing the solution plan	3	7	11	Strength, Generality
Reviewing the solution	4	8	12	Generality

The self-efficacy questionnaire data, which utilized a five-point Likert scale, were treated as interval data, allowing for analysis using Pearson correlation with the interval-scaled problem-solving test data and regression analysis. However, if the data were not normally distributed, the Spearman's rank correlation test was applied as a non-parametric alternative to ensure the validity of the analysis (Paul, 2020).

Procedure

This research consists of three stages of activities, namely the preparation stage, the implementation stage, and the final stage (Figure 1). The preparation stage is carried out through: (a) observation of biology learning problems through interviews with Biology subject teachers at SMA Muhammadiyah 2 Bandar Lampung, and conducting direct observations in the classroom and school environment to determine the condition of the school and the facilities and infrastructure at the school. (b) Determining the research sample using the purposive sampling technique. (c) Compiling research instruments. (d) Conducting validation tests of research instruments by expert lecturers.

Implementation stage activities carried out in the implementation stage include: (a). Collecting data by providing problem-solving ability questions on the human reproductive system material to students. (b). Collecting data by providing self-efficacy questionnaires to students. (c). Providing scores for the results of the problem-solving ability test and the self-efficacy questionnaire of students. Final Stage. At this stage, the activities carried out are: processing and analyzing data from the results of the problem-solving ability test of students, processing and analyzing data from the results of the self-efficacy questionnaire of students, and representing conclusions based on the results obtained from the data analysis steps.

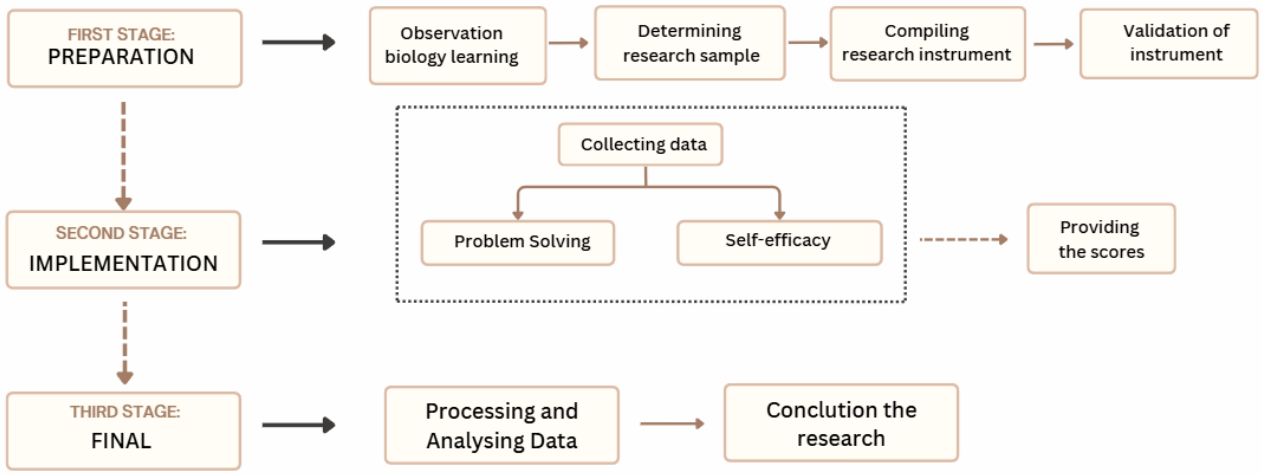


Figure 1. Research Procedure

Data Analysis Techniques

The research data was obtained from a questionnaire analyzing students' self-efficacy and problem-solving abilities. The self-efficacy scale assessment data was obtained from the questionnaire. The self-efficacy measurement scale used was a Likert scale with four response options: strongly agree/appropriate (SS), agree/appropriate (S), disagree/appropriate (TS), and strongly

disagree/appropriate (STS). The problem-solving ability data was obtained through 12 descriptive questions. The data results are presented in a table using calculations including the highest score, lowest score, average, and standard deviation. The descriptive data obtained for self-efficacy and problem-solving abilities were then analyzed descriptively using frequency distributions to illustrate the frequency and percentage of each variable and group them into criteria.

Further analysis uses the product-moment correlation test in the SPSS for Windows 23.0 program by comparing the calculated significance with the established significance to determine the relationship between two variables, namely self-efficacy and students' problem-solving abilities. This was followed by regression analysis in the study to predict the dependent variable, namely problem-solving abilities, if the independent variable, the self-efficacy, was known. Regression is based on the functional relationship between the independent variable and the dependent variable. To find out the interpretation of the level of relationship regarding the high and low correlation coefficients, it can be seen from Table 3.

Table 3.
Reference for Correlation Coefficient Interpretation

Coefficient Interval	Relationship Level
0.00 – 0.199	No relationship/Very low relationship
0.20 – 0.399	Low relationship
0.40 – 0.599	Relationship enough
0.60 – 0.799	Strong relationship
0.80 – 1.00	The relationship is very strong

Source: (Nurhaswinda, et al., 2025)

RESULTS AND DISCUSSION

The results of research carried out on class XI students at SMA Muhammadiyah 2 Bandar Lampung show that there is a relationship between self-efficacy and problem-solving abilities. Below, we will examine the research results in depth. The research data were obtained by administering a questionnaire with a total of 9 questions to class XI students at SMA Muhammadiyah 2 Bandar Lampung. The frequency distribution of students' self-efficacy can be seen in Figure 2.

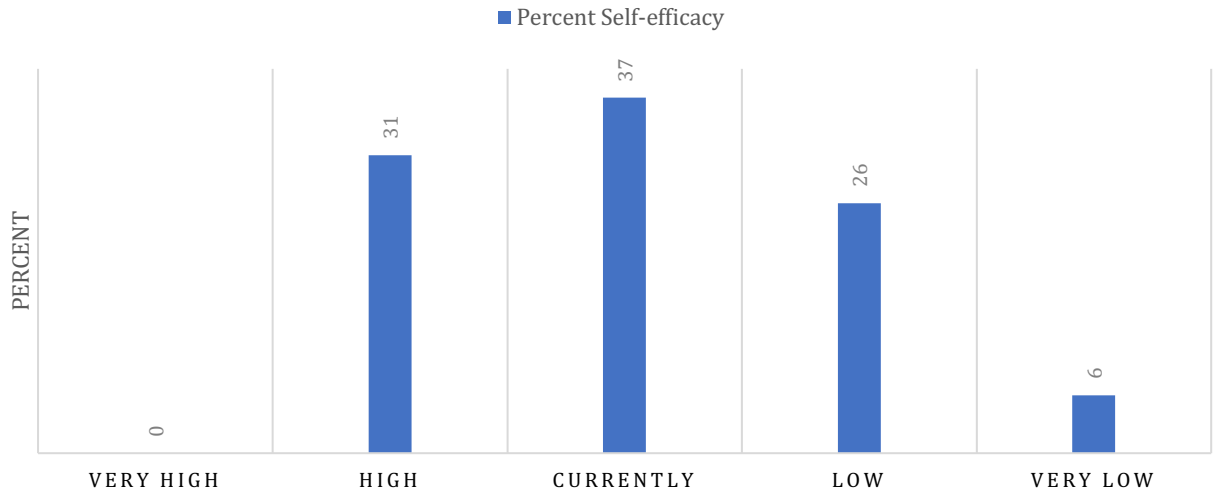


Figure 2. Frequency Distribution of Student Self-efficacy

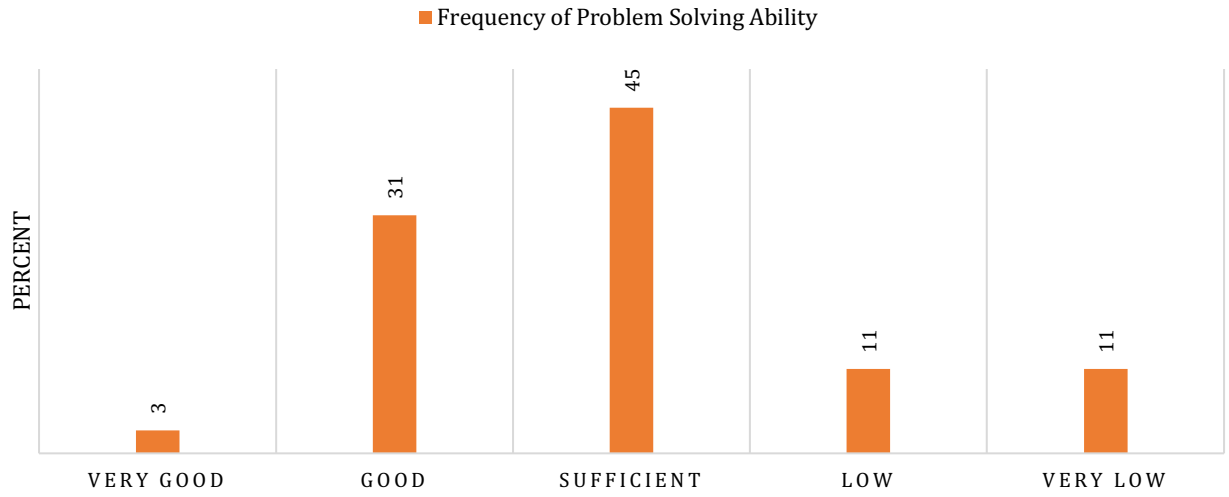
Figure 2 shows that the highest frequency of students was in the medium criteria, as much as 24 people with a percentage of 37%. Then, the lowest frequency of students is in the Very High criteria, the frequency distribution of students is 0 people with a percentage of 0%. Percentage distribution data for each dimension of self-efficacy, namely level of difficulty (level), level of strength (strength) and generalization (generality), was obtained, namely that the level of difficulty aspect had the highest percentage, namely 36%. This level of difficulty includes indicators of how much interest you have in the lessons and assignments, as well as having an optimistic outlook in working on the questions. In the generalization level aspect, it has the lowest percentage, namely 31%. This level of generalization

includes indicators of mastering learning-related materials, responding well to different situations and thinking positively, being able to handle all situations effectively.

Reviewing the description regarding self-efficacy, the level of a person's self-efficacy can be seen from three aspects/dimensions. According to (Bhati & Sethy, 2022; Hamedi et al., 2021; Linge et al., 2021) there are 3 dimensions of self-efficacy, namely the level of difficulty (level), the level of strength (strength), the level of generalization (generality). Based on the scores from the self-efficacy questionnaire that the respondents filled out, scores were obtained for each dimension. The self-efficacy dimension that has the highest percentage is the level of difficulty (level) dimension, with a percentage of 36%.

The results of the questionnaire that has been given, it was clear that students have the enthusiasm and interest to complete the assignment, as most of the students could fill in all the questions. Self-efficacy really helps students in working on test questions when entering the stage of implementing problem-solving strategies. Students feel capable of working with their own abilities without looking at their friends' work and are optimistic about what they have done. Problem-solving is a challenge for students so whatever value they get is an experience, and they are sure that it will be better in the future. This is in line with Bandura's statement (de la Fuente et al., 2023; Kincheloe et al., 2006) that students who have high self-efficacy have good feelings, behavior, positive thinking, can motivate themselves to act and act accordingly, strive for achievement, are not afraid of difficult task challenges. , and persist longer when they face difficulties until they find a solution to a problem.

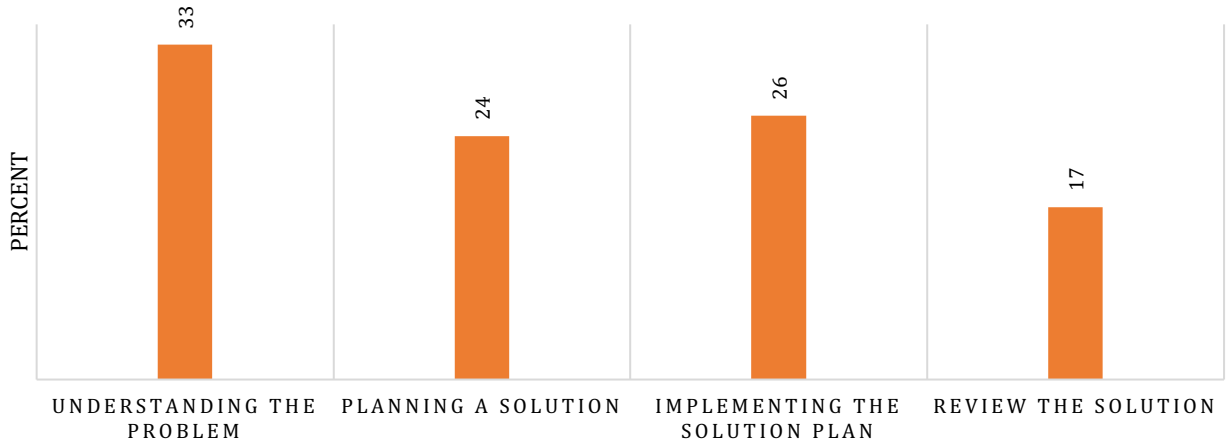
The research data was obtained by giving test questions with a total of 12 questions to class XI students at SMA Muhammadiyah 2 Bandar Lampung. The frequency distribution of students' problem-



solving abilities (PSA) can be seen in Figure 3.

Figure 3. Frequency Distribution of Students' Problem-Solving Ability

Figure 3 could be seen that the highest percentage score for students is in the "Sufficient" criteria with a frequency of 29 people and a percentage of 45%. Meanwhile, the lowest percentage score for students is in the "Very Good" criteria with a frequency of 2 people and a percentage of 3% of all students. The results of the problem-solving analysis based on problem solving indicators show that each student has a different PSA. So that in learning, teachers need to guide students during the initial stages of learning in the form of instructions, motivation, warnings, describing problems into problem-solving steps, providing examples, and other actions aimed at making students learn effectively



independent (Ardianti et al., 2024; Mahanal et al., 2022).

Figure 4. Students' Problem-solving Abilities

As for the results of the problem-solving ability test based on the indicator (Figure 4), it is known that the highest percentage of students is found in the problem understanding indicator (33%). In this indicator, students are able to find the main problem of the given event and formulate the main problem in the form of a question such as "*PCOS disorders in the female reproductive system are caused by hormonal regulation abnormalities that could be corrected through a healthy lifestyle*". Where the learning process is demonstrated by the teacher providing opportunities for students to identify as many main problems as possible that are found and are relevant to the lesson material. In line with research by (Daryanes et al., 2023a), which also shows the highest score for students' PSA, namely on the indicator of diagnosing problems. Students in this indicator understand the problem given, so they are able to solve the problem. Polya in (Daryanes et al., 2023a; Siswanto & Meiliasari, 2024) explains that "The first stage in solving a problem is understanding the problem itself."

Meanwhile, for the indicator of checking completion again, the lowest percentage was obtained (17%). Learners are asked to consider carefully which strategy is the most appropriate and logical for solving the problem and think about the positive and negative consequences of the solution. According to Polya (Nurmeidina, et al., 2025; Schoenfeld, 1987), it is important to assess the results obtained correctly. At this stage, students are expected to try to check again carefully every stage that has been carried out. In this way, errors and mistakes in solving problems can be found. The low achievement of results in this aspect is because there are still many students who do not review the answers they have made. Students' ability to carry out an assessment of a case includes the abilities needed in the learning process. This ability can be trained by getting used to analytical and critical thinking (Ftik et al., n.d.).

Decision-making in solving problems is achieved through collecting facts, analyzing information, compiling various alternative solutions, and choosing effective problem-solving methods (Mahanal et al., 2022; Pimdee et al., 2024). Based on this opinion, a person's PSA can be a benchmark for determining the level of success in learning subject matter. This is certainly related if you look at the difficulty level aspect of self-efficacy, which includes students' confidence in completing a task. Students who have high confidence in completing a task will have good PSA; in other words, problem-solving ability is related to self-efficacy.

To find out the linearity test, whether the data collected meets the requirements for analysis using the planned technique, prerequisite tests are carried out, consisting of normality, homogeneity, and linearity tests. The results of the prerequisite tests that have been carried out can be seen in Table 5.

Table 5.
Prerequisite of Linierity Test

Variable	Normality Test	Homogenity Test	Linierity Test
Self-efficacy & PSA	0.090 > 0.05	0.159 > 0.05	0.157 > 0.05

The prerequisite test results in Table 5, it can be seen that the normality and homogeneity test results on self-efficacy and problem-solving ability data are normally and homogeneously distributed. Furthermore, the linearity test results based on the test criteria showed that the data were linear. After carrying out the prerequisite tests, it can be concluded that the data on self-efficacy and PSA are normally distributed, homogeneous, and linearly distributed; the hypothesis test is then carried out. The results of the hypothesis tests that have been carried out in Table 5.

Table 6.
Linierity Test of Self-Efficacy and PSA

		Self-efficacy	PSA
Self-efficacy	Pearson Correlation	1	.700**
	Sig. (2-tailed)		.000
	N	65	65
PSA	Pearson Correlation	.700**	1
	Sig. (2-tailed)	.000	
	N	65	65

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

Table 6 shows that interpreted by referring to decision making in Pearson correlation analysis, namely the known sig value. (2-tailed) of 0.000 < 0.01 and rcount of 0.700 > rtable 0.244, which means there is a positive and very significant correlation between the self-efficacy variables and problem-solving abilities. This shows that H0 is rejected, meaning that there is a very significant relationship between self-efficacy and students' problem-solving abilities in the human reproductive system material in class XI SMA Muhammadiyah 2 Bandar Lampung. In line with previous research, self-efficacy influences PSA and there is a positive and significant correlation between mathematical problem-solving abilities and self-efficacy (Zamnah, 2019).

Determining the criteria for the relationship between self-efficacy variables and problem solving abilities can be seen using the interpretation of the correlation coefficient obtained or r value (Table 3). The interpretation index of the correlation coefficient between self-efficacy and the problem solving ability of class Table 6 is in the r value range between 0.600 to 0.799 with a strong level of relationship. Therefore, there was not only a positive and significant relationship between self-efficacy and problem solving ability, but there was also a strong relationship. In line with research conducted by (Gao et al., 2025) which states that there is a positive relationship and is in the very strong category. This shows that students' confidence in using problem-solving abilities such as understanding problems, planning problem solutions, carrying out solution plans, and re-checking solutions in tasks related to biology learning is at strong criteria.

It could be explain that there was a strong relationship between self-efficacy and problem-solving abilities because self-confidence in students' abilities will make students feel capable of working on and solving a problem in a problem well. This is in line with research conducted (Bakdoolot & Dangin, 2024; Flammer, 2010) which states that students' self-efficacy is directly proportional to students' PBA. This shows that the higher the self-efficacy that students have, the higher their ability to solve problems will also be. Students who have high self-efficacy will survive the difficulties they face, try harder and be more persistent to solve the problems they face, and will not give up easily when they get grades that do not match their expectations.

The discovery learning model leads student to be independent in solving problems, therefore having an impact on bilding students' self-efficacy. The use of this learning model is in accordance with the objectives to be analyse, namely being able to help students develop problem-solving abilities and increase students' self-efficacy. Learning using the discovery learning model has been proven to

improve problem-solving abilities and self-efficacy, such as the results of research conducted by (Hwang & Oh, 2021) which concluded that the discovery learning model is effective for increasing students' self-efficacy.

In line with, that one learning model is able to train students to be proficient in solving the problems they face and can find concepts according to themselves and can train students to think so that they can improve self- Student efficacy in learning is a discovery learning model. The discovery learning model contains syntax/stimulation stages to generalization stages which can improve students' problem-solving abilities and self-efficacy because this model provides students with the opportunity to use their thinking skills in investigating the concepts presented in efforts to solve the problem. In line with Bandura (Bandura et al., 2006; Bhati & Sethy, 2022), after getting real individual personal experiences in the form of success and failure. Experiences of success will increase an individual's self-efficacy, while experiences of failure will decrease it. Once strong self-efficacy develops through a series of successes, the negative impact of common failures is reduced. Due to their success in following the learning process using the discovery learning model, students will have the confidence to be able to solve the next problem in the next question. To determine the extent of the relationship between the two variables. The general regression equation for the variable PSA on self-efficacy can be seen in Figure 4.

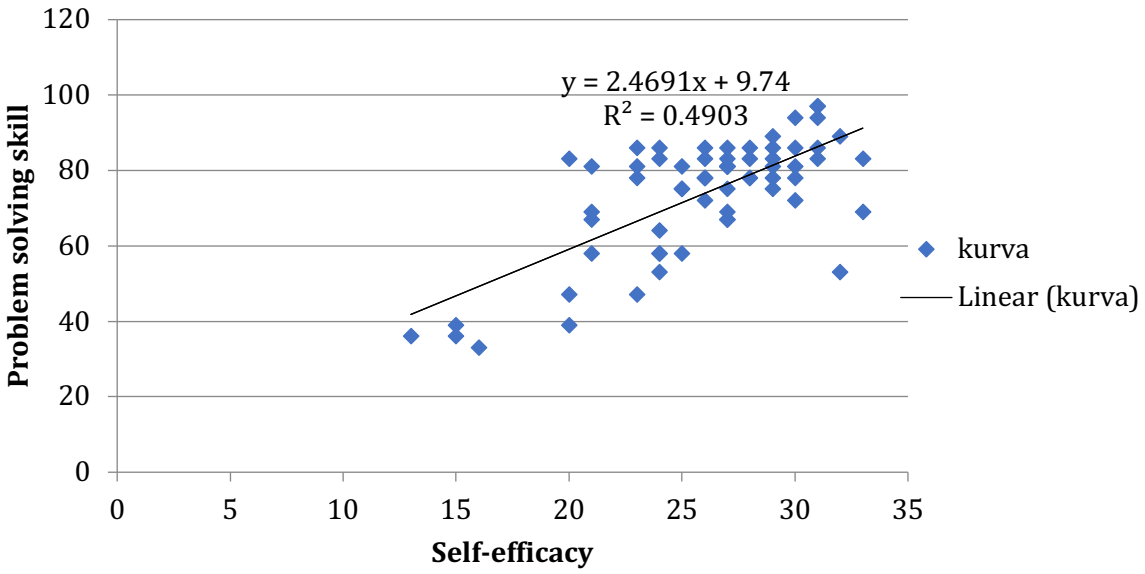


Figure 5. Regression equation for the relationship between problem-solving ability and general self-efficacy.

Figure 5 shows that y = 2.469x + 9.74. This means that the value (a) or constant is 9.740. This value shows that when self-efficacy (x) is zero or does not increase, then the student's PSA (y) will still be 9.740. The regression coefficient value (b) is 2.469 (positive), which shows a unidirectional influence, which means that if self-efficacy is increased by one unit, it will increase students' PSA by 2,469 units. Based on these calculations, it is known that the coefficient of determination is 49%, which means that the self-efficacy variable contributes 49% to the problem-solving ability variable. Meanwhile, the remaining 51% was caused by other factors not researched by the author.

Researchers conducted regression tests based on each dimension of self-efficacy and problem-solving abilities. A regression test was carried out to determine the extent to which students' self-efficacy values influence students' problem-solving ability values. Overall, based on Figure 1, the relationship between each dimension of self-efficacy is a positive relationship with students' PSA. The self-efficacy variable contributes 49% to the PSA variable. Based on research results it shows that self-efficacy is an important variable in influencing PSA in the learning process(Hwang & Oh, 2021; Tasha, 2023). Self-efficacy can be used as an independent variable or predictor to predict or measure students' problem-solving abilities. Self-efficacy can encourage involvement in learning activities which can influence the level of PSA (Bakdoolot & Dangin, 2024). The better the students' self-efficacy, the higher

the students' problem solving abilities (Kyriazis et al., 2024) in line with the statement according to (Jamil & Mahmud, 2019; Juan et al., 2018) the self-efficacy of students is more confident in their abilities so that it has an impact on increasing their ability to solve problems in learning, shown by good enthusiasm and persistence in solving the questions given.

CONCLUSION

The results of the research conducted indicate that there is a significant relationship between self-efficacy and students' problem-solving abilities in biology learning, with the correlation level being within the strong criteria.

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