RESEARCH ARTICLE

Improving students' metacognitive and self-efficacy in learning Biology through reducing academic stress and cognitive anxiety using IBSR technique

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Abstract: Student academic stress can impact class participation. Integrating psychological treatment into learning strategies can help manage academic stress. The objective of this research is to enhance students' metacognitive and self-efficacy by reducing their learning difficulties and cognitive anxiety. This will be achieved by integrating Inquiry-Based Stress Reduction (IBSR) into learning strategies, which will help to alleviate academic stress during the learning process. The study is designed as a quasi-experimental study using a pretest-posttest nonequivalent control group design. The study was conducted at Bandung City State High School with the participation of 70 class XI MIPA students from two different classes, 35 in the experimental class and 35 in the control class. Both classes utilized problem-based learning (PBL), with the experimental class receiving the IBSR technique at the beginning of learning and various stages of core PBL activities. A questionnaire rating scale with 8 scales was used to collect data on academic stress, learning difficulties, cognitive anxiety, and student self-efficacy. Additionally, students' metacognitive abilities were measured using an open-ended essay. After two weeks of learning, the IBSR psychological intervention in the experimental class had lower student learning difficulties and cognitive anxiety than the control class. The IBSR psychological intervention in the experimental class on students' self-ability and metacognitive abilities also had higher results than the control class. The research suggests that teachers should consider psychological interventions when implementing learning innovations that improve student learning performance.

Keywords: cognitive anxiety; IBSR technique; learning difficulties; metacognitive abilities; self-efficacy

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Introduction

Every curriculum transition in Indonesia should ideally keep learning student-centered (Bariyyah, 2021; Dewantara et al., 2020). Student-centered learning has the advantage of interactive learning between teachers and students and improving the quality of learning optimally (Ghofur, 2020; M. Nur Salim Muzakki et al., 2021). However, if students lack the requisite, unengaged, fail to participate in the learning process, they are likely to encounter difficulties in their academic pursuits (Zakiyah et al., 2018). These difficulties can be defined as conditions where students are unable to achieve the desired learning outcomes due to specific obstacles (Muderawan et al., 2019). Students' learning difficulties are not only caused by learning materials but can also be caused by the stress that students experience while learning. Stress is one of the inhibiting factors in academics because it has an impact on academic achievement (Frazier et al., 2019). Student learning difficulties caused by learning stress can arise from the environment around the student, such as the family environment, school environment, and community environment, as well as from within the student, such as health, disability, intelligence, talent, interest, and learning style (Muderawan et al., 2019; Priliyanti et al., 2021; Sudiana et al., 2019).
Stress is one of the most common problems among students (Husky et al., 2020; Li et al., 2020; Luo et al., 2020; Patsali et al., 2020). Student stress is the cause of student learning difficulties. This stress can come from learning task loads, learning methods, and learning styles that are not suitable (Minkley et al., 2018). Stress will cause extraneous to students so which has a negative impact such as decreased productivity (Jowkar et al., 2022), decreased academic performance (Frazier et al., 2019) physically,

mentally and emotionally exhausted (Lasalvia et al., 2021), the incidence of diseases such as gastric disorders (Zhang et al., 2019). Based on research by Lew et al., (2019) stress is a major factor in student suicide. Stress experienced by students is called academic stress (Gao et al., 2020).

Academic stress is one of the main problems among students, especially high school students who have various academic demands (Safiany & Marytmi, 2018). This is according to Bedanta (2020) stated that one of the problems of high school students is academic stress. Academic stress is the stress caused by the school environment. Students' weak ability to solve various learning problems, such as many academic demands, causes students to experience academic stress (Barseli et al., 2020). Students' academic stress can be influenced by several factors, including internal factors (factors that come from within the student, such as motivation, self-efficacy, and anxiety) and external factors (factors that come from the student's environment, such as the educational system, teacher attitudes, treatment by friends and family) (Alvin, 2007; Basith et al., 2021; Oktavia, 2019).

Based on the results of preliminary research on biology learning in one of the public high schools in Bandung City, more than 50% of students in MIPA class XI suffered from academic stress caused by self-efficacy (Salsabila et al., 2023). The high percentage illustrates students' lack of confidence in their ability to learn biology, so it is feared that it will have an impact on students' anxiety about their abilities. Student self-efficacy has a negative correlation with student stress levels, so it can be concluded that students with low self-efficacy will have high-stress levels (Navarro-Mateu et al., 2020). Self-efficacy is thought of as self-control to reduce stress because it represents a person's sense of optimism about their ability to successfully cope with stress (Ngui & Lay, 2020; Schwarzer & Warner, 2013).

Some of the causes of low self-efficacy in students include passive learning and the failure of schools to develop the higher-order thinking skills of students (Allanta & Puspita, 2021). The inability of students to develop higher-level thinking skills is due to the unoptimized knowledge gained from lower-level thinking skills activities (Halimah et al., 2021). One of the higher-order skills according to Marzano and Kendall's (2007) new taxonomy is a metacognitive system or metacognitive ability. Metacognitive ability is the ability of students to control cognitive skills or the ability of students to use prior knowledge to solve problems by planning, evaluating, and modifying (Abdelrahman, 2020; Carpenter et al., 2019). There is a correlation between metacognitive abilities with self-efficacy and student learning achievement. Students with low self-efficacy tend to have low metacognitive abilities, so student learning achievement decreases because they cannot overcome learning difficulties (Hayat et al., 2020).

Another factor is that students' self-efficacy is still low because they think science is a complex subject (Dorfman & Fortus, 2019). One of the biology learning materials considered to be high difficulty, based on the results of the researcher's interview with one of the biology teachers, is the immune system. The low student learning outcomes on the immune system material are an indication of this. Dewantara et al., (2020) 67.2% of grade XI high school students thought that the immune system is a biological material that is considered difficult because it is abstract, many terms are difficult to understand, and the teacher's delivery is not understood. Difficulty in understanding the material can cause academic stress in students (Qonita et al., 2021). In addition, the presence of the teacher is very important in the learning process, especially in student-teacher cognitive interaction. The less cognitive interaction between students and teachers is also suspected to be another factor causing students' academic stress. According to Sudirgayasa et al. (2021), meaningful learning occurs when there is cognitive interaction between teachers and students when students are invited to try to connect new phenomena into their knowledge structure while teachers provide intensive guidance to students. The learning process should be able to improve students' thinking skills, but the teacher's role in learning is certainly one of the causes of students' decreased thinking skills (Buchari, 2018). Causes of low student self-efficacy include passive learning and the lack of schools that develop students' higher-order thinking skills (Allanta & Puspita, 2021).

In addition to the correlation with stress, self-efficacy also has a negative correlation with anxiety: the less confidence students have in their abilities (low self-efficacy), the higher the level of anxiety or fear among these students (Gutiérrez-García & Landeros-Velázquez, 2018). Anxiety is a form of psychological barrier to learning when it is present in an excessive amount (Sukarno & Widdah, 2020). Cognitive anxiety is a feeling of tension, worry, fear, and anxiety that can cause students to be unable to concentrate on learning and end up feeling insecure (Son et al., 2020; Velazco et al., 2021; Yang et al., 2020). Based on several previous studies, it is determined that the level of cognitive anxiety in some students is in the high category (Son et al., 2020; Xiong et al., 2020). High levels of cognitive anxiety affect student learning performance, and high cognitive anxiety has an impact on reducing student learning outcomes (NurCita & Susantiningsih, 2020). The statement is also supported by research by Morales and Perez-Marmol (2019) who found that levels of cognitive anxiety are negatively correlated with student learning outcomes. Low levels of student self-efficacy and lack of cognitive interaction between teachers and students are academic problems that become barriers for students in learning, so they need attention.

To reduce the stress caused by students' learning difficulties, several alternative solutions utilize psychological intervention techniques (Landau et al., 2021; Schnaider-Levi et al., 2017). Alternative solutions include Problem Focus Coping, Mindfulness-Based Stress Reduction (MBSR), and Inquiry-

Based Stress Reduction (IBSR) (Romero et al., 2020; Tajnia et al., 2022; Xunlin et al., 2020). Problem-focused coping has weaknesses in its implementation because it requires the help of others, making its implementation in learning becomes more complicated. In Mindfulness-Based Stress Reduction (MBSR), a very conducive situation is needed because there is an awareness phase that requires a high level of calm, which is not possible in schools. Meanwhile, Inquiry-Based Stress Reduction (IBSR) addresses stress or difficulties through an inquiry process that can be done independently. This technique is based on the use of metacognitive skills to find the things that are causing stress or difficulties for the students. Thus, this technique can be applied in schools. Therefore, in this study, researchers are interested in using the Inquiry Base Stress Reduction (IBSR) technique to overcome students' learning difficulties.

The Inquiry-Based Stress Reduction (IBSR) technique is one the psychological intervention technique based on self-exploration, experience, meditation, and mindfulness to reduce stress (Landau et al., 2021; Smernoff et al., 2019). According to Nye (2011) the application of the IBSR technique has the benefit of helping participants to achieve better stress and anxiety levels, which in turn enhances their quality of life. Research by Krispenz and Dickhäuser (2019) indicates that the IBSR technique is an effective method for reducing anxiety and chronic stress. Moreover, in medical cases, the IBSR technique has been shown to have a positive influence on cancer patients due to the stress and worry associated with the disease (Landau et al., 2016). This strategy has been used to help teachers cope with high workloads in education (Katie, 2002; Schnaider-Levi et al., 2017). In this case, however, the researcher is attempting to apply the use of Inquiry-Based Stress Reduction (IBSR) in the field of education, specifically for students, by transforming it into a learning strategy. According to Katie and Mitchell (2003), Inquiry-Based Stress Reduction (IBSR) consists of three main steps in its implementation. These Inquiry-Based Stress Reduction (IBSR) steps are integrated into a learning strategy, thus creating a new learning strategy innovation that is expected to reduce student learning difficulties caused by stress due to student-centered learning and learning materials that are considered difficult. The IBSR technique is implemented at the beginning and at the end of the learning meeting to effectively manage the stress experienced by students throughout the learning process. Furthermore, the IBSR technique is also carried out in every introductory activity to release student stress before the learning activities core. The IBSR technique will be integrated into the learning strategy through the PBL model in the syntax of conducting investigations (end of the first meeting) and drawing conclusions (end of the second meeting). In this study, the PBL model was selected due to its emphasis on students' metacognitive abilities in problem-solving. This aligns with the principles of the IBSR technique in reducing stress.

The high level of student stress that causes biology learning difficulties, low student self-efficacy, the presence of student cognitive anxiety about cognitive tasks such as understanding complex biology concepts and exams, and the lack of schools in training student metacognitive skills can have a negative impact on student cognitive function, attention, and memory. This hinders student learning and learning achievement. The potential of the IBSR technique in addressing stress and anxiety led the authors to become interested in innovating learning strategies in this study, which aims to create a learning environment that supports students in managing stress and anxiety while developing metacognitive abilities and self-efficacy. It is imperative to examine the potential of innovative biology learning strategies to reduce stress levels. Consequently, it is essential to examine the impact of integrating the IBSR technique into the PBL model on student learning difficulties, cognitive anxiety, self-efficacy, and student metacognitive abilities. Furthermore, the study aims to investigate the relationship between student learning difficulties, cognitive anxiety, self-efficacy, and student metacognitive abilities. The results of this study are expected to provide teachers with an alternative learning strategy that can reduce student learning difficulties, thereby enhancing the effectiveness and efficiency of biology learning.

Method

Research Design

This research is quasi-experimental research using a pre-test post-test nonequivalent control group design. The research was conducted in one of the public high schools in Bandung by involving 70 students of class XI MIPA from two different classes, namely 35 students from the experimental class and 35 other students from the control class. This research design can be seen in detail in Figure 1.

Research Procedure

Learning about the immune system in the control class and experimental class is divided into 2 learning Meetings. The first meeting and the second meeting discussed the disorders of the human immune system through the presented LKPD. In the first meeting, students carried out activities to identify the problems contained in the LKPD, gather information, and select references related to the problem. In the second meeting, students carry out presentation activities on the results of discussions related to the presented problems, then other students respond to the results of the presentation of the presenting group to draw conclusions related to human immune system disorders. Learning in the experimental

group was carried out using the IBSR technique, which consisted of three main steps: In the first step, students identify stressful thoughts and write the stressful thoughts in a paper (in research using Google form). In the second step, students self-inquire or with the help facilitator (teacher trained in the IBSR technique) about their stressful thoughts using 4 integrated questions that are meditative: (a) Do you currently have any stressful thoughts? Such as annoyance, disappointment, anger, or other things that are interfering with your thoughts about learning right now? (b) Are these thoughts important and will they be bad for you? (c) If YES, can you forget these thoughts for a moment to start studying today? (d) How bad is it for you to forget these thoughts for a moment? (Students are instructed to forget these disturbing thoughts for a moment to focus on learning). The goal is realization, not rationalization. In the final step, students "turn around" their stressful thoughts. In the turnarounds, student identify possible evidence for the opposite of the thought. For example: The student's initial thought is "I don't like my biology teacher". A possible turnaround can be: "The biology teacher likes/wants me to follow the biology lesson" (reversing of the original thought), "The biology teacher gives me space for independent learning" (turnaround to the self) and "The biology teacher wants me to understand the material presented so that I can pass the exam" (turnaround to another point of view).

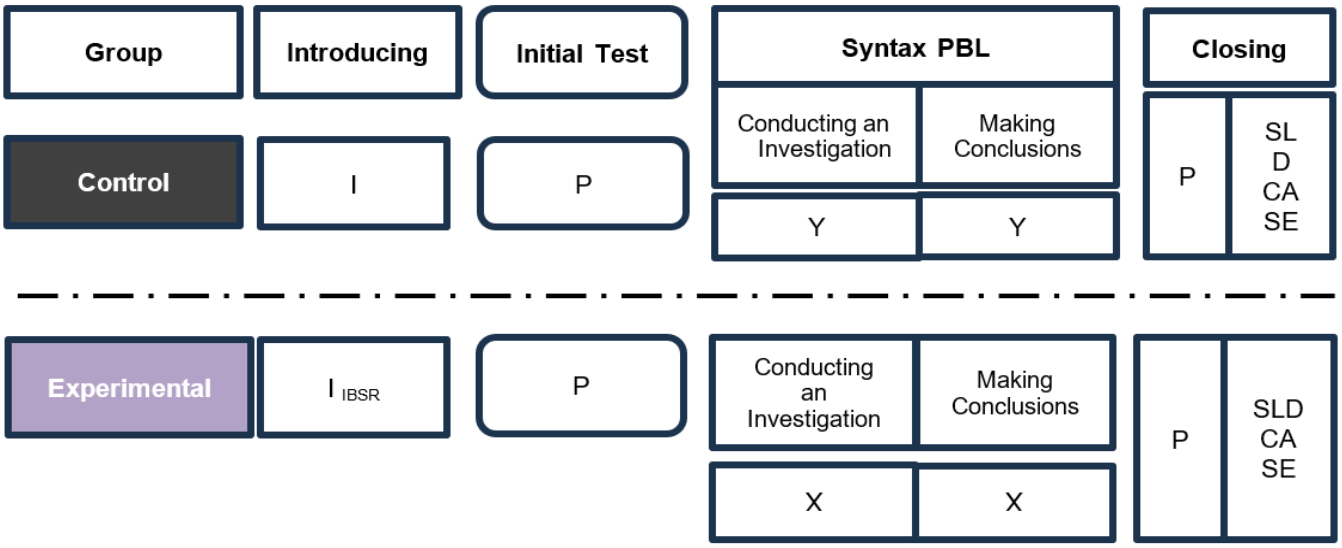

Figure 1. The research is designed to measure the effect of IBSR on learning difficulties, cognitive anxiety, self-efficacy, and metacognitive abilities of students on immune system material. I: preliminary learning activities without IBSR techniques; I: IBSR preliminary learning activities with IBSR techniques; P: data collection of students' metacognitive abilities (pretest-posttest); Y: learning without using IBSR techniques; X: learning using IBSR techniques; SLD: data collection of students' learning difficulties; CA: data collection of students' cognitive anxiety; SE: data collection of students' self-efficacy.

Table 1 shows the stages of each lesson. In the control group, learning was conducted using only the problem-based learning (PBL) model. Student Learning Difficulty (SLD) in the control and experimental classrooms describes the level of academic stress experienced by the students as measured at the end of the learning. Cognitive anxiety (CE) describes students' level of cognitive anxiety during learning measured at the end of learning, Self-efficacy (SE) describes students' self-belief in their abilities and academic success measured at the end of learning. Pretest (P) describes students' prior knowledge and Posttest (P) describes students' metacognitive abilities.

The video used in this study is an educational video that explains how to improve the immune system and various types of immune system disorders from trusted sources (doctors). The video shows what happens when the human body experiences immune system disorders and the general steps that can be taken to improve the immune system. In addition, as the video plays, the teacher also emphasizes some concepts that students need to understand before moving on to the next stage of learning. The selection of videos in this study refers to Brame's (2016) *weeding* technique, where the video does not contain background music and complex backgrounds that may become extraneous during learning. The questions given to students through the LKPD contain concepts that have been taught and are being taught. The questions are given in an open-ended essay format so that students have the flexibility to present ideas from various credible references they have obtained about the concepts they have learned. The instruments used in this study are a 1-8 scale questionnaire to measure students' learning difficulties, cognitive anxiety, and self-efficacy, and essay questions to measure students' metacognitive abilities, which have been validated by experts. The pre-test score between the control class and the

experimental class is assumed to be the initial knowledge of the students. The difference in post-test scores between the control class and the experimental class is assumed to be the effect of the treatment.

Table 1. Inquiry-Based Stress Reduction (IBSR) strategy on immune system material through Problem-Based Learning model

Syntax	Learning Activities
Meeting 1	
Apperception (stimulation of prior knowledge and learning orientation)	• Review of prior knowledge through question-and-answer sessions • Connecting previous material to the material being discussed • Providing learning objectives • Stimulate new knowledge by showing videos related to immune system disorders • Perform the IBSR technique
Problem Identification	• Observe and identify the problems presented in the LKPD
Formulate the Problem	• Formulate problems presented in the LKPD
Planning the Investigation	• Develop appropriate steps and strategies to solve the problems presented in the LKPD
Conduct the Investigations	• Perform the IBSR technique • Information gathering and selecting of references about the problem
Meeting 2 **(Repeat Apperception with IBSR technique)**	
Analyze the data	• Present and discuss related immune system disorders found
Drawing Conclusions	• Perform the IBSR technique • Conducting question-and-answer activities that lead to conclusions related to the knowledge the students have gained during the learning process.
Implementation	• Search for information related to new problems

Research Instrument

Student Learning Difficulties

The questionnaire on students' learning difficulties is based on an instrument developed from the construct of learning difficulties according to Kirk and Gallagher (1989). The questionnaire comprises 15 statements based on five aspects: students' slowness in following lessons, inability in certain areas, academic difficulties due to uncontrolled behavior, problems related to learning motivation, and problems related to learning difficulties due to teachers. The statements used to measure students' learning difficulties are divided into positive and negative statements, which can be seen in detail through the instrument grid in Table 2.

Table 2. Grid of Student Learning Difficulty Instruments

Aspect	Indicator	Statement	+/-
Students' slowness in following lessons	Requires extra time to complete assignments	I need extra time to complete my assignments on the immune system material.	+
	Gained less understanding compared to his peers	I understand the immune system material better than my friends	-
	Requires repetition to understand the material	I need repetition to understand the immune system material	+
Inability in certain areas	Difficulty in receiving messages given through hearing	I am hard of hearing, so the material on learning the immune system presented by the teacher cannot be heard properly.	+
	Difficulty in understanding message given pictures	It is easier for me to understand the immune system material presented by the teacher through pictures.	-
	Obstacles in vision	I have poor eyesight, which interferes with the learning process of immune system material.	+
	Has barriers to fluent speech	I have difficulty speaking in front of my friends.	+
Academic difficulties due to uncontrolled behavior	Difficulty concentrating	Classes that are too early in the morning or afternoon make me sleepy and hard to concentrate.	+
	Ignoring the teacher's explanations	The teacher's explanation was so difficult to understand that I did not pay attention.	+
	Can't work well in a study group	I can cooperate well in a group	-
	Inability to express emotions naturally	I find it difficult to express my opinion when learning about the immune system.	+

Aspect	Indicator	Statement	+/-
Problems related to learning motivation	Lack of enthusiasm for the lesson	I am excited to learn biology, especially about the immune system.	-
Problems related to learning difficulties due to teachers	Doesn't match the learning method or model used by the teacher	The learning method used by the teacher to present the immune system material was effective for my understanding.	-
	Doesn't match the learning style used by the teacher	I liked the way the teacher presented the immune system material	-
	Doesn't match the teacher's attitude during the lesson	I liked the teacher's attitude during the immune system lesson.	-

The data obtained from the student learning difficulties questionnaire on a scale of 1 (strongly disagree) to 8 (strongly agree) for positive statements and 1 (strongly agree) to 8 (strongly disagree) for negative statements were then categorized based on Table 3.

Table 3. Student Learning Difficulties Questionnaire Scale Categories

Scale	Category
1 - ≤ 4	Low
>4 - ≤ 8	High

The results of categorizing students' learning difficulties are grouped by aspect, and then the percentage is calculated using the Formula 1.

$$\text{Percentage} = \frac{\textit{Sum of the percentages of each statement}}{\textit{Number of statements/aspects}} x\ 100\% \quad (1)$$

The results of the percentage of students with learning difficulties are then categorized based on the adaptation of Arikunto (2012) in Table 4.

Table 4. Categorization of the Percentage of Student Learning Difficulties

Percentage	Criteria for Learning Difficulties
0-20%	Very Low
21-40%	Low
41-60%	Fair
61-80%	High
81-100%	Very High

Cognitive Anxiety

The Students' cognitive anxiety questionnaire was based on an instrument developed by Cassady and Johnson (2002) modified from the Cognitive Test Anxiety (CTAS) instrument. The questionnaire comprises 14 statements based on five aspects, namely Anxiety before exam, Anxiety about abilities during exam, Anxiety in answering exam questions, Anxiety about getting into trouble during the exam and Anxiety about the exam results. The statements used to measure students' cognitive anxiety are divided into positive and negative statements, as detailed in the instrument grids in Table 5.

Table 5. Cognitive Anxiety Instrument Grid

Aspect	Statement	+/-
Anxiety before exam	I was very nervous when I was about to take the immune system exam.	+
	I am pressured to get a good grade on the immune system exam.	+
	I have more difficulty than my friends in learning the immune system material	+
	I was confident and calm before taking the immune system exam	-
Anxiety about abilities during exam	During the immune system exam, I did not do well on the exam	+
	When taking the immune system exam, I was worried that my friends would do better than me.	+
	I was very nervous during the immune system exam even though I had prepared beforehand.	+
	I can do well in exams even with limited time.	-

Aspect	Statement	+/-
Anxiety in answering exam questions	I find it hard to concentrate during immune system exams	+
	I have no difficulty compared to my friends in taking the immune system exam	-
Anxiety about getting into trouble during the exam	I was calmer in the immune system exam than my friends	-
Anxiety about the exam results	When I get the immune system exam paper, I immediately focus on the questions.	-
	During the immune system exam, I didn't think about the failure I would get if I didn't understand the material.	-
	After taking the immune system exam, I found that I could do better on the exam.	-

The data obtained from the student cognitive anxiety questionnaire, which was rated on a scale of 1 (strongly disagree) to 8 (strongly agree) for positive statements and 1 (strongly agree) to 8 (strongly disagree) for negative statements, were then categorized by Table 6.

Table 6. Categories of Student Cognitive Anxiety Questionnaire Scale

Scale	Category
1- ≤ 3	Low
>3 - ≤ 5	Medium
>5 - ≤ 8	High

The results of categorizing students' cognitive anxiety are grouped based on indicators, and then the percentage is calculated using the Formula 2.

$$\text{Percentage} = \frac{Sum\ of\ the\ percentages\ of\ each\ statement}{Number\ of\ statements/aspects}\ x\ 100\% \quad (2)$$

The results of the percentage of students' cognitive anxiety are then categorized based on the adaptation of Arikunto (2012) in Table 7.

Table 7. Percentage Categorisation of Students' Cognitive Anxiety

Percentage	Criteria for Cognitive Anxiety
0-20%	Very Low
21-40%	Low
41-60%	Fair
61-80%	High
81-100%	Very High

Self-Efficacy

The self-efficacy questionnaire is made based on an instrument adapted by Bandura (2006). The questionnaire is comprised of nine statements, divided into three levels. These levels are as follows: (1) Level, which refers to confidence in the actions taken; (2) Strength, which is the level of confidence in completing the task; and (3) Generality, which refers to the breadth of belief in one's abilities. The statements used to measure student self-efficacy are divided into positive statements and negative statements which can be seen in detail through the instrument grids in Table 8.

Table 8. Self-Efficacy Instrument Grid

Aspect	Indicator	Statements	+/-
Level	Students' level of confidence in the actions taken during learning	I believe I can deal with learning difficulties in the immune system material.	+
		I believe I can utilize my understanding of this immune system material in my daily life.	-
Strength	Student's level of confidence to complete a task	I believe I can do the tasks given by the teacher related to the immune system material well.	+
		I believe I can do the exam questions because I have prepared well.	-
Generality	The freedom of belief in one's abilities possessed by the student	I believe I have a better ability than my other friends on the immune system material.	+
		I believe I can control myself positively when I experience stress while learning about the immune system.	-

The data obtained through the student self-efficacy questionnaire were categorized based on Table 9,

which presents a scale of 1 (strongly disagree) to 8 (strongly agree) for positive statements and 1 (strongly agree) to 8 (strongly disagree) for negative statements

Table 9. Category of Student Self-Efficacy Questionnaire Scale

Scale	Category
1- ≤ 3	Low
>3 - ≤ 5	Medium
>5 - ≤ 8	High

The results of categorizing student self-efficacy are grouped by aspect and then the percentage is calculated using the Formula 3.

$$\text{Percentage} = \frac{Sum\ of\ the\ percentages\ of\ each\ statement}{Number\ of\ statements/aspects}\ x\ 100\% \quad (3)$$

The percentage results are categorized based on AL Ghani (2022) which can be seen in Table 10.

Table 10. Categorization of Student Self-Efficacy Percentage

Percentage	Category
0-20%	Very Unsure
21-40%	Not Sure
41-60%	Less Sure
61-80%	Sure
81-100%	Very Sure

Students Metacognitive Ability

The question of metacognitive ability is comprised of four essay questions based on the indicators of Marzano and Kendall's (2007) new taxonomy includes specifying goals, process monitoring, monitoring clarity, and monitoring accuracy. The questions used to measure students' metacognitive abilities can be seen through the instrument lattice in Table 11.

Table 11. Grid of Student Metacognitive Ability Questions

Indicator	Questions
Specifying Goals	What is your goal in learning about the human immune system?
Process Monitoring	To achieve the goal of learning about the human immune system, what steps did you take?
Monitoring Clarity	If you have not achieved your goal of learning about the human immune system, what will you do to achieve that goal?
Monitoring Accuracy	After studying the human immune system, provide 3 proofs that you have a correct understanding of the human immune system!

The data obtained were pretest and posttest scores. The questions used have been validated by experts and tested on students. The validity and reliability of the tested data have been analyzed. The analysis results showed that the four metacognitive ability questions were valid (average Sig. (2 tailed) = 0.000 < 0.05) and had a high level of reliability (alpha = 0.630). The data obtained from the pretest and posttest essay questions regarding students' metacognitive abilities in the experimental and control classes were then compared to the average score and categorized according to Arikunto (2012), as shown in Table 12.

Table 12. Categorization of Students' Metacognitive Ability Score

Score Interval	Criteria
80-100	Very Good
66-79	Good
56-65	Enough
40-55	Less
<39	Fail

Data Analytics

The differences in learning difficulties, cognitive anxiety, self-efficacy, and metacognitive abilities between the control and experimental classes were analyzed using independent T-tests or Mann-

Whitney tests. After these tests were conducted on each variable, a correlation test was conducted to determine whether there was a relationship between one variable and another, and a simple linear regression test was performed to assess the contribution of the relationship between variables using IBM SPSS 26.

Results and Discussion

The Effect of IBSR on Student Learning Difficulties

The learning difficulties experienced by students are an illustration of the academic stress experienced by students. Academic stress is defined as stress by students due to the school environment. Academic stress experienced by students during biology learning is the cause of students experiencing learning difficulties (Salsabila et al., 2023). Learning difficulties have a positive relationship with stress, the higher the level of student learning difficulties, the higher the level of stress experienced by students (Komarudin et al., 2022). The stress experienced by students can become a significant burden, particularly when it impairs their working memory, making it challenging for them to achieve their learning goals. Academic stress can have a negative impact on academic achievement, including lower learning outcomes, reduced self-efficacy, resilience, and social support, which can lead to learning difficulties (Frazier et al., 2019). In the control group, learning was conducted without applying the IBSR technique, while in the experimental class learning was conducted by applying the IBSR technique which was applied to each introductory activity and core activity (conducting investigations and drawing conclusions). Biology material used in both control and experimental classes is immune system material, with a specific focus on immune system disorders. The mean score on the student learning difficulty questionnaire for the control and experimental classes indicates that there is a significant difference in the learning difficulties of students in the two classes about the material on the immune system (Figure 2). Students in the control class exhibited higher learning difficulties than students in the experimental class.

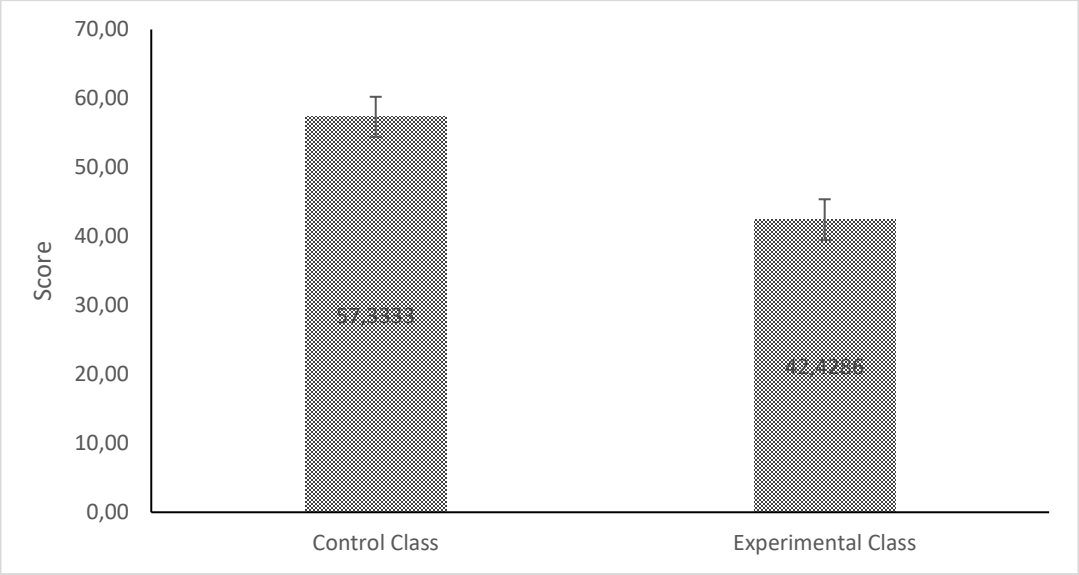

Figure 2. The scores of students' learning difficulties in the control class and experimental class show significant differences. Error bars show standard deviation.

The control and experimental classes were found to have mean scores for learning difficulties in the low category (Table 3). However, despite this similarity, there was a significant difference between the mean scores of the two classes (Table 13). The significant difference in students' learning difficulties between the control class and the experimental class is that in the experimental class, the academic stress experienced by students is reduced by the application of the IBSR technique during the learning process. In contrast, in the control class, academic stress has not been released, which results in a less optimal learning environment. This research conducted by Krispenz and Dickhauser (2019) that the use of IBSR techniques on someone who is experiencing stress can help reduce stress and anxiety. The stress experienced can decrease because the mind has become calmer and more controlled (Landau et al., 2016; Zadok-Gurman et al., 2021). A decrease in stress levels has effects on life including a more optimistic and positive life (Plexico et al., 2005). In learning, stress can cause students to experience

learning difficulties that have an impact on learning outcomes (Utami, 2020). Stress also correlates with learning outcomes, the higher the level of student stress, the lower the learning outcomes (Handayani et al., 2023). Based on this, learning difficulties experienced by students must be a concern.

Table 13. Independent Sample t-Test of Student Learning Difficulties

Student Learning Difficulties		Levene's Test for Equality of Variances		t-test for Equality of Means				95% Confidence Interval of the Difference	
		F	Sig	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Difficulties After Learning (Final)	Equal variances assumed	0.000	0.991	69	0.000	-14.90476	0.69565	-16.29254	-13.51698
	Equal variances not assumed			68.866	0.000	-14.90476	0.69580	-16.29290	-13.51663

Figure 3 shows data on the learning difficulties of control class students (without IBSR technique intervention) and control class students after IBSR technique intervention based on aspects. A comparison of the control and experimental classes reveals differences in the highest and lowest percentages of students experiencing learning difficulties across the five identified aspects. Students who did not receive the IBSR intervention exhibited the highest percentage of learning difficulties in aspect 1, which was classified as a high category.

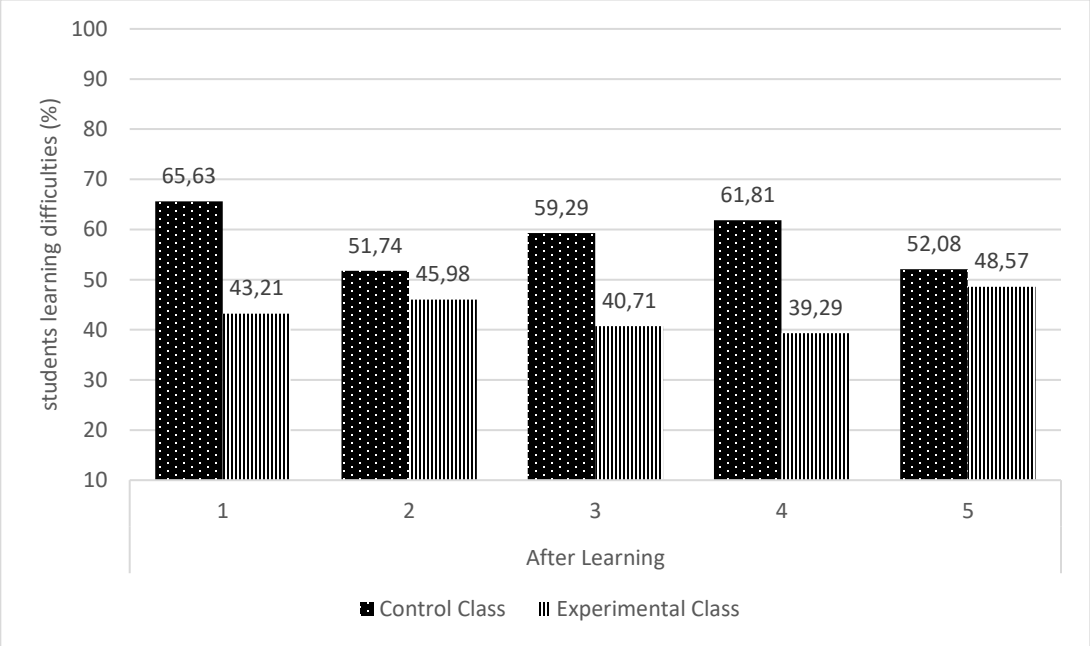

Figure 3. Percentage level of student learning difficulties per aspect of human immune system material (1 = students are slow to follow the lesson, 2 = inability in certain areas, 3 = academic difficulties in relation to uncontrolled behaviour, 4 = problems related to learning motivation, 5 = problems related to learning difficulties due to the teacher)

The high percentage results of the first aspect indicate that some students require additional time to complete tasks, which impedes their ability to follow lessons. This results in a lack of understanding of the material, necessitating repetition to ensure comprehension. This is to the research of Ananda and Wandini (2022) that students who experience learning difficulties have a behavior of always lagging in learning and doing assignments, the learning outcomes obtained are lower than their groupmates, and the teacher's strategy in overcoming these learning difficulties by repeating material in additional hours. Students with high stress levels will tend to exhibit slower learning rates due to the detrimental effects of stress on working memory (Berretz et al., 2021; Law & Clow, 2020). Students who received the intervention (IBSR technique) exhibited the highest percentage of learning difficulty levels in aspect 5. This percentage is included in the fair category. The intervention resulted in some students still experiencing learning difficulties related to learning methods or models, learning styles, and teacher attitudes applied by teachers during learning. This is normal because each student has a different learning style, the suitability of different learning methods or models to achieve the desired learning

objectives (Azizi et al., 2022; Fatmawati et al., 2019; Zamzami et al., 2020). The limited skills of teachers in choosing a suitable learning method or model also influence students' understanding when learning (Sudrajat, 2020). Students' low understanding of subject matter and mastery of concepts can be an academic stressor for students, resulting in learning difficulties (Safira & Hartati, 2021; Setyaningrum et al., 2023).

Students who did not receive IBSR technique intervention exhibited the lowest percentage of learning difficulties in aspect 2. This percentage includes the fair category. This category of students' learning difficulties shows that some students in the control class in learning do not experience learning difficulties related to hearing, vision, understanding messages through pictures, and obstacles in speaking. Although student learning difficulties in this aspect have the lowest percentage, at least it shows that the limitations of students' abilities influence student learning difficulties. Each student is unique, one of which is the limitations of abilities and circumstances that make each student have different difficulties (Kolipah, 2022).

Students with intervention (IBSR technique) who have the lowest level of learning difficulty are in aspect 4. The percentage is included in the low category. The intervention allows students to overcome learning difficulties related to learning motivation. The intervention helps students release stress due to a lack of enthusiasm for learning so that learning becomes more optimal. Based on research by Sujadi et al. (2021) Academic stress has a relationship with student learning motivation, the lower the student's academic stress, the higher the student's learning motivation. The low level of learning difficulties associated with learning motivation describes the stress experienced by the class with IBSR intervention due to lack of learning motivation can be resolved properly. When students' learning motivation is well maintained, learning outcomes will also be good (Priliyanti et al., 2021).

The Effect of IBSR on Students' Cognitive Anxiety

Cognitive anxiety is defined as the emotional state of students, manifested by feelings of tension, anxiety, and worry, which arise when learning biology. This emotional state causes discomfort in the cognitive system of students. One of the causes of students' difficulties in achieving learning objectives is cognitive anxiety, which can result in stress. Statistical analysis showed that there was a significant difference ($p < .001$) between the cognitive anxiety of control class and experimental class students during biology learning on immune system material (Table 14). The mean score on the cognitive anxiety questionnaire for students in the control class and the experimental class demonstrates that the material on the immune system has a significantly different impact on students' cognitive anxiety (Figure 4). Control class students exhibited higher levels of cognitive anxiety than those in the experimental class.

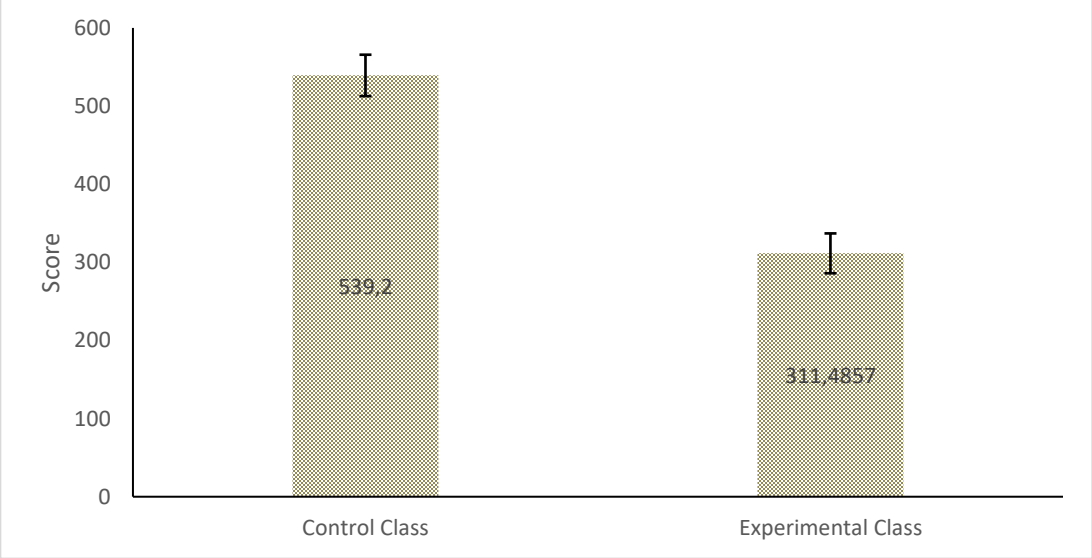

Figure 4. Students' cognitive anxiety scores in the control class and experimental class show significant differences. Error bars show standard deviation.

Table 14. Independent Sample t-Test of Students Cognitive Anxiety

Students Cognitive Anxiety	Levene's Test for Equality of Variances		t-test for Equality of Means				95% Confidence Interval of the Difference	
	F	Sig	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	0.020	0.887	68	0.000	-227.71429	6.21683	-240.11979	-215.30879
Equal variances not assumed			67.906	0.000	-227.71429	6.21683	-240.12010	-215.30847

Table 14 shows a significant difference in cognitive anxiety between the experimental class and the control class. After the intervention of the IBSR technique in learning the immune system, the experimental class students' cognitive anxiety had lower results than the cognitive anxiety of the control class. The cognitive anxiety of students in the experimental class is included in the medium category while the control class is included in the high category (Table 6). The cognitive anxiety of students in the experimental class in this moderate category is still within normal limits because in learning, especially during the test, students' cognitive anxiety must exist. However, if the amount is excessive, it will negatively impact student learning outcomes. Research by Permatasari et al.,(2018) and Putriani et al., (2020), indicated that Students' anxiety in facing exams, as long as it is still in the moderate category is a natural phenomenon, but when the anxiety is excessive will have an impact on disrupting learning and exam implementation. The high cognitive anxiety of students in the control class requires attention. Chen (2019), posits that high cognitive anxiety exerts a detrimental influence on academic performance and student motivation. Conversely, students with high anxiety exhibit a lack of motivation to learn, which subsequently impairs their academic performance. Students' cognitive anxiety can arise due to tension, anxiety, worry, and other unpleasant feelings in a certain condition (Yang et al., 2020). Cognitive anxiety can be defined as a person's ability to regulate cognitive processes (Hong et al., 2017). Research conducted by Mulyana et al. (2021) indicates that cognitive anxiety may be caused by a variety of factors, including difficulties in concentrating during learning, comprehension challenges, difficulties in working on questions or exams, and low confidence. Additionally, fear of decreased achievement may contribute to this phenomenon. This statement is similar to the research of Wahid et al.(2018) and Tijaroh et al. (2021) students with high levels of anxiety tend to have lower achievement than students with low anxiety. This can occur because academic anxiety has an impact on students' emotions, physiological and cognitive processes, thus affecting student performance and achievement at school (Chaku et al., 2021; Ciobotaru et al., 2021; Conroy et al., 2022; Suranata & Prakoso, 2020).

Figure 5 shows the difference in cognitive anxiety levels after learning the imun system in experimental and control classes based on aspects. In general, the intervention of IBSR technique in the experimental class can reduce all aspects of cognitive anxiety of students. This shows that the intervention of IBSR techniques carried out at several stages of learning is able to reduce stress due to anxiety about ability during the exam, anxiety in answering exam questions, anxiety getting into trouble during the exam and anxiety about exam results. The IBSR technique intervention helps release these thoughts so that students can better control the anxiety they experience. Meanwhile, although in aspect 1 the decrease in anxiety was not as optimal as other aspects, the IBSR technique intervention was able to reduce the level of anxiety before the exam to normal limits. Basically, student anxiety in facing exams is a phenomenon that usually occurs in learning when it is still within reasonable limits. This is in accordance with the statement of Nofrialdi et al. (2018) that anxiety is a common thing for students both during exams and while studying, but when anxiety is excessive it will affect one's activities. In contrast to the control class, after learning the immune system students tend to still have a relatively high level of anxiety compared to the experimental class because the stress due to anxiety experienced by students the exam to be faced is not released.

The five aspects of students' cognitive anxiety demonstrate a divergence in the acquisition of the highest and lowest percentages between the control class and the experimental class. The control class, which did not receive the IBSR technique, exhibited the highest percentage of cognitive anxiety in aspect 5. The high percentage of aspect five indicates that some students in the control class experience stress as a result of difficulty concentrating when taking the exam, worrying about failing the exam when they lack understanding of the immune system material, and worrying about not being able to do well on the exam. These stresses remain unresolved, resulting in elevated levels of cognitive anxiety. There is a positive correlation between stress and anxiety. In other words, the higher the level of stress, the higher the anxiety experienced (González-Valero et al., 2019; Stromájer et al., 2023; Xu et al., 2020; Zheng et al., 2023). These findings align with the assertion of Suswitha et al. (2022) that the most prevalent form of anxiety among students is difficulty concentrating during examinations and a fear of not achieving the desired results on examination outcomes. The ability of students to learn effectively can be influenced by a number of factors, both internal and external. Internal factors include hunger, nutritional intake, fatigue, and sleep. External factors include noise disturbance, the presence of others, an uncomfortable

physical environment, an excessive task load, inappropriate teaching methods, and stress (Noviansyah & Mujiono, 2021; Putri et al., 2021).

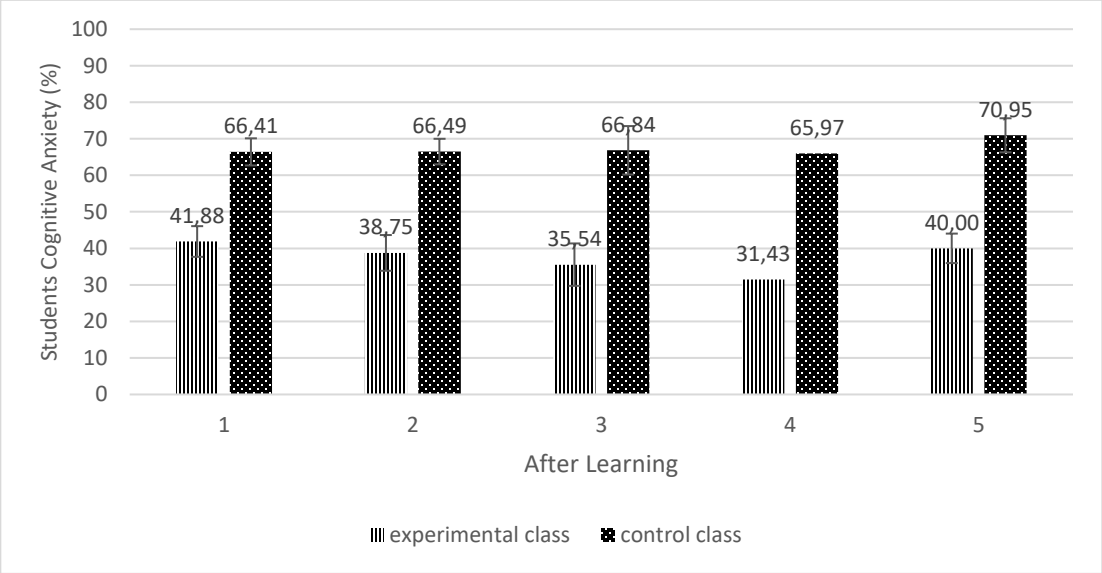

Figure 5. Percentage of students' cognitive anxiety per aspect on human immune system material (1= Anxiety before exam, 2= Anxiety about abilities during exam, 3= Anxiety in answering exam questions, 4=Anxiety about getting into trouble during the exam, 5=Anxiety about the exam results)

A study by Dewi et al. (2021) found a negative correlation between the level of concentration of students' learning and anxiety. The lower the level of concentration of students' learning, the higher the anxiety levels of students, and vice versa. Furthermore, the high level of cognitive anxiety observed in aspect 5 indicates that control class students have been unable to effectively manage excessive worry in the context of poor exam results. As indicated by Christianto et al. (2021), academic failure can instigate anxiety in students due to its bearing on academic success. This is consistent with the findings of Kusumastuti (2020), who demonstrated a negative correlation between anxiety and academic achievement. A reduction in student anxiety is associated with an increase in academic achievement, while an increase in anxiety is associated with a decrease in academic achievement. The high level of cognitive anxiety observed in this context indicates that some students in the control group are concerned about failing the examination due to a lack of understanding of the material pertaining to the immune system. Students may experience academic anxiety for a number of reasons. These include concerns about performing worse than their peers, the possibility of declining academic performance, the fear of not passing, and the inability to comprehend the subject matter, which can result in a decline in academic performance (Idris & Idris, 2019; Nurjanah & Alyani, 2021). In addition to the relationship with the teacher, the fear of failure in tests or exams is the most common source of anxiety experienced by students (Syarkawi, 2019).

The experimental class, which received the IBSR technique intervention, exhibited the highest level of anxiety in aspect 1. Although it represents the highest percentage, the level of anxiety in this aspect is included in the moderate category. As stated by Apriliana et al. (2019), anxiety is considered normal at low and moderate levels. This aspect describes the stress experienced by control class students as a result of self-preparation before the immune system exam begins. This includes difficulties learning immune system material, self-confidence and anxiety before taking the immune system exam, a state of pressure to get a good score on the immune system exam, and nervousness before the immune system exam material is still well controlled. This occurred as a result of the IBSR technique, which was implemented at various stages of the learning process before the exam. In addition to training students to eliminate the burden of thoughts, students were also trained to alter the initial mindset of students who were stressed due to negative thoughts into a more positive one. This enabled students to face the exam in a calmer manner. In accordance with the research of Landau et al (2016, 2021), the IBSR technique has been demonstrated to facilitate a more clear and focused mindset in individuals. The change in mindset direction is a consequence of a series of IBSR technique interventions that exert a positive influence, such as a shift in perspective on the stress encountered prior to the examination. This is consistent with the findings of Luff and Ledingham (2017), which indicate that IBSR intervention can facilitate a shift in perspective. This assertion is corroborated by the findings of Krizpenz and Dickhauser

(2019) and Feldman et al (2021), which indicate that IBSR is capable of facilitating the transformation of negative thoughts into positive ones.

Furthermore, the IBSR technique intervention has been demonstrated to influence the anxiety and worry experienced by students in the context of examinations. This is due to the fact that students have engaged in self-preparation prior to the examination, which has resulted in a reduction in their anxiety levels. The aforementioned preparations and the stressors that have been alleviated have resulted in students in the experimental class exhibiting a greater sense of self-assurance in their abilities. The characteristics of an individual with self-confidence can be observed in their attitudes, including behavior. These include being calm, not easily hesitating, not nervous, and being assertive (Wulandari et al., 2021). High self-confidence that causes anxiety will affect student learning outcomes (Sihotang, 2021). The results of the study indicate that students in the experimental class exhibited a greater sense of composure when approaching the exam, as they had a more comprehensive understanding of the material pertaining to the immune system. In contrast, students in the control class continued to experience feelings of nervousness when approaching the exam, as negative thoughts about the exam had not been addressed, thereby impeding their ability to comprehend the material. In accordance with the findings of Milena et al. (2022), the lack of comprehension of a subject can give rise to feelings of anxiety, nervousness, and pressure during learning, which subsequently affects the academic performance of students. Additionally, numerous studies have demonstrated a negative correlation between cognitive anxiety and academic achievement. Students exhibiting higher levels of cognitive anxiety tend to exhibit lower academic achievement (Kusumastuti, 2020; Tirajoh et al., 2021; Wahid et al., 2018).

Despite being classified as the lowest level of cognitive anxiety, the percentage of students in the control class who exhibited cognitive anxiety was included in the high category. In the control class, the high level of cognitive anxiety exhibited by students in aspect four indicates that they continue to experience stress due to concerns about the immune system exam, particularly when comparing themselves to their peers. One of the causes of academic stress among students is anxiety about facing exams and the concern that their peers are more adept at handling the pressure of these assessments (Alimah, 2019; Nofrialdi et al., 2018). The presence of competition with peers can result in elevated levels of cognitive anxiety, diminished attention, and suboptimal test performance (Fardani et al., 2021; Liu et al., 2024). In contrast, in the experimental class, this percentage is in the low category. This demonstrates that the IBSR technique intervention enables students to overcome anxiety related to exam stress if they are able to compare themselves favorably with their peers. The intervention facilitates the release of stress due to the presence of negative thoughts when facing the immune system exam, in comparison to other friends, thereby enhancing the optimality of the exam process. The IBSR technique intervention has the capacity to alter students' outlooks, rendering them more optimistic about their own efforts to confront the exam, while simultaneously lessening their tendency to dwell on the perceived shortcomings of their peers. Consequently, students in the experimental class tend to exhibit a greater degree of composure and tranquility in their approach to the exam, in comparison to their counterparts in the control class. This illustrates that the level of anxiety in facing this exam is of great importance, as it determines the optimality of the exam process. This is consistent with the findings of Ahmad et al. (2022), which indicate that elevated levels of student anxiety during the exam process can impede the effectiveness of the exam itself, resulting in suboptimal outcomes. A reduction in test anxiety levels has been demonstrated to have a positive impact, including an improvement in student academic performance (Pachaiappan et al., 2023).

The Effect of IBSR on Student Self-Efficacy

Self-efficacy refers to the belief held by students in their ability to achieve the learning goals set out for them. Self-efficacy can be considered as self-control that can reduce stress (Schwarzer & Warner, 2013). Statistical analysis showed that there was a significant difference ($p < .001$) between the self-efficacy of the control class and experimental class students during the learning of the immune system (Table 15). The mean score of the student self-efficacy test in the control class and the experimental class illustrates that the material of the immune system between the control class and the experimental class has significantly different student self-efficacy (Figure 6.) The self-efficacy of students in the experimental class is higher than that of students in the control class.

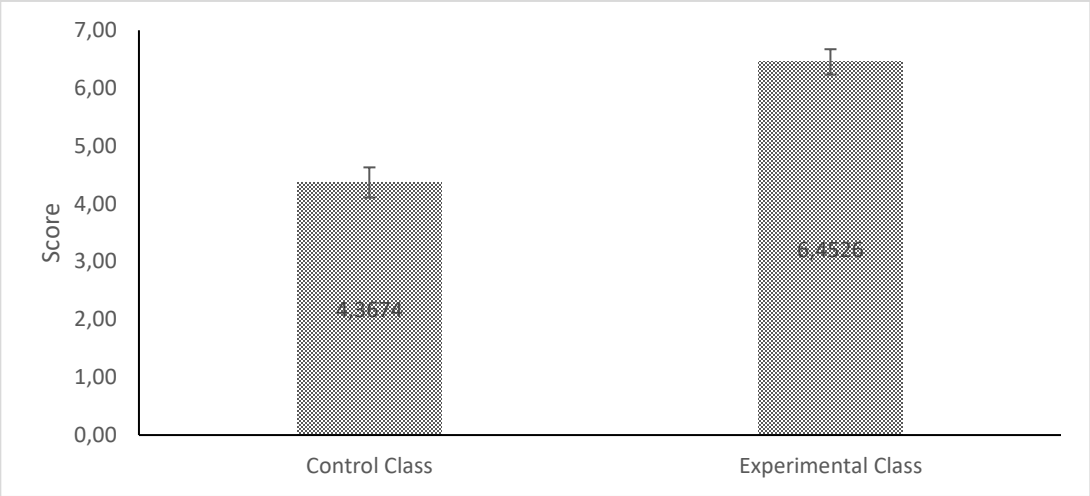

Figure 6. Significant difference in scores between students' self-efficacy in the control class and the experimental class on the material of the immune system. Error bars show standard deviation.

Table 15. Mann-Whitney Test of Student Self-Efficacy

Non-Parametric Test	Student Self-Efficacy
Mann-Whitney U	.000
Wilcoxon W	630.000
Z	-7.220
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Class	

Table 15 shows a significant difference in students' self-efficacy between the experimental and control classes. Based on the category, students who were given the intervention (IBSR technique) obtained a high category while students without intervention obtained a medium category (Table 9). These differences indicate that the IBSR technique intervention influences student self-efficacy in learning about the immune system. The IBSR technique intervention makes students reduce stress due to self-confidence in their abilities so that students become more confident in their abilities. Students' self-efficacy is negatively correlated with stress, the higher the students' self-efficacy of their abilities, the lower the stress experienced by students (Mo et al., 2020; Zheng et al., 2023). In the context of learning, self-efficacy plays a role in reducing stress due to academic conditions. Academic stressors include task overload, pressure due to work, frequent evaluations (exams), pandemic situations, and others (Alemany-Arrebola et al., 2020). This assertion is based on the findings of Tuzzahra et al. (2022), which indicates that the learning mode and tasks assigned by the teacher can impact students' self-efficacy. According to several studies, some factors cause high and low student self-efficacy, including internal and external factors. These internal factors include nervousness and student mood (Ahn & Bong, 2019; Sigiro et al., 2017) and external factors including cognitive anxiety, teacher support, peer support, and family support (Budescu & Silverman, 2016; Gutiérrez-García & Landeros-Velázquez, 2018; Landau et al., 2021; Nauvalia, 2021; Prihastyanti & Sawitri, 2020).

Figure 7 shows the percentage of students' self-efficacy in the experimental class (IBSR intervention) and control class (without IBSR intervention) based on aspects. The highest percentage of students' self-efficacy on immune system material between the control class and the experimental class is in aspect 1, namely the level aspect. Although the control and experimental classes exhibited comparable highest percentage results, there were discernible differences in percentage categories between students who received the intervention (IBSR technique) and those who did not. Students who received the intervention (IBSR technique) were in the very sure category, while students who did not receive the intervention were in the less sure category. This illustrates that students in the experimental class are highly confident in their ability to comprehend and utilize immune system material in their daily lives, while students in the control class exhibit less confidence in their understanding of immune system material. In the experimental class, the stress conditions resulting from students' uncertainty regarding their ability to comprehend the immune system and its practical applications were mitigated through the IBSR technique, enabling students to prioritize the learning process and temporarily disregard external distractions. When the stressors are alleviated through the IBSR technique, students can optimize their abilities, fostering high confidence in their ability to overcome the challenges encountered during the learning process and apply their understanding in their daily lives. Students with low academic stress

will produce high self-efficacy. The higher the student's self-efficacy, the lower the academic stress experienced by students (Avianti et al., 2021; Fatmana & Ansyah, 2023; Zheng et al., 2023). Student self-efficacy is positively correlated with student comprehension, the higher the student's self-efficacy, the higher the student's comprehension of the material (Ramadoni & Mustofa, 2022). Students without intervention cannot control their stress conditions well, so it is difficult to achieve concentration during immune system learning. Students' understanding of biological material becomes less effective when students find it difficult to concentrate while learning (Azizah & Alberida, 2021). Academic stress is one of the reasons why students find it difficult to concentrate (Andiarna & Kusumawati, 2020).

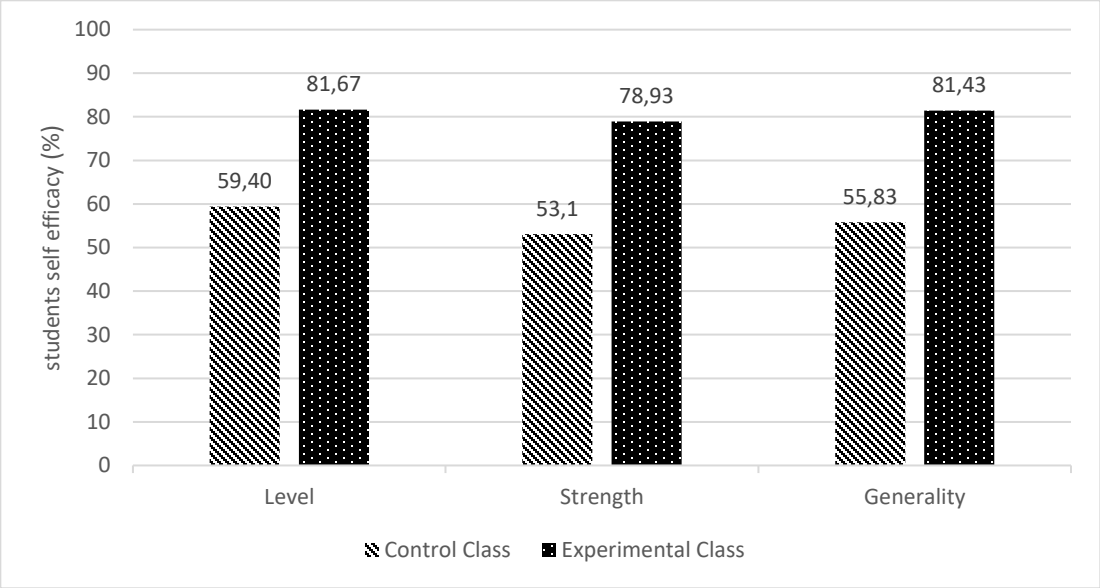

Figure 7. Percentage of students' self-efficacy based on aspects of the human immune system material

The lowest percentage of students' self-efficacy in immune system material between the control class and the experimental class is in aspect 2, the strength aspect. Although the control class and the experimental class have the same lowest percentage results, there are differences in the percentage categories between the students who received the intervention (IBSR technique) and the students who did not receive the intervention. In the strength aspect, the students who received the intervention (IBSR technique) were in the sure category and the students who received no intervention were in the less sure category. These results illustrate that students who are given the intervention have good confidence in completing tasks and problems of learning the immune system well, while in the control class, students are less confident in being able to complete tasks and problems of the immune system given by the teacher. Based on unstructured interviews, students who are less confident in being able to complete tasks well because there is influence from their peers and feel the burden of tasks from different subjects given is too much, making students stressed and lazy to do assignments. One of the strongest factors that influence students' self-efficacy is their peers (Altermatt, 2019). Students who have low self-efficacy in the strength aspect will be easily influenced by their environment so that they become lazy in learning and tend to give up quickly when faced with tasks (Lianto, 2019; Lubis et al., 2022; Rosdiana et al., 2020). Stress conditions due to high task load and bad environmental influences on students in experimental classes were investigated using the IBSR technique so that students could optimize the actions they take during learning. Properly resolved stress affects belief in the actions taken (Ngui & Lay, 2020). Self-efficacy is considered a strong attitudinal determinant of student behavior because it can control stress (Freire et al., 2020; Lannin et al., 2019).

The Effect of IBSR on Students' Metacognitive Ability

The initial test (pretest) was conducted to measure students' initial knowledge of immune system material. The average pretest score of the control class (M = 41.81, SD = 13.168) compared to the experimental class (M = 44.09, SD = 9.095) showed no significant difference ($p > .05$). The final test (posttest) illustrates students' ability to plan, monitor and evaluate learning activities optimally. The average posttest score of the control class (M = 66.19, SD = 12.506) compared to the experimental class (M = 73.09, SD = 10.785) showed there was a significant difference ($p < .05$). A detailed statistical analysis of pretest and posttest can be seen in Table 16.

Table 16. Independent Sample t-Test of Students' Metacognitive Ability

Metacognitive Ability		Levene's Test for Equality of Variances		t-test for Equality of Means				95% Confidence Interval of the Difference	
		F	Sig	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pretest	Experimental Class	9.018	0.084	69	0.356	2.502	2.693	-2.870	7.875
	Control Class			62.329	0.354	2.502	2.680	-2.853	7.858
Posttest	Experimental Class	0.533	0.468	69	0.015	6.891	2.775	1.356	12.427
	Control Class			68.042	0.015	6.891	2.769	1.366	12.417

The results of the pretest demonstrated that the experimental class (IBSR technique intervention) exhibited a lower average score than the control class (without IBSR technique intervention), which scored in the poor (less) category. Conversely, the average posttest score of the experimental class was classified as very good, while the control class scored in the good category (Table 12). The acquisition of the average post-test score was significantly different. The discrepancy in the average post-test score between the control class and the experimental class is believed to be attributable to the differing metacognitive abilities of the students. In the control class, some students experienced stress that was not released, which negatively impacted their metacognition of things outside of learning. This resulted in an inefficient learning process. In contrast, students in the experimental class utilized the IBSR technique to reduce stress, which enhanced their metacognitive abilities in learning. This assertion is corroborated by the findings of Landau et al. (2021), which indicates that the implementation of the IBSR technique can effectively mitigate stress.

Figure 8 illustrates the discrepancy in the mean post-test score between the control and experimental classes. In addition to the potential influence of students' metacognitive abilities, several other factors may contribute to this discrepancy.

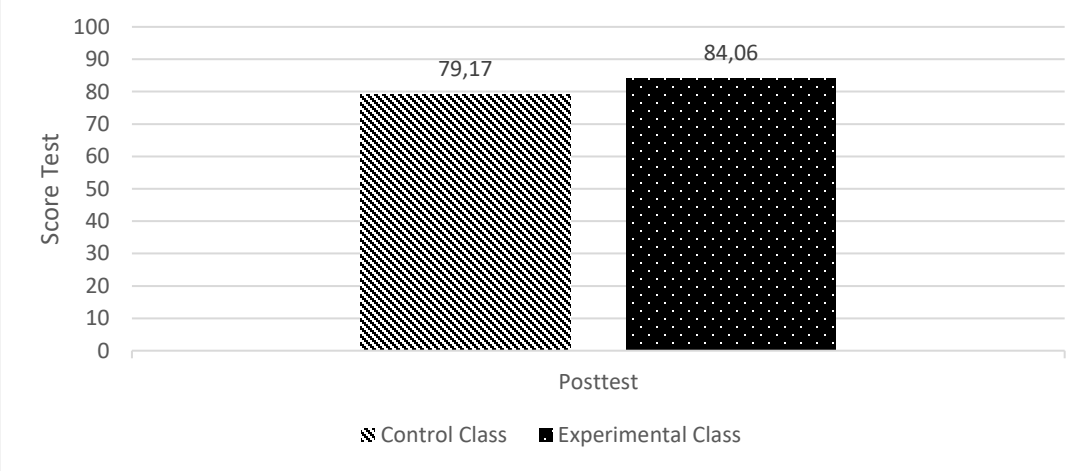

Figure 8. Average Posttest Score of Control Class and Experimental Class on Immune System Material

These include the lack of teacher-led learning activities that foster metacognitive abilities, the continued dominance of teacher-centered learning approaches, the limited availability of learning resources, and the use of repetitive learning methods and models that prevent students from developing their metacognitive abilities (Ermin, 2021; Sari & Subali, 2021; Wilis et al., 2023). Based on the results of the researcher's study in pre-research, the teacher still uses conventional learning methods in learning. Research by Adiansyah et al. (2022) indicates that to improve metacognitive abilities, it is necessary to apply a learning model that can develop students' metacognitive abilities. The Problem-Based Learning (PBL) model has the characteristics of student-centered learning (Widodo, 2021). Student-centered learning supports students in practicing their metacognitive abilities such as how students can know good learning, know their learning abilities and modalities, and know effective learning strategies (Erlin et al., 2021). Biology learning should not only be about learning concepts and theories but students are also directed to learn to observe various phenomena in life so that they can formulate problems, provide solutions, and solve these problems (Azrai et al., 2022). This PBL model trains students to cognitively search for information related to the topic of disorders in the immune system more, but in stress conditions that have been accommodated by the intervention (IBSR technique) the metacognitive abilities of students in the experimental class obtained better results than the control class which can be seen from the average posttest score.

The relationship between learning difficulties, cognitive anxiety, self-efficacy, and students' metacognitive abilities

Prior to the administration of the correlation test, the requisite preliminary tests were conducted, namely the normality and homogeneity tests. The objective of the correlation test was to ascertain the relationship between learning difficulties, cognitive anxiety, self-efficacy, and students' metacognitive abilities. The simple linear regression test was conducted to determine the extent to which student learning difficulties caused by academic stress contributed to cognitive anxiety, self-efficacy, and metacognitive abilities. Further details are shown in Table 17 and Table 18.

Table 17. The results of the correlation analysis of learning difficulties, cognitive anxiety, self-efficacy, and metacognitive abilities of students on the material of the immune system

Variables	r	Sig.	Correlation
Student Learning Difficulties→Student Cognitive Anxiety	0.397	0.004	Correlated**
Student Learning Difficulties→ Student Self-Efficacy	-0.390	0.001	Correlated**
Student Learning Difficulties→Student Metacognitive Ability	-0.274	0.111	Uncorrelated

*p** < 0.05

*p*** < 0,01

Note: r: Correlation Coefficient Value, Sig: Significance

Table 17 shows the difference in the relationship and the value of the correlation coefficient between variables. The value of the correlation coefficient on the relationship between student learning difficulties with student cognitive anxiety, the relationship of cognitive anxiety with self-efficacy, and the relationship between self-efficacy and students' metacognitive abilities show a positive relationship. Conversely, the correlation coefficient values for the relationships between student learning difficulties and self-efficacy, cognitive anxiety and self-efficacy, and cognitive anxiety and students' metacognitive abilities indicate a negative correlation. The results of the correlation test indicate that a reduction in student learning difficulties does not significantly contribute to a reduction in cognitive anxiety and an increase in student metacognition. The reduction in students' learning difficulties only contributes to an increase in self-efficacy and cognitive anxiety, and even then, only about 15% (Table 18). Thus, the IBSR intervention can indeed reduce student learning difficulties. However, these learning difficulties do not have a large contribution to self-efficacy, metacognitive ability, and cognitive anxiety. The high self-efficacy and metacognitive ability of students and the low cognitive anxiety of students are direct effects of the IBSR technique intervention. This result is from the research of Krispenz et al. (2019) that IBSR can reduce anxiety. Reinforced by research by Smernoff et al. (2019) that IBSR can reduce levels of depression, and anger anxiety and improve happiness and quality of life.

Table 18. Results of linear regression analysis of student learning difficulties on student cognitive anxiety and student self-efficacy on immune system material.

Variables	B	R^2	*p*-value
Student Learning Difficulties→ Student Cognitive Anxiety	0.368	0.158	0.004**
Student Learning Difficulties→ Student Self-Efficacy	-0.157	0.152	0.001**

*p** < 0,01*

*p** < 0.05*

Note: B: Regression Coefficient Value; R2: Coefficient of Determination

Table 18 shows that the greatest contribution of IBSR intervention is found in the relationship between decreased student learning difficulties and decreased student cognitive anxiety. Although the contribution is the largest, the actual decrease in student learning difficulties is not a large contribution to the decrease in student cognitive anxiety and the increase in student self-efficacy. The reduction in students' learning difficulties only contributed to students' cognitive anxiety and an increase in students' self-efficacy, and even then, only to a limited extent, amounting to approximately 15%. Consequently, the implementation of the IBSR technique can effectively diminish students' learning difficulties. However, this reduction in students' learning difficulties does not have a substantial impact on the enhancement of students' self-efficacy and the alleviation of students' cognitive anxiety. The observed increase in students' self-efficacy and the decline in students' cognitive anxiety can be attributed to the direct effects of the IBSR technique.

The decrease in student learning difficulties has a very significant contribution (p> .01) to the decrease in cognitive anxiety, which is 15.8%. This is in line with the results of research by Smernoff et al. (2019), which indicates that IBSR is an effective intervention for reducing anxiety in secondary school students,

with a 7.1% reduction in anxiety observed. The regression coefficient is positive, so it can be concluded that the decrease in students' learning difficulties in decreasing students' cognitive anxiety has a positive direction. So if students who experience learning difficulties due to stress are high then students' cognitive anxiety will also be high (Onieva-Zafra et al., 2020; Pokhrel et al., 2020). Research conducted by Hoying et al. (2020) indicates that a person's high level of stress is one of the factors that affect anxiety. Some research findings indicate that students' stress has a relationship with students' cognitive anxiety (Ferreira et al., 2020; Moghadam & Ganji, 2019) moreover, there is a positive correlation between student stress and student cognitive anxiety (González-Valero et al., 2019; Xu et al., 2020).

The reduction in student learning difficulties has a highly significant impact ($p > .01$) on increasing student self-efficacy, which is 15.2%. The regression coefficient is negative, indicating that the effect of reducing student learning difficulties caused by stress on increasing student self-efficacy has a negative direction. This assertion is supported by several studies indicating a negative correlation between student stress and student self-efficacy. The lower the stress experienced by students, the higher the student self-efficacy (Sharififard et al., 2020; Suresh et al., 2020). According to research by Vasquez et al. (2022) Self-efficacy is one of the predictors of student stress.

Conclusion

The IBSR technique, which is a psychological intervention, has been demonstrated to reduce students' academic stress and cognitive anxiety in the context of immune system material. This has the effect of improving students' metacognitive abilities and self-efficacy. A correlation exists between a reduction in student learning difficulties and a decline in cognitive anxiety, as well as an enhancement in student self-efficacy. However, the decrease in student learning difficulties is not causally linked to an increase in student metacognitive abilities.

A limitation of this study is the relatively small sample size, which may not be representative of secondary education units. To ensure the reliability of the results, students must undergo habituation through the IBSR technique to familiarize themselves with the activities of the IBSR technique during learning, particularly during the "turnaround" stage. This may lead to students attributing blame to themselves. Our highest appreciation goes to all the experts involved in validating the instruments of students' learning difficulties, students' cognitive anxiety, students' self-efficacy, and students' metacognitive abilities. We would also like to thank the school principal for permitting us to conduct the research and all the teachers and students who participated in this study.

Conflicts of Interest

The authors declare that there is no conflict of interest

Author Contributions

A. Salsabila: Data collection, Data analysis, and Interpretation of results**. A. Rahmat:** Provide direction on data analysis, interpretation of analysis results, direct and provide input on the presentation of results and discussion and are academically responsible for the overall results of the contents of this article. **Y. Hamdiyanti:** Provide direction on data analysis, interpretation of analysis results, direct and provide input on the presentation of results and discussion and are academically responsible for the overall results of the contents of this article.

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