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Identification of Students' Science Anxiety: Do Grade Level and Gender Affect It?

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Abstract: This study aims to identify the level of junior high school students' science anxiety, determine the effect of the three indicators of science anxiety on the level of science anxiety, and explore the differences between students' science anxiety based on class and gender. The study was conducted descriptively quantitatively through a survey of 205 junior high school students in Bandung Raya, using the Science Anxiety Questionnaire instrument which was developed multidimensionally by measuring students' learning anxiety, test anxiety, and class anxiety. Parametric statistical tests stated that the three indicators predicted students' science anxiety, students' test anxiety was higher than other anxieties, there was no significant difference in science anxiety between females and males, and there was a significant difference in science anxiety between students in grades VII, VIII, and IX.

Keywords: Emotion in classroom; Gender; Grade level; Science anxiety; Science learning

Introduction

Emotion is a stimulus felt by a person when they get or experience an event that is subjectively important to themselves, giving rise to an adaptive psychological response (Li et al., 2020). Because of their role as determinants of behavior, emotions are central to life (Edara, 2023; Li et al., 2020). Since the symposium on "emotions in learning" in 1998, there has been a significant increase in scholarly interest and research on emotions in educational contexts (Pekrun, 2024; Schutz & Lanehart, 2002). Various studies in this field have come to the generally agreed conclusion that students' emotions, especially children and adolescents, are essential to every aspect of learning, whether positively or negatively (Glaser-Zikuda et al., 2013; Mustafina et al., 2020; Pekrun et al., 2017; Schutz & Lanehart, 2002). Emotions are believed to have an impact on various academic elements such as motivation, cognitive performance, and personal development, and are even predicted to be a key precursor of student success in achieving (Mustafina et al., 2020; Pekrun, 2024; Pekrun et al., 2017; Pekrun & Stephens, 2009). This is because emotions determine what students can learn and what they can retain in the long term, as an important component of cognitive processes that can regulate perception, attention, memory, and decision-making (King & Chen, 2019; Li et al., 2020; Mustafina et al., 2020).

In addition to being assumed to be the cause of how students shape the quality of their learning outcomes, emotions themselves are seen as an impact of learning achievement that still needs attention because it is related to students' self-identity, mental health, and well-being (Pekrun et al., 2017). For example, students who get bad grades in science will feel sad or disappointed. If not helped to deal with it, these emotions may make students reluctant to study science again. The back-and-forth relationship between students' achievement and emotions has opened up the view of so-called achievement emotion, which occurs

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specifically in the educational domain, or a specialized form of academic emotion, and may explain how emotions and achievement are connected to each other (Harley et al., 2019; Pekrun et al., 2017). On the other hand, an additional reason why emotions are considered something very important and need to be aware of their presence is because they also have an effect on the way students socialize with their peers and teachers, or social functioning (Mustafina et al., 2020).

The classroom, where emotional dynamism occurs in students, can produce different forms of emotions. There are two major groups used to classify emotions based on what students feel in the classroom when faced with learning activities, namely negative emotions such as anxiety, fear, annoyance, embarrassment, and boredom; and positive emotions such as comfort, hope, pride, and satisfaction (Harley et al., 2019; King & Chen, 2019; Pekrun, 2024). However, positive emotions do not always have a positive impact and negative emotions do not always have a negative impact, so educators are advised to be nonjudgmental of students' feelings during learning. Both positive and negative emotions can have positive or negative effects depending on how students manage them, especially with the help of educators.

For example, a student who is anxious because they are about to face an exam has two possibilities, the first is to study to prepare themselves so that their anxiety subsides, or focus on distracting themselves because they do not want to continue feeling anxious (Harley et al., 2019). So, although anxiety is included in negative emotions, there is no certainty that its impact will also be negative because, on the other hand, anxiety can be a trigger to do positive things if handled properly (Rebolledo-Mendez & Huerta-Oacheco, 2021). Therefore, emotion regulation is needed to make emotions when learning can be controlled and not have bad consequences (Harley et al., 2019). Those who are emotionally intelligent or have Emotional Intelligence are more likely to do well in emotion regulation because there is a qualified ability to perceive emotions, understand, and realize them before regulating them (Arias et al., 2022; Sánchez-álvarez et al., 2020). Emotional intelligence is also positively correlated with learning motivation and has a significant effect on student academic achievement (Arias et al., 2022; Sánchez-álvarez et al., 2020). However, before getting to the regulation stage, the most crucial first stage is to recognize emotions.

Of the two types of academic emotions that students can potentially feel during learning, research suggests positive emotions are difficult to identify because only a few physical responses can be observed by the eye, whereas this type has no distinctive features that distinguish it from other expressions. In addition, positive emotions are also found to be fewer than negative emotions, with a 1:3 ratio (Valiente et al., 2012). Based on these considerations, what teachers can do to make students able to undergo learning without being distracted by emotions is to try to identify negative emotions to minimize the adverse effects that may occur, such as the spread of negative emotions transmitted from one student to another. The mechanism of emotional contagion can be explained by the neuroscience theory of mirroring and mentalization networks that make a person imitate and adjust their expressions, vocals, and posture automatically with others due to the presence of unified emotional states (Li et al., 2020). In education, emotional contagion is an interesting concept because it has a high chance of occurring, especially in the classroom, where there are many students of relatively similar age and learning experiences sitting close to each other and spending time together.

One negative emotion that often arises in the academic realm and has long been a focus of research in educational psychology is anxiety (Pekrun, 2024; Schutz & Lanehart, 2002). Anxiety is a very complex form of emotion because its symptoms are diverse and broad, with impacts that are also not mild (Nuraeni & Ratnaya, 2023). Anxiety can be defined as unpleasant feelings such as worry, nervousness, and restlessness that create discomfort due to a feeling of being threatened by something uncertain (Barlow, 2002). Anxiety is referred to as academic anxiety if it occurs in a learning environment, which includes anxiety due to fear of not being able to do assignments or complete classes with good performance (Purwanti et al., 2019). However, some subjects that have high abstraction, such as mathematics and science, have more specific anxiety characteristics (Parikesit & Damiyanti, 2019). Math and science anxiety were once unified and assumed to be related to each other (Chiarelott & Czerniak, 2010). However, in 1977, the first reported case of clinical science anxiety was when a student experienced symptoms of anxiety towards science subjects, even when his performance in Math subjects was good (Mallow, 1987). From there, the concept of science anxiety emerged, which eventually separated from Math anxiety.

Science anxiety can be defined as a condition when a student is uncomfortable when confronted with the concept of science, scientists working in the field of science, and all science activities in general which will usually end up in a desire to avoid science things, even more dangerous, anti-science (Chiarelott & Czerniak, 2010; Davis, 1981; Mallow, 1981). The causes of science anxiety are diverse, such as bad experiences during

science learning, science anxiety experienced by teachers who teach in the classroom, the absence of role models, racial and gender stereotypes, and stereotypes of scientists presented by the media (Mallow et al., 2010). Science anxiety is related to students' science self-efficacy, achievement, and performance in science subjects (Avci & Kirbaşlar, 2017; Burns et al., 2021; Cho & Aye, 2020). In addition, other findings also explain that students' science anxiety levels vary depending on grade level, gender, exposure to books and scientific documentation, scores obtained in science exams, comfort level when studying science subjects, parents' education level, whether or not there is a habit of studying science at home, and pressure to study science that comes from parents (Karakaya, 2016; Mallow et al., 2010; Mallow, 1987; Ucak & Say, 2018).

After understanding the role of emotions in the classroom, particularly science anxiety that can impact various elements of learning, this study is intended to focus on identifying science anxiety among junior high school students in Indonesia. By adopting the multidimensional concept of Math anxiety with three indicators, namely learning anxiety, class anxiety, and test anxiety (Andre & Peetsma, 2022), the research aims to fill a gap in the local literature that tends to focus only on one particular indicator. The research offers a more comprehensive picture of science anxiety by exploring a holistic understanding of the indicators believed to influence it. This approach has not been widely practiced in previous studies in the context of science anxiety, especially in Indonesia. The research will also dissect differences in science anxiety levels by gender and class, providing a deeper understanding of how demographic factors and science anxiety are interconnected. The results are expected to make an important contribution to understanding emotion dynamics in the classroom, potentially providing a foundation for emotion-based educational policies in more adaptive science learning.

Method

This study was conducted using a descriptive quantitative method through a survey of 205 junior high school students in two places in Bandung Raya. Both schools are public schools with a zoning system, where students who are accepted are students who live not far from the school. The difference lies in the area of the school, with one school located in Bandung City, in the densely populated north part of Bandung City (school A), and one school located in West Bandung Regency, in a large tea plantation area (school B). The samples were drawn randomly. The survey was conducted over one week in September 2024. Demographic data of the sample can be seen in Table 1.

Table 1. Demographic Data of the Research Sample

Category		N	Percentage (%)
School Origin	Bandung City	121	59
	Bandung Regency	84	41
Grade	VII	125	61
	VIII	52	25
	IX	28	14
Gender	Female	106	52
	Male	99	48

The instrument used in the study was the Science Anxiety Questionnaire with a 5-point Likert scale (never, rarely, sometimes, often, and very often) developed from the research of Guzeller et al. (2012) and Henschel (2021), with three indicators, namely study anxiety, class anxiety, and science test anxiety. Each indicator had expanded sub-indicators adopted from Pekrun et al. (2009) research, which included cognitive, affective, physiological, and motivational sub-indicators. Some of the items were adopted and translated from the original language, while others were created directly according to the context to be measured. The validated questionnaire resulted in a 47-item Science Anxiety Questionnaire with a Cronbach Alpha of 0.889, which is reliable.

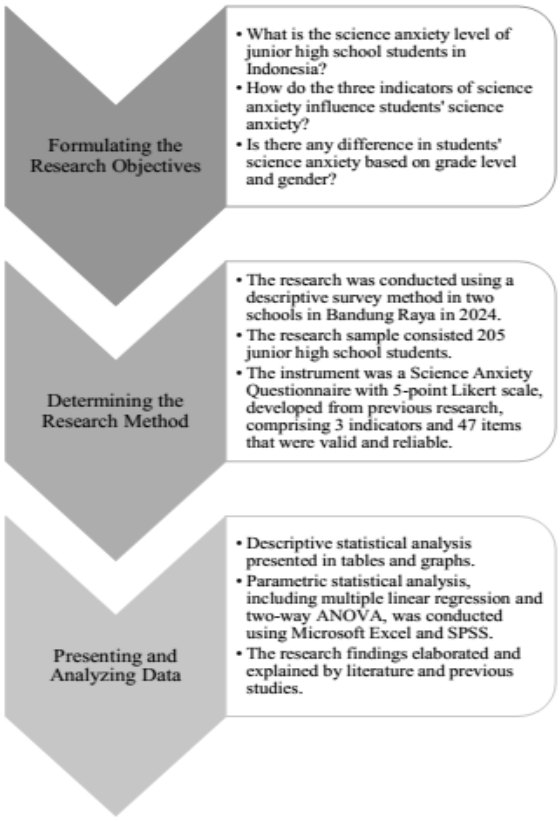

Figure 1. Illustration of the research flow

The research data were presented in tables and bar charts, then processed using descriptive and parametric statistical tests using Microsoft Office Excel 2016 and SPSS version 22 with multiple linear regression tests to determine the most influential indicators on science anxiety and Two-Way ANOVA tests to see the effect of gender differences and grade level on science anxiety. After that, the analysis is done by explaining the results and relating them with existing studies and theories. Briefly, the research flow can be reviewed from Figure 1.

Result and Discussion

The Effect of Science Anxiety Indicators on Students' Science Anxiety

The multiple linear regression test showed that all indicators of science anxiety (learning anxiety, test anxiety, and class anxiety) have a significant positive effect on student science anxiety, marked by a value of 0 in the Sig column. The value of Sig. <0.05 means that there is a partial positive effect of each indicator on the dependent variable. With the equation formula Y = a + b1x1 + b2x2 + b3x3, the equation is obtained as follows: Y = 0.197 + 0.330 + 0.469 + 0.445. In addition, Table 2 on Standardized Beta Coefficients also shows that the effect produced by test anxiety is higher than the effect produced by the other two indicators, followed by class anxiety, and ending with learning anxiety. Seeing that Science test anxiety is the most influential indicator of overall science anxiety, which although the value is not high, is the highest when compared to other indicators, it is assumed that it affects the urgency of the research so that more research is done independently than research on other indicators of science anxiety.

Table 2. Coefficient Table of Multiple Linear Regression Test Results

Model		UC		SC	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.197	0.024		8.058	0
	Learning anxiety	0.330	0.014	0.291	23.720	0
	Test anxiety	0.469	0.012	0.517	40.675	0
	Classroom anxiety	0.445	0.015	0.361	29.973	0

Note: UC = Unstandardized coefficients; SC = Standardized coefficients; *Dependent Variable = Science Anxiety

Science anxiety determined by three main indicators is based on previous research on mathematics anxiety, which distinguishes aspects of the weight of the material both in learning and assignments, the circumstances of facing exams, as well as external factors that are less controllable by students such as classroom conditions, including physical factors in the classroom and students social interactions with teachers or peers (Amico & Geraci, 2022; Andre & Peetsma, 2022; Tracy et al., 2022). The purpose of developing these indicators is to explain how science anxiety can be predicted by several dimensions of learning, rather than being seen from only one side so that it is comprehensive. In another study, science anxiety was also determined by an additional indicator, namely laboratory activity anxiety (Cho & Aye, 2020). The results obtained from this study indicate that science anxiety experienced by students is a combination of various aspects of anxiety felt by students towards science subjects, both before, during, and after learning is carried out.

The elements considered in science anxiety are generally related to learning anxiety, test anxiety, and science class anxiety, although not explicitly grouped into three indicators. Students usually feel anxious about assignments, have negative opinions and attitudes towards science teachers, are uncomfortable when science class begins, and feel other negative emotions when trying to solve problems related to science (Fia et al., 2022). The anxiety arises because students have thoughts about the past that are less pleasant or fear the future related to science (Mallow & Greenburg, 1983). The causes are diverse and different in almost every person but have some things in common, namely family, school, and media (Mallow & Greenburg, 1983). In more detail, science content may be perceived as difficult or disliked, lack of qualified infrastructure, and lack of teacher ability to deliver teaching materials, especially those that are complex in nature (Fia et al., 2022).

Differences in Science Anxiety Based on Grade Level and Gender

Overall, the average score of students' science anxiety level in this study was 2.63, which means they have "rarely" to "sometimes" anxiety in science. Meanwhile, the students' total score of science anxiety is 123.61 out of 235. This means that the students' anxiety level is at a percentage of 52.6% or in the medium category. This contradicts previous research which states that students' academic anxiety, especially those related to science subjects, tends to be high (Halmuniati et al., 2018; Hasniati, 2017; Lusi et al., 2023; Purnama et al., 2023; Yusna, 2021), while students' test anxiety is in a low category (Azrai & Prasetya, 2016; Nurfitri & Muldayanti, 2018). The existing differences may occur because, in previous studies, the form of science anxiety measured only uses one separate dimension, while in this study it is a combination of multidimensions.

Table 3. Summary of the Descriptive Analysis Results

Category		N	Mean	SD	SE	Min	Max
Grade	VII	125	2.64	0.42	0.37	1.65	3.56
	VIII	52	2.77	0.41	0.58	1.83	3.75
	IX	24	2.43	0.32	0.60	1.65	3.06

Category		N	Mean	SD	SE	Min	Max
Gender	Female	106	2.66	0.41	0.40	1.65	3.56
	Male	99	2.63	0.42	0.42	1.65	3.75

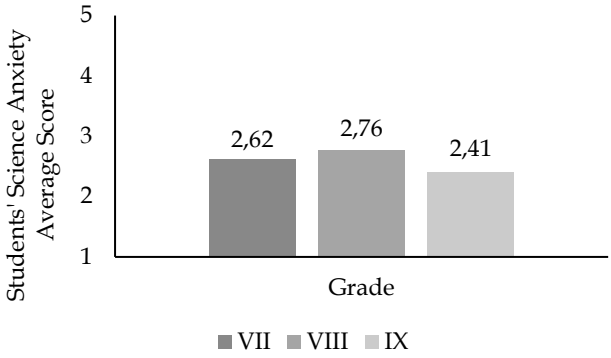

Figure 2. Comparison of student science anxiety average score by grade level

The results shown in Figure 2 explain that grade VIII students felt higher science anxiety than grade VII and IX students, followed by grade VII students, and the lowest was grade IX students. This finding is not in line with various studies that mention that students in higher grade levels are more anxious than students in middle and lower grade levels, because students who already have complex learning loads accompanied by the goal of continuing their education to advanced levels tend to feel excess academic anxiety (Karakaya, 2016; Santos et al., 2021; Ucak & Say, 2018). There are several assumptions that make the results of this study different. First, the science curriculum in Indonesia creates a dense academic workload for grade VIII students, including material related to numbers and formulas (Physics). Second, students in grade VII have a high level of science anxiety potentially due to the transition of material, environment, and habits from elementary school to secondary school. Third, the sample data that is currently in grade IX has the least amount than the samples of grade VII and grade IX, so the data is less representative of the population.

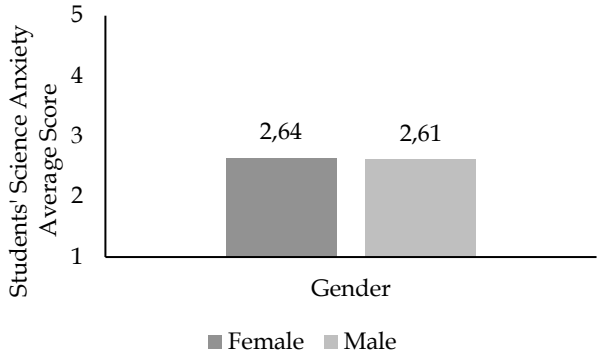

Figure 3. Comparison of student science anxiety average score by gender

From figure 3, it can be seen that the level of female students' science anxiety is slightly higher than males. This result is in line with previous studies (Kiran & Sungur, 2012; Mallow et al., 2010; Mallow, 1981; Martínez-Pérez et al., 2023; Megreya et al., 2021). The same findings are almost always consistent. A possible reason could be gender stereotype (Mallow et al., 2010). Therefore, teachers need to be cautious if they find differences in emotions in female and male students. In the Western, emotions have a hierarchy based on whether they are desirable or undesirable. Positive emotions will be recognized more than negative emotions because social norms have indirectly selected certain emotions that are allowed to emerge or not by people who are considered competent—in the context of education, teachers. This has the potential to lead to oppression and injustice towards certain groups who may be more likely to show negative emotions, such as women and children, and they will be considered 'less rational' (Cliffe & Solvason, 2020).

Table 4. Anova Two-Way Test Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.640a	5	0.528	3.017	0.012
Intercept	960.607	1	960.607	5488.875	0.000
Class	2.213	2	1.107	6.324	0.002
Gender	0.000	1	0.000	0.003	0.958
Class * Gender	0.338	2	0.169	0.966	0.383
Error	34.827	199	0.175		
Total	1455.379	205			
Corrected Total	37.467	204			

Dependent Variable: Science Anxiety

On the other hand, the parametric quantitative data analysis in Table 3 has shown that there is a significant difference in students' science anxiety based on class, with a Sig. Value of 0.02 <0.05, which is supported by previous studies (Ucak & Say, 2018). While the gender factor does not cause a significant difference in students' science anxiety with a Sig. Value of 0.958 > 0.05, which is contrary to several other studies (Barlow, 2002; Mallow et al., 2010). Finally, there is no interaction between class

and gender factors that can produce a significant difference in students' science anxiety.

Conclusion

The study shows that the level of junior high school students' science anxiety in Indonesia is in the moderate category with a score of 2.63 ("rarely" to "sometimes") from a 5-point Likert scale, or 52.6%. In addition, the findings show evidence that science anxiety can be predicted by three main indicators, namely learning anxiety, test anxiety, and class anxiety, which simultaneously also affect science anxiety. Furthermore, the most frequently felt anxiety part of students is exam anxiety, followed by class anxiety, and learning anxiety. In order to explore the influence of class and gender on science anxiety, the study showed that there was no significant difference between science anxiety in female and male students, although female students were recorded as having slightly higher science anxiety than male students. However, there was a significant difference between science anxiety felt by students in grades VII, VIII, and IX, where students in grade VIII experienced the highest anxiety, followed by students in grade VII, and students in grade IX. There was no interaction between class and gender factors that influenced science anxiety. The limitations of this study are the number of samples, the unbalanced distribution of sample categories, and only representing students from Bandung Raya. Therefore, generalizations must be made with caution because the results may be less representative for a larger population. Retesting is needed if the population size, demographic background of students, and curriculum used in learning are different. However, this study has quite significant implications in the education field, especially in science learning. By knowing the level of students' science anxiety, educators are expected to be able to create a more conducive classroom atmosphere and support the teaching and learning process, implement learning that can reduce science anxiety, such as a humanistic approach that is friendly to students' socio-emotional aspects, provide appropriate emotional support for students who show high levels of science anxiety, and provide a basis for the development of educational or psychological interventions that specifically designed to help students manage their science anxiety, such as coping mechanism training, mindfulness programs, or emotion-based counseling approaches. Furthermore, other studies are needed on the identification of students' science anxiety with a larger population so the results tend to be consistent, which can indicate whether the characteristics of science anxiety reported in this study are universal or not. Then, in order to understand how science anxiety affects learning, it is advisable to examine the impact of science anxiety on other aspects of education, such as learning performance, academic achievement, self-efficacy, emotional intelligence, and so on. Studies can also be conducted by exploring the effectiveness of various interventions designed to reduce science anxiety.

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Author Contributions

Conceptualization was carried out by PPN, RR, and AW. Instrument development was carried out by PPN, RR, AW, RI, and FHWA. Data collection was conducted by PPN. Writing of the paper was completed by PPN. The research was supervised by RR and AW.

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Conflicts of Interest

There is no conflicts of interest.

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