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EXPLORING THE INTERACTION BETWEEN LEARNING STYLES AND MATHEMATICS ANXIETY AMONG SECONDARY SCHOOL STUDENTS: A CORRELATIONAL STUDY IN SOUTHERN MALAYSIA

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Abstract

Mathematics is a subject that is extensively used in real-life situations, but it has been found to be a difficult subject to master. Accordingly, mathematics anxiety has been found to be highly prevalent in students' lives, whereby learning styles have been underlined as one of the factors that may impact attainment of mathematics skills. This study aims to determine the relationship between learning styles and mathematics anxiety. The correlational study was conducted by using questionnaire adapted from Dunn and Dunn Model and Mathematics Anxiety Scale; involving 389 secondary school students located in the southern region of Malaysia. The study's findings revealed a positive correlation and distinguished between learning styles and mathematics anxiety. It shows that learning styles have an impact on mathematics anxiety. Hence, this study helps the students to embrace and improve their learning styles to minimize the level of anxiety towards mathematics, while the teachers may find it useful in guiding the students to control their mathematics anxiety.

Keywords – Dunn and Dunn model, Learning styles, Mathematics, Mathematics anxiety.

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1. Introduction

Mathematics is a crucial subject or skill that significantly influences technology, scientific development, professional areas, and daily life (Osman, Abu, Mohammad & Mokhtar, 2016). Its role is essential and relevant to the country's development, including Malaysia (Ling, Osman, Daud & Hussin, 2019).

Unfortunately, not all students can perform well in mathematics (Ali & Hassan, 2019). As far as performance is concerned, Malaysia's students' results from the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) in mathematics are still unsatisfactory (Kong & Matore, 2022).

While pedagogical aspects are stressed to improve students' mathematics performance, numerous other psychological, cognitive, environmental, and social factors may also require attention. It has been demonstrated that psychological aspects such as beliefs, attitudes, motivation, control over learning, learning styles, cognitive styles, self-efficacy and anxiety all contribute to mathematics performance (Mohamed & Tarmizi, 2010).

Anxiety, in general, is caused by strain, stress, tension, or perplexity in the mind and body of an individual (Ismail, Garba, Osman, Ibrahim & Bunyamin, 2022). There are several different types of anxiety, including generalised anxiety disorder (GAD), social phobia, panic disorder, agoraphobia, specific phobia, post-traumatic stress disorder (PTSD), and obsessive-compulsive disorder (OCD) (Bandelow, Sher, Bunevicius, Hollander, Kasper, Zohar et al., 2012). Mathematics anxiety is a type of anxiety that falls under the heading of specific phobia. It can appear in the early stages of school, and much like other particular phobias, sufferers tend to avoid the subject because it might trigger fear and horror (Garba, Ismail, Osman & Mohd-Rameli, 2020).

Mathematics anxiety can be further defined as tension when students are faced with numbers and solving mathematical problems in various cases from daily life to school (Tatar, 2012). As one of the negative emotional responses that arise in students either before class, during class, or on examination, mathematics anxiety is considered a negative element related to mathematics achievement (Ying, Osman, Kurniati, Masykuri, Kumar & Hanri, 2020). Similarly, mathematics anxiety can be linked to working memory resources involving short-term memory toward mathematics (Pellizzoni, Cargnelutti, Cuder & Passolunghi, 2021).

According to Garba et al. (2020), personal feelings may trigger mathematics anxiety through observation and interaction in a classroom environment. Other than that, mathematics anxiety is also often rooted in individual factors such as past mathematical experiences and learning styles (Yüksel-Şahin, 2008). Thus, it is crucial to have empirical data to prove the correlation between mathematics anxiety and learning styles.

In Malaysia, accessible empirical findings have shown a trend of focus on the adult perspectives or higher education level of mathematics anxiety (Ali & Hassan, 2019; Gholami, Ayub, Yunus & Kamarudin, 2021; Seng, 2015; Siaw, Shim, Azizan & Shaipullah, 2020). On the other hand, Ramirez, Chang, Maloney, Levine and Beilock (2016) indicated that anxiety first emerges from the primary and secondary levels of schooling and can be correlated with students' mathematics achievement.

The relationship between learning styles and mathematics anxiety is essential and can be related to each other (Tatar, 2012). One such model used to categorise learning styles is Dunn and Dunn's models of learning style, which describe the need to complement learning style with teaching methods to ensure better motivation and knowledge acquisition.

Therefore, specifically, the researchers will observe how learning style preferences based on Dunn and Dunn's Model of five wide-ranging categories, namely: (1) Environmental, (2) Emotional, and (3) Sociological.

Therefore, this study focuses on three research objectives:

1. To identify the learning styles based on Dunn and Dunn Model among secondary school students,
2. To identify Mathematics Anxiety levels among secondary school students,

3. To determine the relationship between learning styles and mathematics anxiety among secondary school students

The study's primary focus will be determining the correlations between students' learning styles and their mathematics anxiety level. This knowledge is hoped to provide teachers with sufficient information on what effective learning styles are for students to learn mathematics and thus be helpful for teachers in helping their students to strive in mathematics learning.

2. Literature Review

2.1. Learning Styles

As stated by Kopsovich (2001), Frank Riessman defines 'Learning Style' as the ways of learning showing the essential elements throughout the learning process. Varying learning styles elements include VAK learning, single learning or variable method using many learning modes, enlarging the time for learning, the noise level during learning, and Thermal Condition of the learning environment while learning difficult tasks or subjects. According to the Dunn model (Bosman & Schulze, 2018), recognising a student's learning style is better than discussing how it occurs as their emotions and sociological, environmental, and physical preferences will collectively affect the final form of learning. Many methods and practices of the learning process can be developed based on the student's cognitive thinking (Sheromova, Khuziakhmetov, Kazinets, Sizova, Buslaev & Borodianskaia, 2020). Therefore, the known aspects of learning styles are divided into three major categories: cognitive, affective, and physiological. Here, the cognitive element involves retrieving and storing the information in the storage. A participant's performance can be expressed in various patterns as they may have different abilities, eventually affecting these major categories (Kopsovich, 2001). Rita and Kenneth Dunn define learning styles as: "how each learner begins to concentrate, process, and retain new and complex information". This interaction occurs differently for everyone, and students' tendencies and learning styles, once activated, aid the process of storing information in their long-term memory.

2.2. Mathematics Anxiety

Mathematical anxiety is a situation encountered by one faced with a mathematical problem. A better feeling towards the subject may yield a good perception of it and vice versa (Puteh & Khalin, 2016). Accordingly, scholars have stated that emotions play the most critical part in this situation. Some may feel anxious when opening a mathematics textbook, or a negative emotion may be triggered when one enters a mathematics classroom. Therefore, mathematics anxiety (MA) is an exhausting emotional reaction that individuals have towards the subject, wherein research targeting primary and early secondary school periods is largely infrequent and inconsistent (Kopsovich, 2001).

Dowker, Sarkar and Looi (2016) stated that mathematics anxiety cannot be reduced to test or general anxiety. Different measures of mathematics anxiety correlate with one another more strongly (0.5-0.8) than test anxiety or general anxiety.

Furthermore, mathematics anxiety can be described as an adverse emotional reaction one perceives when doing mathematics (Mohamed & Tarmizi, 2010). Here, Sokolowski, Hawes and Lyons (2019) have stated that it is an experience of negative emotions when engaging with numerical and mathematical tasks, correlating its negative impact on one's mathematics performance. Many factors may result in mathematical anxiety, such as classroom climate, mathematical abstraction, past experiences, family matters, bad experiences in front of the class, and more (Ying et al., 2020).

Throughout the years, studies on mathematics anxiety have been focusing on tertiary education level students, whether in a global or local context; thus, little is known about its pervasiveness in younger demographics (Ali & Hassan, 2019; Mutodi & Ngirande, 2014; Seng, 2015; Siaw et al., 2020).

Although some studies report a significant number of mathematics anxiety among secondary school students, severe mathematics anxiety is almost uncommon among young children (Dowker et al., 2016).

Conversely, mathematics anxiety commonly appears to increase with age during childhood (Kucian, McCaskey, O'Gorman-Tuura & von Aster, 2018). This apparent increase in mathematics anxiety with age is consistent with findings showing that other attitudes toward mathematics may also change (Wigfield & Meece, 1988). Two-thirds of 11-year-olds identify mathematics as their favourite subject, but just a small percentage of 16-year-olds agree, according to Biatchford (1996). Thus, studies need to study the occurrence of mathematics anxiety among secondary student demographics to tackle the issues.

2.3. The Relationship between Learning Styles and Mathematics Anxiety

According to Siaw et al. (2020), learning style and mathematics anxiety are both factors that affect students' performance (Bosman & Schulze, 2018). Thus, there is a link between learning style and mathematics anxiety.

The relationship between learning style and mathematics anxiety has been explored for decades by various researchers (Hernandez-Baňaga & Fabella, 2018). Math anxiety was found to be more common in tactile-kinaesthetic learners, according to McCoy (1992), and it was found to be positively connected with auditory preferences learners by Onwuegbuzie (1998). Another research done by (Sloan, Daane & Giesen, 2002) reported that the results of their study indicated that there was a relationship between mathematics anxiety and a global learning style. This showed that there is relationship between students learning styles and their possibility in having mathematics anxiety.

According to Dunn and Dunn Model of Learning Styles, individuals have different learning preferences and styles, the model was developed based on the premise that students can better engage with and retain information when the instruction and the learning environment align with their preferred learning style (Dunn, Griggs, Olson, Beasley & Gorman, 1995). The Dunn and Dunn Model of Learning Styles identified a range of factors that influence learning styles, including environmental, emotional, sociological, physiological, and psychological elements (Larkin, Budny & Budny, 2003).

In the context of mathematics anxiety, a student's learning style preferences can significantly impact their experience with mathematics (Bhattacharyya & Shariff, 2014). For instance, if a student's preferred learning environment does not align with the classroom setting or the way mathematics is taught, this mismatch may contribute to heightened anxiety (Mutodi & Ngirande, 2014). Likewise, emotional factors play a role, and high levels of anxiety can impede a student's ability to engage with mathematics material effectively (Gholami et al., 2021).

Sociological preferences for social interaction can influence mathematics anxiety, as peer interactions and social pressures related to mathematics performance can either alleviate or exacerbate anxiety (Garba et al., 2020). Physiological factors, such as overall physical well-being, can also affect cognitive abilities and stress levels, which in turn may influence mathematics anxiety (Mutodi & Ngirande, 2014).

Moreover, psychological preferences related to cognitive styles, such as visual, auditory, or kinesthetic learning, can impact how a student perceives and engages with mathematics (Kurniawan & Hartono, 2020). Recognizing and accommodating these learning style preferences can help teachers create a more supportive and personalized learning environment that may mitigate mathematics anxiety and enhance students' mathematics related experiences (Bhattacharyya & Shariff, 2014).

Given the lack of research in the area of secondary school students' learning styles and mathematics anxiety (Rozgonjuk, Kraav, Mikkor, Orav-Puurand & Täht, 2020), this study was conducted to contribute to the existing body of knowledge. The learning styles of secondary schools' students were paired with their levels of mathematics anxiety to determine if there was a correlation between mathematics anxiety and learning styles.

3. Methodology

3.1. Research Design

This study was designed to investigate the relationship between learning styles and mathematics anxiety among secondary school students. This study used a correlational research design. The diagram below summarises the research methodology of this study:

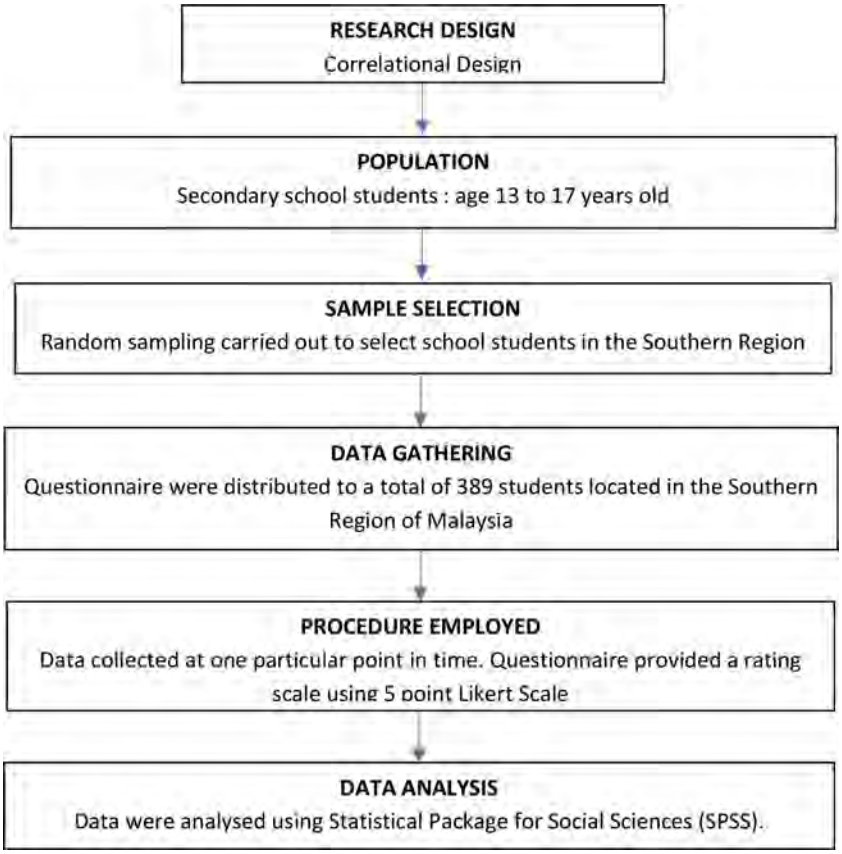

Figure 1. Research methodology summary

3.2. Participants

The population in this study involved secondary school students located in the southern region of Malaysia. According to the Malaysian Ministry of Education, 577 125 secondary school students are located in this region, which comes from 1187 secondary schools. The students involved in this study ranged from 13 to 17 years old and undertook mathematics in their schooling as a core subject. The sample selection denoted the students to be randomly selected, yielding a total of 389 participants about Morgan's Table for sample size and chosen from five secondary schools located in the southern region of Malaysia.

Variables	Frequency	Percent
Gender		
Male	172	44.2159
Female	219	56.2982
Age Group		
13	15	3.85604
14	120	30.8483
15	67	17.2237
16	69	17.7378
17	118	30.3342

Table 1. Demographic data of the Respondents

3.3. Instruments

In the context of data collection, a questionnaire was administered, comprising three distinct sections. The initial section, Part A, encompassed inquiries pertaining to demographic characteristics, including but not limited to gender, age, race, urban or rural residency, and school affiliation. The second section was dedicated to ascertaining students' learning style preferences, encompassing 18 items rooted in the Dunn and Dunn Inventory Model. This model effectively captures environmental, emotional, and sociological dimensions, all of which are integral to understanding students' learning styles. Responses to these items were recorded on a 5-point Likert scale, and the questionnaire structure drew inspiration from the Learning Styles Inventory (LSI) survey developed by Kopsovich in 2001. The final section delved into the subject of mathematics anxiety. It featured 14 items designed to evaluate students' apprehension and unease regarding mathematics. These items were adapted from the Math Anxiety Rating Scale (MARS), which was originally formulated by Mahmood and Khatoon in 2011. The questionnaire adapted exhibited internal consistency, with a split-half reliability coefficient of 0.89 and a Cronbach's alpha of 0.87, as reported by Mahmood and Khatoon in 2011.

Given that the instrument employed in this study was derived from pre-existing research questionnaires and scales, the necessity for revalidating the instrument's reliability is considered redundant.

3.4. Data Analysis

Given that the data collection was carried out via a questionnaire, and the resultant dataset exhibits an ordinal nature, the subsequent statistical analyses are predicated on non-parametric testing methodologies. All data obtained were analyzed by using the Statistical Package for Social Sciences (SPSS) software, descriptive statistics analyses were conducted to obtain frequency distribution and central tendency of the variables on Learning Styles based on emotional, environmental and sociological perspective to identify the learning styles based on Dunn and Dunn Model among secondary school students and to identify Mathematics Anxiety levels among secondary school students. While to determine the relationship between learning styles and mathematics anxiety among secondary school students, correlation analysis was used to find out either the relationship is positive, negative or no correlation. The variable of Age and Gender involved as the controlled variables.

4. Results

4.1. Analysis of Learning Styles Inventory (LSI) using the Dunn and Dunn Model

This section has investigated the distribution of the respondents based on the questionnaires provided.

Next, two variables in the study summarised the Learning Styles Inventory, which consists of 18 items focused on three major environmental, emotional, and sociological categories. Meanwhile, the variable of Mathematics Anxiety reviewed the 14 items provided in the questionnaire.

4.1.1. Environmental

Noise Level

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B1: I prefer a silent learning environment	28 (7.2%)	33 (8.4%)	68 (17.4%)	123 (31.6%)	137 (35.2%)
B2: I prefer soft noise from nature in a learning environment	111 (28.5%)	87 (22.4%)	88 (22.6%)	70 (18%)	33 (8.4%)

Table 2. Frequency Distribution on the Noise level

The first element in environmental categories is Noise level (as shown in the table above), which consists of preferring silent or soft noise during learning. In the first item on learning styles, 137 students (35.2%) strongly agree that they prefer a silent learning environment, while only 28 people (7.2%) strongly disagree with the silent learning environment. The second item shows that only 33 respondents (8.4%) strongly agree to study in a soft-noise learning environment, and 111 students (28.5%) strongly disagree with preferring a soft-noise learning environment.

Interior Light

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B3: I prefer dim light in a learning environment.	92 (23.7%)	93 (23.9%)	109 (28%)	61 (15.7%)	34 (8.7%)
B4: I prefer bright in a learning environment.	17 (4.4%)	43 (11.1%)	52 (13.4%)	117 (30.1%)	160 (41.1%)

Table 3. Frequency Distribution on Light

From the table above, the light element consists of two items; the third item is to prefer dim light in the learning environment, while the fourth is to prefer bright light. There are 34 students (8.7%) who strongly agree to study in a dimly light environment, while about 23.7% or 92 students choose to strongly disagree with the statement. But most students have a reasonable opinion on this item. For the fourth item, 160 students (41.1%) strongly agreed and preferred a bright learning environment. At the time, only 17 people or 4.4%, chose, strongly disagree and preferred bright in a learning environment.

Thermal Condition

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B5: I prefer warm temperatures in a learning environment.	35 (9.0%)	54 (13.9%)	97 (24.9%)	126 (32.4%)	77 (19.8%)
B6: I prefer cold temperatures in a learning environment.	23 (5.9%)	41 (10.5%)	77 (19.8%)	102 (26.2%)	146 (37.5%)

Table 4. Frequency Distribution on Thermal Condition

In Thermal condition context, there are two items being asked in the questionnaire. The first item is do students prefer warmer thermal condition and the second item is do students prefer colder condition when studying. 126 students or 32.4% of the students agree that, warmer environment works better for them when learning mathematics and only 35 students who disagree with this statement. While for colder environment item, 146 students or 37.5% strongly agree with the statement and only 23 students or 5.9% strongly disagree with the statement.

Setting

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B7: I choose formal setting of the learning environment. (Example: Sit on desk and chair)	23 (5.9%)	29 (7.5%)	83 (21.3%)	117 (30.1%)	137 (35.2%)
B8: I choose informal setting of the learning environment. (Example: Study on beanbags)	57 (14.7%)	76 (19.5%)	90 (23.1 %)	90 (23.1 %)	76 (19.5%)

Table 5. Frequency Distribution on Setting

The last element in environment categories is the setting. From the table above, two items are stated under this element: students choose the formal setting of the learning environment. 35.2% or 137 students strongly agreed to study in a formal environment. But only 23 students or 5.9% strongly disagreed with the formal setting during learning. For the eight-item stated, students prefer the informal setting for the learning environment; the highest number of students of 23.1%, or 90 students chose agree with this statement and supported with another 76 or 19.5% students strongly agree with the statement; making the conclusion that majority of the students agree with informal environment setting even though the numbers of students with no opinions are at highest too which is 90 or 23.1%.

4.1.2. Emotional

Motivation

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B9: I am self-motivated to do well in school.	18 (4.6%)	30 (7.7%)	137 (35.2%)	115 (29.6%)	89 (22.9%)
B10: I must have to monitor the tasks I do	57 (14.7%)	76 (19.5%)	105 (27.0%)	97 (24.9%)	53 (13.6%)

Table 6. Frequency Distribution on Motivation

From table 5, motivation is one of the elements, and this element involves two items. The first item was about students who feel self-motivated to do well in school. 35.2%, or 137 students, chose no opinion with this statement, while 4.6% or 18 students, strongly disagree with feeling self-motivated to do well in school. For the tenth item, a majority of the students also chose no opinion on whether they must have someone to monitor their tasks. But 13.6% or 53 students strongly agree to be monitored while they do the tasks.

Responsibility

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B11: I am responsible in completing a difficult task or assignment.	17 (4.3%)	22 (5.6%)	119 (30.6%)	150 (38.5 %)	81 (20.8%)

Table 7. Frequency Distribution on Responsibility

The element of responsibility states the students responsible for completing a difficult task. Referring to the table above, most of the students, 38.5% or 150 students, agree with the statement. While a minority of the students, 4.3% or only 17 students chose strongly disagree with this item.

Persistent

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B12: I am persistent in completing a difficult task or assignment.	24 (6.2%)	31 (8.0%)	106 (27.2%)	150 (38.5%)	78 (20.1%)

Table 8. Frequency Distribution on Persistent

According to the table above, persistence is also an element in the emotional categories. This item shows that only 24 students or 6.2%, strongly disagree to be persistent in completing a difficult task or assignment. Although the number of students who chose no opinion for this statement is high which is 106 or 27.2% students the majority of the students (150 or 38.5%) agree that they are persistent when they complete their tasks are given.

Structure of Learning

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B13: I prefer structure in the learning assignment such as revision book, answer worksheet.	12 (3.1%)	10 (2.5%)	43 (11.1%)	99 (25.4%)	225 (57.8%)

Table 9. Frequency Distribution on Structure of learning

The last element involved in emotional categories is structure. The table above shows that 225% or 57.8% students strongly agree to have a structure in the learning environment. While only 12 (3.1%) strongly disagree with the structure while doing assignments or learning.

4.1.3. Sociological

Learning alone with peers

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B14: I prefer learning a difficult task alone.	14 (3.6%)	22 (5.7%)	59 (15.2%)	132 (33.9%)	162 (41.6%)
B15: I prefer learning a difficult task with peers.	17 (4.4%)	34 (8.7%)	69 (17.7%)	143 (36.8%)	126 (32.9%)

Table 10. Frequency Distribution on Learning alone or with peers

Sociological categories included learning alone or with peers, as shown in Table 10. A majority of 162 students or 41.6% of the students strongly agree that they prefer to learn alone it comes to comprehend difficult task. While only 3.6% or 14 students strongly disagree with the statement. For item 15, 143 students (36.8%) agree that when learning a difficult task, they prefer to be with peers and only 4.4% or 17 students strongly disagree with the statement.

Authority Figures

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B16: Teachers need to be present when learning a difficult subject.	69 (17.3%)	95 (24.4%)	106 (27.2%)	72 (18.5%)	47 (12.1%)

Table 11. Frequency Distribution on Authority Figures

For the authority figures element, the results are shown above. The highest number of the of students chose no opinion with the statement; 106 students or 27.2%. But students who chose agree is at 18.5% or

72 students and students who chose strongly agree is 47 students or 12.1%. So, the data can be concluded as majority of the students 119 students agree with statement; that the need teachers to be present when dealing with difficult tasks.

Learning in several ways

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
B17: I prefer several ways when learning a difficult subject.	16 (4.1%)	24 (6.2%)	65 (16.7%)	134 (34.4%)	150 (38.6%)
B18: I prefer only one way when learning a Difficult subject.	21 (5.4%)	15 (3.9%)	77 (19.8%)	109 (28.0%)	167 (42.9%)

Table 12. Frequency Distribution on Learning in several ways

The last element for sociological categories is learning in several ways. Based on the table above, item 17 prefers several ways when learning a difficult subject. 150 students (38.6%) strongly agree to study in several ways and 4.1% or 16 students strongly disagree to learn in several ways when doing the difficult subject. For the last item, 5.4% or 21 students strongly disagree with using only one way when learning a difficult subject and majority of the students 167 (42.9%) strongly agree to use one way of learning.

4.2. Analysis of Mathematics Anxiety Level

4.2.1. Frequency Distribution on Math Anxiety (Items 1 to 5)

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
C1: I usually am at ease in math classes.	24 (6.2%)	28 (7.2%)	113 (29.0%)	122 (31.4%)	102 (26.2%)
C2: I see math as a subject I will rarely use.	61 (15.7%)	82 (21.1%)	139 (35.7%)	76 (19.5%)	31 (8.0%)
C3: I'm no good at math.	72 (18.5%)	58 (14.9%)	120 (30.8%)	78 (20.1%)	61 (15.7%)
C4: Generally, I feel secure about attempting math.	11 (2.8%)	28 (7.2%)	94 (24.2%)	143 (36.7%)	113 (29.0%)
C5: I'll need mathematics for my future work.	15 (3.9%)	23 (5.9%)	105 (27.0%)	103 (26.5%)	143 (36.7%)

Table 13. Frequency Distribution on Math Anxiety (Items 1 to 5)

Based on the table above, the first 5 items were analysed using a 5-point Likert scale similar to the previous analysis. The first item stated that students are usually at ease in math classes. 122 students (31.4%) agree on the statement and 6.2% (24 students) strongly disagree. For item 2, 139 students (35.7%) chose no opinion on the item, stating that students see math as a subject they will rarely use. While 15.7% or 61 students strongly disagree with the item stated in item 2. Besides, 120 students (30.8%) had no opinion on the third item, which stated that they felt no good at math. But 18.5% or 72 students strongly disagree with a feeling of no good at math while 15.7% or 61 students strongly agree with the statement. Item 4 stated that students feel secure attempting mathematics. 2.8% or 11 students, strongly disagree with the statement. But a majority of 143 students (36.7%) agree to feel secure when attempting mathematics. The fifth item stated that they need mathematics for their future work. This item was strongly agreed by 36.7% or 143 students who need mathematics in the future. Meantime, there were 15 students (3.9%) chose strongly disagree, whereby they did not need mathematics in their future work.

4.2.2. Frequency Distribution on Math Anxiety (Items 6 to 9)

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
C6: I'd be happy to get good grades in mathematics.	15 (3.9%)	10 (2.6%)	61 (15.7%)	64 (16.5%)	239 (61.4%)
C7: I don't think that I could do advanced math.	73 (18.8%)	74 (19.0%)	145 (37.3%)	67 (17.2%)	30 (7.7%)
C8: For some reason, even though I study math seems unusually hard for me.	17 (4.3%)	23 (5.9%)	80 (20.6%)	121 (31.1%)	148 (38.0%)
C9: My mind goes blank and I am unable to think clearly when working in mathematics.	78 (20.1%)	89 (22.9%)	131 (33.7%)	58 (14.9 %)	33 (8.5%)

Table 14. Frequency Distribution on Math Anxiety (Items 6 to 9)

The following 4 items were analysed, which continues from the previous item about mathematics anxiety among secondary school students. Based on table 14, item 6 shows the students felt happy to get good grades in mathematics. This statement was strongly agreed upon by the majority of 239 students (61.4%) who felt happy with the good grades. But also a few students of 15 students (3.9%) strongly disagree with the statement given; although they get good grades it maths, they doesn't really feel that their liking to the subject increases. Students being good in mathematics does not necessarily they are less likely to have mathematics anxiety. As for the following item, students don't think they could do advanced mathematics. 145 students, or 37.3%, chose no opinion on this item statement about advanced mathematics. Only 7.7%, or 30 students, strongly agreed they could do advanced mathematics. Next, item 8 stated that sometimes, students feel math is unusually tough; this was strongly agreed upon by 38% or 148 students. On the other hand, 4.3%, or 17 students, strongly disagree with the statement. This means these students believe they can find mathematics easy after learning hard on the subject. For item 9, 33.7%, or 131 students have no opinion on the statement of their mind goes blank and unable to think clearly when working in mathematics. But 78 students (20.1%) strongly disagree with the statement as they might think clearly when working with mathematics.

4.2.3. Frequency Distribution on Math Anxiety (Item 10 to 14)

Item	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
C10: Knowing mathematics will help me earn a living.	10 (2.6%)	31 (8.0%)	125 (32.1%)	115 (29.6%)	108 (27.8%)
C11: Math has been my worst subject.	121 (31.1%) 79	(20.3%)	123 (31.6%)	28 (7.2%)	38 (9.8%)
C12: I think I could handle more difficult mathematics	40 (10.3%)	60 (15.4%)	145 (37.3%)	94 (24.2%)	50 (12.9%)
C13: I'm not the type to do well in mathematics.	71 (18.3%)	51 (13.1%)	122 (31.3%)	78 (20.1%)	67 (17.2%)
C14: Math doesn't scare me at all.	48 (12.3%)	47 (12.1%)	133 (34.2%)	89 (22.9%)	72 (18.5%)

Table 15. Frequency Distribution on Math Anxiety (Items 10 to 14)

Table 15 shows the last 5 items of mathematics anxiety, continuing with item 10, which states that knowing mathematics will help the students earn a living. Only 10 students (2.6%) strongly disagree with the statement. Meanwhile majority of the students, 125 (32.1%), had no opinion of this statement. For item 11, mathematics has been the student's worst subject was strongly disagreeing by 31.1% or 122 students. On the other hand, 123 students (31.6%) had no opinion regarding the statement and 38 students (9.8%) strongly agreed with the statement. For item 12, data showed that 37.3% or 145 students,

chose no opinion about whether they could handle more difficult mathematics and students who chose strongly disagree, 40 students (10.3%) with small difference from students who chose strongly agree; 50 students (12.9%). As for the next item, 31.2% or 122 students chose no opinion on whether they were the type that did well in mathematics. 13.1% or 51 students chose to disagree with the statement. Lastly, for the item, mathematics doesn't scare me at all; majority of the students chose no opinion on the statement, resulting in 34.2% or 133 students. Students disagree rather than strongly disagree with the statement, resulting in 12.1% or only 47 students disagree.

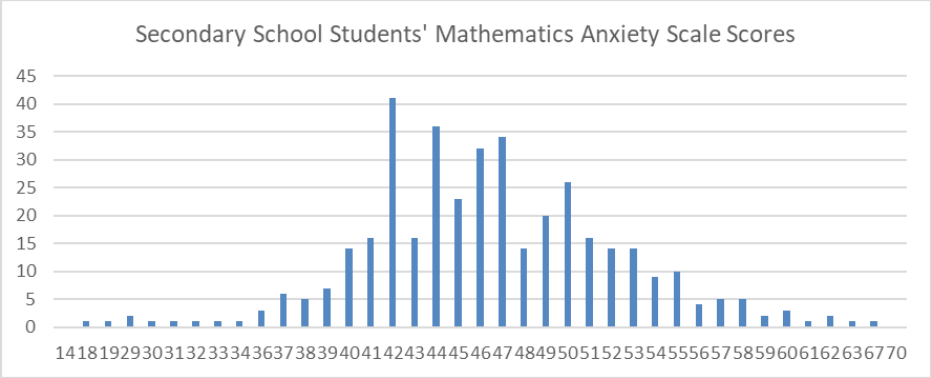

Figure 2. Secondary School Students' Mathematics Anxiety Scale Scores

Figure 2 shows that the secondary school students' mathematics anxiety level in Southern Johor. The students' scores were ranging from 18-67, where 18 indicates the lowest mathematics anxiety level while 67 is the highest, with the mean score of 46.40. Among the 389 students' participants, the highest numbers of students which is 41 students scored 42 marks.

4.3. Relationship between Learning Styles and Mathematics Anxiety among Secondary School Students

This analysis involved 18 items of the Learning Styles Inventory (LSI) and 14 items of Mathematics Anxiety (MA). Therefore, the analysis investigated the relationship between two variables of Learning Styles and Mathematics Anxiety among secondary school students. The results generated by SPSS showed that among the 18 items of LSI and 14 items of MA there are consistent relations between learning styles and mathematics anxiety. But according to the data there are prominent relations between the 3 major categories of LSI and MA. The results are as shown below:

4.3.1. LSI (Environment) and MA

		LSI	MA
LSI	Spearman Correlation	1	.310**
	Sig. (2-tailed)		0.000
	N	389	389
MA	Spearman Correlation	.310**	1
	Sig. (2-tailed)	0.000	
	N	389	389

* Correlation is significant at the 0.05 level (2-tailed)

Table 16. Correlation between Learning Styles (Environment) and Math Anxiety

Based on the table above, it is shown that in the context environmental condition of learning styles, there is a moderate correlation between the learning style context and mathematics anxiety. The correlation data

stated that r=0.310 and the significant p-value is 0.000, which is below 0.05 proving that even though the relationship is a moderate strength relationship but it is significant.

4.3.2. LSI (Emotional) and MA

		LSI	MA
LSI	Spearman Correlation	1	.434**
	Sig. (2-tailed)		0.000
	N	389	389
MA	Spearman Correlation	.434**	1
	Sig. (2-tailed)	0.000	
	N	389	389

* Correlation is significant at the 0.05 level (2-tailed)

Table 17. Correlation between Learning Styles (Emotional) and Math Anxiety

For the second context in the learning style, the emotional context showed a stronger relation between emotional condition of learning style and mathematics anxiety. The r-value generated by SPSS for the Spearman correlation is r=0.434 and the p-value is 0.000, below 0.05. The relationship between emotional context of learning style and mathematics anxiety is in a moderate level and significant.

4.3.3. LSI (Sociological) and MA

The last main category of learning styles is the sociological context. For this context; the relationship between the LSI item and MA items showed a moderate relation. The r-value is 0.415 and the p value is 0.000; resulting a moderate relation and significant effect.

		LSI	MA
LSI	Spearman Correlation	1	.415**
	Sig. (2-tailed)		0.000
	N	389	389
MA	Spearman Correlation	.415**	1
	Sig. (2-tailed)	0.000	
	N	389	389

* Correlation is significant at the 0.05 level (2-tailed)

Table 18. Correlation between Learning Styles (Sociological) and Math Anxiety

Although, all the LSI items and MA items does not show strong relationship, but it is consistent through the results. Other than that, all the relation showed p-value lower than 0.05; showing that there are significant relations between the learning styles and mathematics anxiety.

5. Discussions

5.1 Learning Styles Based on Dunn and Dunn Model among Secondary School Students

The study delves into the learning styles of secondary school students based on the Dunn and Dunn Model, focusing on environmental, emotional, and sociological factors (Che-Ahmad, Yahaya & Shaharim, 2012). The examination of these factors provides valuable insights into the preferences and behaviours of students in the learning process. Students display a clear inclination towards a conducive learning environment. The preference for a quiet atmosphere (Valtonen, Leppänen, Hyypiä, Kokko, Manninen, Vartiainen et al., 2021), bright lighting (Che-Ahmad et al., 2012), and a colder temperature indicates a collective desire for conditions that foster concentration and comfort. Formal settings with tables and chairs are highly favoured, reflecting a preference for structured learning spaces (Valtonen et al., 2021). Emotionally, students show that they motivate themselves strongly to do well in academics (Li, Cho,

Cosso & Maeda, 2021), especially in Mathematics. Students also express a strong sense of responsibility, indicating a high commitment to finishing difficult assignments, even when they have a lot of work from other subjects. Persistence is another key characteristic, as students demonstrate a strong work ethic when dealing with challenging tasks (Saeed & Zyngier, 2012). The structure of learning activities is crucial for students, a high preference for organized materials such as revision books and answer worksheets (Atoyebi & Atoyebi, 2022). This highlights the significance of having a structured plan to make learning experiences more effective. Sociologically, the study uncovers the significance of peer interaction and the presence of authority figures, particularly teachers, in the learning process (Yang, Zhao, Tian & Xing, 2021). Students lean towards collaborative learning, expressing a preference for tackling difficult tasks with peers (Dunn, 1990). Furthermore, wanting the teacher to be there during difficult subjects, especially Mathematics, shows how important it is to get direct help and guidance (Biatchford, 1996). There is evident diversity in the ways students prefer to approach difficult subjects. Although majority leans towards utilizing multiple methods for learning, there are still a significant number of students that prefer a singular approach. This diversity emphasizes the necessity for instructional flexibility to accommodate a range of learning styles (Mutodi & Ngirande, 2014). The findings collectively showed the nature of students' learning styles, emphasizing the need for teachers to consider a range of environmental, emotional, and sociological factors. Tailoring instructional strategies to align with students' preferences can enhance engagement and overall learning outcomes.

5.2. Mathematics Anxiety Levels among Secondary School Students

The assessment of mathematics anxiety levels in secondary school students, conducted through an adapted version of the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972), yielded insightful results. The questionnaire consisted 14 items measured on a 5-point Likert-type scale, provided a bidimensional perspective of mathematics anxiety by including both positively and negatively worded items (Mahmood & Khatoon, 2011). The scores, ranging from 18 to 67, with a mean score of 46.40 indicated a moderate level of mathematics anxiety among the students in Southern Johor.

This finding aligns with the study by Zakaria, Zain, Ahmad and Erlina (2012) in Selangor, further corroborating that secondary school students, regardless of geographic location, tend to experience a moderate level of mathematics anxiety. The consistency in results suggests that this pattern may be prevalent among students in various regions, indicating a broader trend. The moderate level of mathematics anxiety prompts reflection on potential contributing factors. The bidimensional assessment capturing both positive and negative aspects provide a deeper understanding of the students' emotional responses to mathematics. With this finding presented, educators and policymakers may consider implementing targeted interventions to alleviate anxiety and enhance students' confidence in dealing with mathematics challenges. Strategies could include incorporating supportive learning environments, employing varied instructional methods, and fostering a positive attitude towards mathematics. In addition, the study opens avenues for further research to delve deeper into the specific factors contributing to mathematics anxiety and explore tailored interventions. The findings underscore the significance of addressing mathematics anxiety among secondary school students. A moderate anxiety level is a call to action for educators and researchers to collaborate on creating inclusive and supportive learning environments that empower students to overcome challenges in mathematics, fostering a positive and confident approach to the subject.

5.3. Learning Styles and Mathematics Anxiety

The research objective of this study was to identify the relationship between learning styles and mathematics anxiety among secondary school students living in the southern region of Malaysia. The results showed positive correlation but with a moderate relationship between learning styles and mathematics anxiety. Furthermore, the average p-value for the correlations included is 0.000 which is lower than 0.05, concluding that the relations are all significant with this result, it can be concluded that the relationship is present between learning styles and mathematics anxiety among secondary school students.

6. Conclusions

The Mathematics Anxiety Scale was used in this study to determine the level of mathematics anxiety possess by the secondary schools' students in Southern Johor. It is found that majority of the students possess moderate level of mathematics anxiety. While for the learning style's part, the Dunn and Dunn model was implemented to assess students' preferences in learning style. This finding from both model and scale was used to correlate the relationship between the variables. The result of the findings showed a positive and moderate correlation between learning style and mathematics anxiety. Therefore, it can be concluded that the learning styles of students conclusive pose an impact on students' anxiety towards Mathematics.

The limitation of this research was the location involved, which was only limited to the Southern Region of Malaysia (Johor), making this study's findings and discussions unsuitable for generalisation. Therefore, the future researchers may broaden its sample derivation area to identify the student's learning styles and mathematics anxiety levels for better generalisation samples. Another limitation of this research was that the study focused on secondary school students only. Thus, there were no different perspectives to compare. The future researchers can further this research towards primary school students using different methods or instruments that suit the students to answer the questions provided by the researchers. This can strengthen the correlation between Learning Styles and Mathematics Anxiety levels among students.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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