The Relationship between Learning Styles and Math Anxiety among Secondary School Students

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Abstract
Mathematics is often perceived as a challenging subject that can trigger significant math anxiety among students. Mathematical anxiety or math phobia among students is associated with various factors, including their learning styles. Therefore, this study was conducted to determine the relationship between learning styles and math anxiety among secondary school students. A simple random sampling technique was used to select 233 Form 4 students at a secondary school in Kota Samarahan, Sarawak, as research respondents. The Grasha-Riechmann Learning Styles Inventory and the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ), which were adapted and modified to measure students' learning styles and levels of math anxiety, were used as research instruments. The instruments used underwent validity checks by expert evaluators and demonstrated high reliability. IBM SPSS version 28 was used to analyse the data, involving descriptive and inferential statistical approaches. Descriptive analysis found that the dependent style of learning was the most dominant style used by students when studying mathematics. The study also indicated that students experienced high levels of math anxiety. Furthermore, Pearson correlation analysis revealed that independent, avoidant, dependent and participative learning styles were significantly related to math anxiety. Therefore, this study suggests that educators consider the variation in learning styles possessed by each student when planning learning activities. By taking the appropriate approach, educators can play a role in helping students gain a better understanding of mathematics and overcome their concerns.
Keywords: Learning Styles, Mathematical Anxiety, Secondary School

Introduction
The inconsistent performance of Malaysia in the Trends in International Mathematics and Science Study (TIMSS) has raised concerns for the government's efforts to advance overall mathematics education in Malaysia (Ahmad & Rosli, 2019). In Malaysia's first participation in TIMSS in 1999, the country achieved an excellent mathematics score with an average of 519 points. However, Malaysian math performance significantly declined in the 2003 cycle (508 points), and the trend continued to deteriorate in the 2007 (474 points) and 2011 (440 points) cycles. There was a slight improvement in the 2015 cycle (465 points), but it declined again in the 2019 cycle (461 points) (Ministry of Education Malaysia, 2020). Khalin (2014) suggested that one of the reasons for the decline in mathematics performance among Malaysian

students is their fear of the subject. This fear may stem from the perception that mathematics is a difficult or complex subject.

Mathematical anxiety or fear arises when students engage in mathematical activities such as number manipulation, solving mathematical problems, or facing math exams (Luttenberger et al., 2018). Mathematical anxiety can occur in daily life or during learning. Students experiencing it may feel anxious and less enthusiastic when performing numerical calculations or solving math problems (Hunt & Zakaria, 2018; Prodromou & Frederiksen, 2018). Muner and Rosli (2023) found that mathematical anxiety has a negative impact on students' math achievements and can hinder them from achieving their educational goals. Therefore, it is crucial for teachers and researchers to understand the factors influencing mathematical anxiety and how to help students overcome this issue.

Mathematical anxiety occurs at every level of education. In Malaysia, studies on mathematical anxiety have been conducted involving university students (Mustaffa, 2017), matriculation students Husain (2020), primary school students Ismail & Maat (2017); Muner & Rosli (2023), and secondary school students (Esa & Mohamed, 2017; Peng & Rosli, 2021; Yahya & Amir, 2018). Mathematical anxiety among secondary school students is often associated with various factors such as math achievement Mutegi et al (2021); Omar et al (2022); Suren & Kandemir (2020), self-efficacy Garba et al (2020); Hui & Rosli (2021); Xie et al (2019), motivation Çağırgan & Soytürk (2021); Deieso & Fraser (2019), and gender (Klee & Miller, 2019; Mann & Walshaw, 2019; Prahmana, Sutanti, & Diponegoro, 2021). Some studies also found a link between mathematical anxiety and students' learning styles (Esa & Mohamed, 2017; Tatar, 2012). Esa and Mohamed (2017) believe that understanding suitable learning styles enables students to learn effectively and helps reduce feelings of nervousness, fear, and discomfort towards mathematics. However, research on the relationship between learning styles and mathematical anxiety is limited. Therefore, there is a need for more in-depth and comprehensive research to understand the connection between learning styles and mathematical anxiety among secondary school students. The researcher aims to fill this research gap on the relationship between learning styles and mathematical anxiety among Form 4 students.

This study is conducted to achieve the following two objectives
  i.   Identify the most dominant learning style and the level of mathematical anxiety among Form 4 students.
  ii.   Determine the relationship between learning styles and mathematical anxiety among Form 4 students.

Literature Review
Learning styles play a crucial role in shaping students' understanding and knowledge of the subjects they study. Various learning style theories are used to identify individual learning styles, and the Grasha-Riechmann is one widely used which looks at the social and affective perspective related to preferred patterns of interaction with teachers and peers. Grasha (1996) states that learning styles are unique traits that influence how students acquire information, interact with peers and teachers, and generally participate in the learning process. Based on this theory, there are six identifiable learning styles: independent, avoidant, collaborative, dependent, competitive, and participative. Independent individuals prefer

thinking individually, seeking additional information, and solving problems on their own. Avoidant individuals are not interested and tend to avoid active involvement in learning activities. Collaborative individuals enjoy working in groups, sharing ideas, and interacting with classmates. Dependent individuals prefer relying on teachers or classmates in learning. Competitive individuals like to compete to achieve high performance and compare themselves with others while participative individuals enjoy actively engaging and enthusiastically participating in learning.

Past studies using the Grasha-Riechmann Learning Style Inventory found that the dominant learning style when studying mathematics among secondary school students is collaborative (Ahmad & Rosli, 2019; Esa & Mohamed, 2017). This suggests that secondary school students in those studies tended to prefer learning that involves collaboration and social interaction. However, there are studies that found secondary school students favour the competitive style when studying mathematics (Nadarajan et al., 2016; Tatar, 2012). This indicates that a significant number of respondents in those studies were inclined to strive for better achievements in mathematics when in a competitive situation or pursuing personal goals in learning. Cardino Jr and Cruz (2020) found that secondary school students were more inclined to practise the dependent style in learning mathematics. This indicates that most respondents in that study tended to rely on the guidance or support of teachers in learning mathematics. The diversity in learning styles illustrates that each individual has unique learning needs and preferences. Therefore, an effective mathematics teaching approach should encompass various learning styles. By considering individual learning styles, teachers can play a role in helping students achieve better understanding in mathematics and overcome mathematical anxiety.

Mathematical anxiety is a common phenomenon among secondary school students (Zay & Kurniasih, 2023). Several studies, both within and outside the country, have found that secondary school students experience high levels of mathematical anxiety (Bornaa, Rahaman, & Iddrisu, 2023; Estonanto & Dio, 2019; Hui & Rosli, 2021; Mutegi et al., 2021; Suren & Kandemir, 2020; Taley & Ndamenenu, 2022). High levels of anxiety refer to the fear and difficulty in participating in activities related to mathematics (Muner & Rosli, 2023). Meanwhile, some studies found that secondary school students' mathematical anxiety levels are moderate (Akbayir, 2019; Azizah et al., 2019; Esa & Mohamed, 2017; Jolejole-Caube et al., 2019; Neelofar et al., 2022; Omar et al., 2022; Peng & Rosli, 2021; Prahmana et al., 2021; Winarso & Haqq, 2019; Yahya & Amir, 2018; Yuliani et al., 2018; Zay & Kurniasih, 2023). Moderate anxiety levels refer to a situation where students still feel anxious or unsure in understanding and answering mathematical questions, but the level of anxiety is not excessively high (Ismail & Maat, 2017). Some studies also found that mathematical anxiety among secondary school students is at a low level (Acevedo et al., 2020; Amam et al., 2019; Hasrin & Maat, 2022). Low-level anxiety refers to a situation where individuals experience anxiety but with positive thoughts that help them cope well with the situation (Hanifah et al., 2023).

Tatar (2012) found a significant but weak correlation between secondary school students' mathematical anxiety and their learning styles, specifically a weak but significant correlation between avoidant and collaborative learning styles with mathematical anxiety. Esa and Mohamed (2017) also found a weak but significant correlation between avoidant,

independent and participative learning styles with mathematical anxiety. However, Taley and Ndamenenu (2022) indicated that the level of mathematical anxiety is not related to students' learning styles. Therefore, understanding the relationship between learning styles and mathematical anxiety still requires further in-depth research.

Methodology

This study uses a correlational survey design. The selection of this method is appropriate for the study's objective, which is to determine the relationship between learning styles and mathematical anxiety. Data collection is done using a questionnaire. The choice of a questionnaire as a research tool is because it does not involve high costs and has a shorter time frame for implementation (Pa, 2016). Additionally, the use of a questionnaire is easy to conduct for studies with a large sample, and closed-ended questions in the survey facilitate data analysis.

The population studied consists of Form 4 students in a secondary school in the Kota Samarahan district, Sarawak. The total number of Form 4 students in this school is 506, comprising 258 male students and 248 female students. Form 4 students were chosen as study respondents because this group is at a critical educational level in preparing for the Sijil Pelajaran Malaysia (SPM) examination. The sample selection was conducted through a simple random sampling method, ensuring that each individual in the population has an equal chance of being selected as a sample (Yahaya et al., 2017). Based on the Krejcie and Morgan (1970) Sample Size Determination Table, this study requires a sample size of 226. Initially, 250 students were selected as samples, but only 233 students provided complete responses to the questionnaire. However, this number is still considered sufficient based on the values suggested by (Krejcie and Morgan, 1970). The selection of this secondary school as the research location was based on considerations such as easy access to the school and suitability with the limited time and budget for conducting the research.

The research instrument uses a questionnaire divided into three sections. Section A is used to obtain demographic information about the respondents, namely gender. Section B contains 42 items related to learning styles, using the Grasha Learning Style Inventory modified by (Chong and Mahamod, 2014). The purpose of this section is to identify the dominant learning style among the respondents. Meanwhile, Section C contains 15 items related to mathematical anxiety, using the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) developed by (May, 2009). The purpose of this section is to assess the level of mathematical anxiety among the respondents. Items in Sections B and C are measured using a five-point Likert scale.

Language and content validity were conducted by two experienced experts with over 10 years of experience in the field of education. Their competence and knowledge in education and mathematics allowing them to assess and ensure that the content and language used in the instrument are relevant, suitable for the study's context, and adaptable to the understanding and needs of Form 4 students. The research instrument was modified based on feedback and suggestions provided by the expert evaluators. The goal of modification is to ensure that the research instrument accurately and consistently measures the learning styles and mathematical anxiety of Form 4 students. To determine the reliability of the measurement, the Cronbach's alpha internal consistency method was used. This study obtained an alpha

value of 0.814, which is considered satisfactory as it falls within the range of 0.65 to 0.95, as stated by (Piaw, 2012). With a satisfactory alpha value, this study ensures that the research instrument can be used in the actual study. Table 1 shows the alpha values for each construct after the pilot study was conducted.

Table 1
Reliability Statistics

Construct	Alpha value	Number of items
Learning Styles (Section B)	0.767	42
Mathematical Anxiety (Section C)	0.895	15
Overall	0.814	57

Before commencing data collection, crucial steps were taken to ensure the smooth and ethical conduct of the study. The first step involved obtaining permission from the Educational Policy Planning and Research Division (EPRD) of the Ministry of Education, Malaysia. This step was essential to ensure compliance with guidelines and regulations set by the central authority. Subsequently, approval was also obtained from the State Education Department of Sarawak. This permission was necessary to conduct the study at the state level and ensure adherence to regulations and procedures set by the state authorities. Additionally, approval was obtained from the District Education Office of Samarahan to conduct the study in the selected secondary school. This step was crucial to obtain consent from the school authorities and ensure the smooth progress of the study at the chosen location.

Data analysis will be conducted using SPSS version 28, involving both descriptive and inferential analysis. Descriptive statistical approaches will utilise measures such as frequency, percentage, mean and standard deviation. Frequency and percentage measures will be employed to depict respondent profiles. To determine the most dominant learning style, assessments will be made based on mean values and standard deviations. The determination of the level of mathematical anxiety among students will utilise the adapted interpretation of mean values from Pallant (2007), namely high (3.67 - 5.00), moderate (2.34 - 3.66), and low (1.00 - 2.33). Inferential statistical approaches will involve Pearson correlation tests to measure the relationship between learning styles and mathematical anxiety. To assess the strength and direction of the relationship between learning styles and mathematical anxiety, the researcher will refer to the interpretation of correlation strength provided by (Piaw, 2012). Table 2 illustrates the interpretation of correlation values used in the analysis.

Table 2
Interpretation of Correlation Strength

Correlation Value	Interpretation
± 0.91 to ± 1.00	Very strong
± 0.71 to ± 0.90	Strong
± 0.51 to ± 0.70	Moderate
± 0.31 to ± 0.50	Weak
± 0.01 to ± 0.30	Very weak
0.00	No correlation

Research Findings
Demographic Profile

The study sample consists of Form 4 students from a secondary school in the Kota Samarahan district, Sarawak. A total of 233 students participated in this study. The profile of respondents examined in this study is based on gender. Figure 1 illustrates the percentage of respondents based on gender.
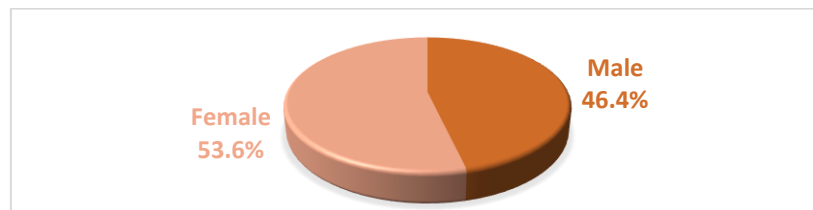

Diagram 1: Percentage of study respondents based on gender

From the total number of respondents, there are 108 male students, representing 46.4% of the overall study respondents. The study also involves 125 female students, contributing to 53.6% of the total number of respondents. This indicates that the majority of the respondents consist of female students.

Dominant learning style of Form 4 students when studying mathematics

Table 3 presents a descriptive analysis of the learning styles of Form 4 students while studying mathematics. Mean values and standard deviations for each practised style are used to determine the dominant learning style. Based on the data analysis conducted, the most dominant learning style is the dependent style (mean = 4.153, sd = 0.511). This is followed by the collaborative style (mean = 3.975, sd = 0.627), the participative style (mean = 3.617, sd = 0.666), the competitive style (mean = 3.193, sd = 0.695), and the independent style (mean = 2.974, sd = 0.661). Finally, the style least practised by students is the avoidant style (mean = 2.726, sd = 0.783).

Table 3
Overall mean results of learning styles analysis

Learning Style	Mean	Standard Deviation	Rank
Dependent	4.153	0.511	1
Collaborative	3.975	0.627	2
Participative	3.617	0.666	3
Competitive	3.193	0.695	4
Independent	2.974	0.661	5
Avoidant	2.726	0.783	6

Level of mathematical snxiety among Form 4 students

Descriptive analysis of the level of mathematical anxiety among Form 4 students is shown in Table 4. The findings indicate that the level of mathematical anxiety among students is at a high level (mean = 3.818, sd = 0.537).

Table 4
Results of the analysis of mean mathematical anxiety

	Mean	Standard Deviation	Interpretation
Mathematical Anxiety	3.818	0.537	High

The relationship between learning style and mathematical anxiety

Table 5 presents the results of the Pearson correlation analysis for the relationship between learning styles and mathematical anxiety among Form 4 students. The study findings indicate a significant relationship between independent, avoidant, dependent and participative styles with mathematical anxiety. The independent style (r(233) = -0.253, p = 0.000) and participative style (r(233) = -0.136, p = 0.039) show a very weak negative relationship with mathematical anxiety. The avoidant style (r(233) = 0.374, p = 0.000) shows a weak positive relationship with mathematical anxiety. Meanwhile, the dependent style (r(233) = 0.229, p = 0.000) shows a very weak positive relationship with mathematical anxiety.

Table 5
Study findings of the correlation test examining the relationship between learning styles and mathematical anxiety

Learning Style	Level of Mathematical Anxiety		Interpretation
	Correlation Coefficient, r	p	
Independent	-0.253*	0.000	Negative and very weak
Avoidant	0.374*	0.000	Positive and weak
Dependent	0.229*	0.000	Positive and very weak
Participative	-0.136*	0.039	Negative and very weak

*significant p<0.05

Discussion

This study found that the dependent learning style is the most dominant among Form 4 students when studying mathematics. This finding aligns with a study by Cardino Jr and Cruz (2020) in the Philippines, which found that the majority of secondary school students adopt a dependent learning style when studying mathematics. Students who use a dependent learning style tend to have lower mathematical intelligence levels and focus only on what they consider essential. They consistently view teachers and classmates as support during learning. To assist students who tend to use a dependent learning style, it is essential for teachers to encourage independent learning skills. Teachers can introduce learning strategies that promote critical thinking, such as using open-ended questions that require deep thinking and independent investigation. Additionally, a collaborative approach where students work together to solve mathematical problems can help them develop confidence and social skills in understanding mathematical concepts. By giving students the opportunity to take initiative in their learning, teachers can guide them towards more independent learning.

The study also found that the mathematical anxiety level among Form 4 students is high. This result is consistent with several studies indicating that secondary school students experience high mathematical anxiety (Bornaa et al., 2023; Estonanto & Dio, 2019; Hui & Rosli, 2021; Mutegi et al., 2021; Suren & Kandemir, 2020; Taley & Ndamenenu, 2022). High mathematical

anxiety needs to be addressed by teachers or educators to prevent the development of more serious negative perceptions at higher educational levels (Hui & Rosli, 2021). Therefore, teachers need to take the initiative in designing effective and comprehensive teaching strategies to address mathematical anxiety among Form 4 students. Measures such as using student-centred learning methods, implementing problem-based approaches, and emphasising creative and discovery learning may help reduce mathematical anxiety (Atoyebi & Atoyebi, 2022).

This study also found that independent, avoidant, dependent and participative learning styles have a significant relationship with Form 4 students' mathematical anxiety. The independent style shows a very weak negative relationship with mathematical anxiety. The findings are consistent with Esa and Mohamed's (2017) discovery of a weak negative correlation between independent learning style and mathematical anxiety among secondary school students. This implies that the higher an individual's tendency towards independent learning style, the lower the mathematical anxiety experienced by that individual. Independent learners tend to seek problem-solving solutions on their own and manage learning without relying on others. Therefore, they are more confident in facing challenging mathematical tasks, ultimately helping to reduce mathematical anxiety.

The avoidant learning style shows a weak positive relationship with mathematical anxiety. The findings align with Esa and Mohamed's (2017) study, which found a weak positive correlation between the avoidant learning style and mathematical anxiety among secondary school students. This means that the higher an individual's tendency towards the avoidant learning style, the higher the mathematical anxiety experienced by that individual. Students who adopt this style often daydream, show little interest in learning sessions, do not complete assignments and frequently skip classes (Ahmad & Rosli, 2019; Azizah et al., 2019). If students tend to avoid learning mathematics or evade complex mathematical problems, their mathematical anxiety may increase.

The dependent learning style also shows a very weak positive relationship with mathematical anxiety. This means that the higher an individual's tendency towards dependent learning style, the higher the mathematical anxiety experienced by that individual. Students with a dependent learning style also prefer teacher-centred learning and expect teachers to provide everything for them (Nadarajan et al., 2016). Students who tend to depend on others for assistance may experience mathematical anxiety when they cannot find help or receive the expected support. This learning style also hinders the understanding of mathematical concepts because students tend to memorise ideas without being able to relate them to solving mathematical problems (Damanhuri et al., 2020).

The participative learning style shows a very weak negative relationship with mathematical anxiety. The findings are consistent with Esa and Mohamed's (2017) study, which found a weak negative correlation between the participative learning style and mathematical anxiety. This means that the higher an individual's tendency towards the participative learning style, the lower the mathematical anxiety experienced by that individual. Students who tend to use the participative learning style are always active and strive to understand mathematics through participation in discussions and group activities. This active interaction allows students to gain a deeper understanding of challenging mathematical concepts. Moliner and

Alegre (2020) also found that active student involvement during peer tutoring is highly beneficial in reducing mathematical anxiety among secondary school students.

Conclusion
The findings of this study indicate that the majority of Form 4 students use a dependent learning style when studying mathematics. Additionally, students also experience a high level of mathematical anxiety. Furthermore, this study also found a significant relationship between independent, avoidant, dependent and participative learning styles with mathematical anxiety.

Overall, this study suggests that the Grasha-Riechmann learning style theory has the potential to help teachers understand how students choose their learning styles. Moreover, the identified correlations between learning styles and mathematical anxiety indicate an interaction between learning styles and psychological factors. In terms of practice, mathematics teachers need to consider individual learning styles when designing teaching strategies. For students who tend to prefer a dependent learning style, teachers can provide additional resources and clear instructions to help them understand mathematical concepts. Additionally, there is a need to pay attention to the high level of mathematical anxiety among students. Schools can provide additional support programmes such as counseling sessions, small classes, or guidance. Finally, the Malaysian Ministry of Education (MOE) should also emphasise teacher training and professional development to address students' mathematical anxiety.

Some suggested future research directions include expanding the study sample to secondary schools in all districts in Sarawak for a more comprehensive overview of students' learning styles and mathematical anxiety. Furthermore, it is recommended to investigate the relationship between student motivation, learning styles and mathematical anxiety. This could help understand the role of motivation in shaping how students learn mathematics and cope with mathematical anxiety. Additionally, qualitative approaches, such as in-depth interviews with students, are also recommended. This could provide a better understanding of how students learn and how mathematical anxiety may arise during their mathematics learning.

Acknowledgements

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