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(IJMOE)**www.gaexcellence.com/ijmoe**A CROSS-SECTIONAL STUDY ON MATHEMATICS
ANXIETY AND MATHEMATICS SELF-EFFICACY AMONG
HIGH SCHOOL STUDENTS USING FUZZY CONJOINT
ANALYSIS**

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Abstract:

Mathematics is a core subject in the Sijil Pelajaran Malaysia (SPM), yet it persistently records one of the highest failure rates among all subjects; in 2024 alone, 22.4% of candidates failed (Lembaga Peperiksaan, 2025). This trend raises critical concern, particularly for students who progressed through the education system without sitting for the Ujian Pencapaian Sekolah Rendah (UPSR) and Pentaksiran Tingkatan 3 (PT3), potentially shaping different learning experiences and psychological responses toward mathematics. Mathematics anxiety and self-efficacy are associated with students' attitudes and performance; however, the interplay between high anxiety and confidence remains insufficiently understood within this particular cohort. This study

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investigates the levels of mathematics anxiety and self-efficacy among 62 secondary school students from Sekolah Menengah Kebangsaan Ketereh, Kelantan. Data were collected using the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) and analysed using the Fuzzy Conjoint Method to determine the degree of similarity for each attribute, while Spearman's Rank Correlation was employed to examine the relationships among variables. The findings reveal that students exhibit high levels of mathematics anxiety, primarily driven by test performance and grading concerns, yet simultaneously demonstrate relatively high self-efficacy regarding coursework effort and learning capabilities. Rather than indicating a psychological contradiction, this key result suggests that anxiety in this cohort is fueled by high achievement motivation and academic expectations rather than low perceived competence. Minimal differences were observed between lower and upper secondary students. In addition, a weak positive correlation was found between self-efficacy and achievement, as well as between anxiety and achievement, while a weak negative correlation was observed between anxiety and self-efficacy. These findings highlight the need to re-examine current instructional approaches and provide targeted interventions that address both the cognitive and emotional dimensions of learning mathematics. This study contributes to the ongoing discourse on mathematics anxiety and self-efficacy, particularly in post-pandemic educational contexts, with the aim of fostering more resilient, confident, and successful learners in mathematics.

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Keywords:

Mathematics Anxiety, Self-Efficacy, Fuzzy Conjoint Analysis, Spearman's Rank Correlation, Secondary School Students



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Introduction

Mathematics serves as a fundamental academic pillar that influences diverse analytical sectors, spanning engineering, economic forecasting, computing infrastructures, quantitative finance, and technological evolution. Proficient mathematical literacy is intrinsically linked to structural national growth, playing a crucial role in cultivating high-calibre human capital capable of driving Science, Technology, Engineering, and Mathematics (STEM) innovations. Despite its systemic significance, the academic progression of secondary school students is frequently impeded by complex emotional and psychological barriers, primarily characterized by mathematics anxiety and deflated self-efficacy.

Garcia (2016) mentioned in his work that personality traits or students' affective characteristics is important due to its significant effect on their learning outcome as outline by Bloom's student learning model. Mathematics Anxiety (MA) represents a persistent psychological state marked by apprehension, tension, and autonomic distress during numerical manipulation and mathematical evaluation. As documented by Fernández-Blanco et al. (2023), elevated mathematics anxiety significantly undermines students' working memory capacity, concentration, and emotional resilience during high-stakes evaluations. Beyond immediate cognitive impairments, structural meta-analyses corroborate that severe mathematics anxiety fosters cognitive avoidance behaviors, directly diminishing students' long-term academic motivation and fostering pervasive negative attitudes toward quantitative domains (Barroso et al., 2021; Namkung et al., 2019).

Concurrently, mathematics self-efficacy (SE) operates as a vital cognitive determinant, reflecting an individual's self-regulatory belief in their capability to successfully execute specific mathematical tasks, understand intricate geometric or algebraic equations, and navigate formal examinations (May 2009). Contemporary empirical assessments underscore that mathematics self-efficacy functions as a robust motivational construct, strongly predicting student task engagement and persistence through rigorous conceptual barriers (Al Umairi, 2024; Yang et al., 2024). Students possessing strong self-efficacy consistently demonstrate enhanced motivational drive, applying strategic problem-solving approaches when encountering abstract mathematical issues, whereas those with low self-efficacy remain prone to premature task abandonment and persistent self-doubt.

Historically, pedagogical literature has often identified a distinct negative correlation between anxiety and self-efficacy, where severe anxiety destabilizes confidence, and low self-efficacy leaves learners vulnerable to evaluation fear (Octaviani & Sundari, 2024; Rozgonjuk et al., 2020). However, in educational systems undergoing transition, unique psychological profiles may emerge where high-performance anxiety coexists with robust learning confidence. In the Malaysian educational landscape, mathematics persistently records noticeable failure rates in national examinations; official analysis reports from the Examinations Syndicate indicate a failure rate of 22.4% in the 2024 Sijil Pelajaran Malaysia (SPM) examination, with a minor shift to 21.7% in 2025 (Lembaga Peperiksaan, 2025, 2026). This affective vulnerability is particularly relevant for the current secondary school cohort, who navigated their schooling years amidst significant structural adjustments, including the abolition of standardized primary and lower secondary baseline assessments (UPSR and PT3) alongside post-pandemic digital learning transitions. While this study does not directly measure the causal impact of examination abolition, this background provides an important context for evaluating the current affective state of secondary school learners.

Liabilities in establishing an empirical evaluation of these altered affective attributes may lead to pedagogical misalignment. To address this clear empirical gap, this study examines secondary school students from Sekolah Menengah Kebangsaan Kereh, Kelantan. It provides a comparative cross-sectional analysis of mathematics anxiety and self-efficacy levels across lower and upper secondary tiers, while simultaneously investigating the exact correlations existing between these psychological variables and actual mathematics achievement.

To ensure analytical rigor, this research deploys Fuzzy Conjoint Analysis (FCA) integrated with Spearman's rank correlation. Affective human responses and psychological constructs are fundamentally subjective, vague, and natural outputs of imprecise linguistic self-reporting

(e.g., "moderately anxious" or "highly confident"). Classical psychometric tools that rely on traditional central tendency frameworks typically reduce these linguistic inputs into crisp numerical values, thereby losing valuable data regarding response distribution and internal uncertainty. As pioneered by Bidin et al. (2026), FCA mitigates this limitation by mapping imprecise linguistic responses from Likert-scale tools into structured membership functions, thereby successfully preserving the vagueness inherent in student perceptions (Lim et al., 2021; Osman et al., 2021). Parallel to this, Spearman's rank correlation coefficient is applied to accurately capture the direction and strength of interactions linking MA, SE, and academic grades, providing an appropriate non-parametric approach for ordinal data without demanding strict distribution normality (Mukaka, 2012).

Gopal et al. (2020) mentioned that students' high anxiety is a consequence of their low self-efficacy. This an unfavourable existing state of mathematics learning among upper secondary students happens due to the nation's aspiration for excellence STEM. Ultimately, the insights generated by this investigation aim to equip teachers, institutional leaders, and curriculum planners with the evidence required to design targeted pedagogical frameworks and empathetic counseling initiatives. By systematically reducing latent mathematics anxiety and reinforcing individual self-efficacy, educational environments can better support resilient student performance, aligning with national aspirations to accelerate high-level STEM alignment amid rapid civilizational progress.

Methodology

This study adopted a quantitative research design to investigate students' mathematics anxiety (MA) and mathematics self-efficacy (SE). Two analytical approaches were employed, namely Fuzzy Conjoint Analysis (FCA) and Spearman's Rank Correlation. FCA was used to analyse students' responses from the 5-point Likert scale questionnaire by transforming linguistic responses into fuzzy sets. This approach is particularly appropriate because it accommodates the uncertainty and vagueness in human judgment based on fuzzy set theory introduced by Lotfi A. Zadeh. In addition, Spearman's Rank Correlation was employed to examine the relationship between mathematics anxiety, mathematics self-efficacy, and mathematics achievement. Since the questionnaire responses were measured on ordinal scale, Spearman's correlation was deemed suitable because it is a non-parametric technique that does not require the assumption of normality (Ali & Al-Hameed, 2022).

Data Collection

The sample comprised 62 secondary school students from Sekolah Menengah Kebangsaan Ketereh, Kelantan, representing a typical rural public secondary school setting in Malaysia. The sample consisted of 24 lower secondary students (Form 1–3) and 38 upper secondary students (Form 4–5). Early identification of mathematics anxiety across lower and upper tiers allows educators to implement timely pedagogical interventions before emotional barriers solidify. The post-pandemic learning context is relevant here, as these students experienced disruptions in traditional learning modes and assessment structures, influencing their study habits, confidence, and exam readiness.

Data were collected using the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) developed by May (2009). The instrument consisted of three sections. Section A gathered demographic information such as age and mathematics grades. Section B assessed mathematics

self-efficacy, while Section C measured mathematics anxiety. The MSEAQ consisted of 29 items, comprising 14 items (SE01-SE14) related to mathematics self-efficacy and 15 items (MA1-MA15) pertaining to mathematics anxiety as shown in Table 1.

Table 1: Items of MSEAQ

Code	Attributes
MA1	I get tense when I prepare for a mathematics test.
MA2	I get nervous when I have to use mathematics outside of school.
MA3	I worry that I will not be able to use mathematics in my future career when needed.
MA4	I worry that I will not be able to get a good grade in my mathematics course.
MA5	I worry that I will not be able to do well on mathematics tests.
MA6	I feel stressed when listening to mathematics instructors in class.
MA7	I get nervous when asking questions in class.
MA8	Working on mathematics homework is stressful for me.
MA9	I worry that I do not know enough mathematics for future mathematics courses.
MA10	I worry that I will not be able to complete every assignment in a mathematics course.
MA11	I worry I will not be able to understand the mathematics.
MA12	I worry that I will not be able to get an “A” in my mathematics course.
MA13	I worry that I will not be able to learn well in my mathematics course.
MA14	I get nervous when taking a mathematics test.
MA15	I am afraid to give an incorrect answer during my mathematics class.
SE1	I feel confident enough to ask questions in my mathematics class.
SE2	I believe I can do well on a mathematics test.
SE3	I believe I can complete all of the assignments in a mathematics course.
SE4	I believe I am the kind of person who is good at mathematics.
SE5	I believe I will be able to use mathematics in my future career when needed.
SE6	I believe I can understand the content in a mathematics course.
SE7	I believe I can get an “A” when I am in a mathematics course.
SE8	I believe I can learn well in a mathematics course.
SE9	I feel confident when taking a mathematics test.
SE10	I believe I am the type of person who can do mathematics.

- SE11 I feel that I will be able to do well in future mathematics courses
- SE12 I believe I can do the mathematics in a mathematics course.
- SE13 I feel confident when using mathematics outside of school.
- SE14 I believe I am the type of person who can do mathematics.

The students rated all the items using a five-point likert scale corresponding to the linguistic variables, L, of agreement and pre-defined fuzzy set (Yahaya and Mohamad, 2011) as shown in Table 2.

Table 2: Likert Scale and Linguistic Variable and Pre-defined Fuzzy Set

Likert scale	Linguistic Variable, L	Pre-defined Fuzzy Set
1	Strongly disagree	$L_1 = \left\{ \frac{1}{1}, \frac{0.75}{2}, \frac{0.5}{3}, \frac{0}{4}, \frac{0}{5} \right\}$
2	Disagree	$L_2 = \left\{ \frac{0.5}{1}, \frac{1}{2}, \frac{0.75}{3}, \frac{0.25}{4}, \frac{0}{5} \right\}$
3	Neutral	$L_3 = \left\{ \frac{0}{1}, \frac{0.5}{2}, \frac{1}{3}, \frac{0.5}{4}, \frac{0}{5} \right\}$
4	Agree	$L_4 = \left\{ \frac{0}{1}, \frac{0.25}{2}, \frac{0.75}{3}, \frac{1}{4}, \frac{0.25}{5} \right\}$
5	Strongly agree	$L_5 = \left\{ \frac{0}{1}, \frac{0}{2}, \frac{0.5}{3}, \frac{0.75}{4}, \frac{1}{5} \right\}$

To analyze the data, the Fuzzy Conjoint Analysis method will be employed. This approach is particularly suitable for capturing the uncertainty and subjectivity inherent in students' perceptions related to mathematics self-efficacy and anxiety, as it integrates fuzzy logic with traditional conjoint analysis techniques.

Fuzzy Conjoint Analysis

Fuzzy Conjoint Analysis (FCA) is an extension of traditional conjoint analysis that integrates fuzzy set theory to handle uncertainty and ambiguity in respondents' judgments. Conventional statistical methods generally assume that respondents' perceptions and preferences are expressed precisely, whereas human opinions are often vague and represented through linguistic expressions such as "strongly disagree", "disagree", "neutral", "agree", and "strongly agree". Fuzzy set theory allows these linguistic variables to be transformed into fuzzy numbers, enabling a more realistic representation of subjective perceptions and reducing information loss.

In FCA, respondents' evaluations of specific attributes are aggregated into a fuzzy set F . The approximate membership degree, $\mu_F(y_j, A_m) \in [0,1]$ for each domain element (linguistic variable), y_j in fuzzy set F is determined as follows:

$$\mu_F(y_j, A_m) = \sum_{i=1}^n W_{(w_i, A_m)} \cdot \mu_{L_i}(x_j, A_m) \quad (1)$$

where

y_j and x_j are elements of the domain, while $j = 1, 2, 3, 4, 5$ denotes the five linguistic terms used in the study.

A_m represents the m -th attribute and $m=1,2,3,\dots, k$. In this study, $k = 14$ for mathematics self-efficacy and $k = 15$ for mathematics anxiety.

$\mu_{L_i}(x_j, A_m)$ is the membership degree of x_j 's response to attribute A_m corresponding to linguistic term L_i .

$W_{(w_i, A_m)}$ is the fuzzified weight assigned for the linguistic rating, w_i corresponding to attribute A_m and it is given as

$$W_{(w_i, A_m)} = \frac{\sum w_i}{\sum_{k=1}^j w_k} \quad (2)$$

where $\sum w_i$ is the sum linguistic rating across students for attribute A_m and $\sum_{k=1}^j w_k$ is the sum all linguistic rating across attribute A_m .

The degree of similarity between the fuzzy set representing all respondents and each fuzzy set associated with the five linguistic values ($L_k = 1, 2, 3, 4, 5$) for each attribute is then calculated using Euclidean distance. The similarity degree of similarity is given by:

$$S(F, L_k) = \frac{1}{1 + \sqrt{[\mu_F(y_j, A_m) - \mu_{L_k}(j)]^2}} \quad (3)$$

where

$\mu_{L_k}(j)$ is the fuzzy set defined for linguistic rating and $\mu_F(y_j, A_m)$ is calculated using equation (1).

The degree of similarity ranges from 0 to 1 and indicates the strength of respondents' agreement for each attribute. A degree of similarity closer to 1 signifies a stronger agreement among respondents and indicates that the corresponding linguistic rating better represents the respondents' opinions. Conversely, a value closer to 0 reflects weaker agreement and a lower degree of similarity.

The followings are the illustrated calculation on the students' opinion to the attribute MA1 which is "I get tense when I prepare for a mathematics test".

Step 1: Calculate the frequency of each rating.

The frequency for the ratings of MA1 are found as the following:

$$n('1') = 0, n('2') = 7, n('3') = 17, n('4') = 9, n('5') = 5$$

where n is the number of rating

Step 2: Calculate the sum of each rating and the sum all ratings

$$w_1 = 0(1) = 0, w_2 = 7(2) = 14, w_3 = 17(3) = 51, w_4 = 9(4) = 36, w_5 = 5(5) = 25$$

$$\sum_{i=1}^5 w_i = 0 + 14 + 51 + 36 + 25 = 126$$

Step 3: Compute the weight or each attribute using

$$W_{(w_i, A_m)} = \frac{\sum w_i}{\sum_{k=1}^j w_k}$$

$$W_1 = \frac{0}{126}, W_2 = \frac{14}{126}, W_3 = \frac{51}{126}, W_4 = \frac{36}{126}, W_5 = \frac{25}{126}$$

Step 4: Calculate the membership degree for each element in fuzzy set F using Equation

$$\begin{aligned} \mu_F(y_j, A_1) &= \sum_{i=1}^n W_{(w_i, A_1)} \cdot \mu_F(y_1, A_1) \\ &= W_1 \cdot \mu_{L_1}(x_1, A_1) + W_2 \cdot \mu_{L_2}(x_1, A_1) + W_3 \cdot \mu_{L_3}(x_1, A_1) + \\ &\quad W_4 \cdot \mu_{L_4}(x_1, A_1) + W_5 \cdot \mu_5(x_1, A_1) \end{aligned}$$

$$\mu_F(y_1, A_1) = \frac{0}{126}(1) + \frac{14}{126}(0.5) + \frac{51}{126}(0) + \frac{36}{126}(0) + \frac{25}{126}(0) = 0.0555$$

Using the same procedure, the membership degrees for the remaining elements of the fuzzy set are obtained as follows:

$$\mu_F(y_2, A_1) = 0.3849$$

$$\mu_F(y_3, A_1) = 0.8016$$

$$\mu_F(y_4, A_1) = 0.6646$$

$$\mu_F(y_5, A_1) = 0.3412$$

Step 5: Calculate the similarity degree between set F and set L using Equation

$$S(F, L_k) = \frac{1}{1 + \sqrt{\sum_{j=1}^k [\mu_F(y_j, A_m) - \mu_{L_k(j)}]^2}}$$

$$S(F, L_1) = \frac{1}{1 + \sqrt{(0.0555 - 1)^2 + (0.3849 - 0.75)^2 + (0.8016 - 0.50)^2 + (0.6646 - 0)^2 + (0.3412 - 0)^2}} = 0.4359$$

Using the same procedure, the similarity degree for degree for $S(F, L_2), S(F, L_3), S(F, L_4)$ and $S(F, L_5)$ are obtained as follows:

$$S(F, L_2) = 0.5178$$

$$S(F, L_3) = 0.6914$$

$$S(F, L_4) = 0.7133$$

$$S(F, L_5) = 0.5474$$

Step 6: Identify the highest similarity degree and draw a conclusion

The highest similarity degree is $S(F, L_4) = 0.7133$, corresponding to the linguistic term "agree". The value of 0.7133 indicates that respondents shows high level of tense when they prepare for mathematics test.

Spearman's Rank Correlation

Spearman's rank correlation coefficient (ρ) is a non-parametric measure used to assess the strength and direction of the monotonic relationship between two variables. In this study, Spearman's Rank Correlation was applied to determine the relationship between mathematics anxiety and mathematics achievement and also between mathematics self-efficacy and mathematics achievement. This method measures the strength and direction of the relationship between two variables using ranked data (Mukaka, 2012).

The Spearman's Rank Correlation coefficient is calculated using the following formula,

$$\rho = 1 - \frac{6(\sum d_i^2)}{n(n^2 - 1)} \quad (4)$$

where

n is the number of paired observation

d_i is the difference in ranks for mathematics anxiety and mathematics achievement and also self-efficacy and mathematics achievement.

The coefficient value ranges from -1 to $+1$, where values close to $+1$ indicate a strong positive relationship, while values close to -1 indicate a strong negative relationship (Ali & Al-Hameed, 2022).

Result

FCA was successfully applied to measure mathematics anxiety and mathematics self-efficacy among selected high school students. The results of the analysis are presented in Table 3, Table 4, Table 5 and Table 6.

Mathematics Anxiety

Table 3 shows that most mathematics anxiety attributes attained the highest similarity with L_4 , indicating that lower secondary students generally agreed with the statement related to mathematics anxiety. Among 15 attributes, eight attributes (MA2, MA3 MA4, MA5, MA11, MA12, MA14 and MA15) were associated with L_4 , four attributes (MA1, MA8, MA9 and MA10) corresponding to L_1 , one attribute (MA6) corresponded to L_2 and two attributes (MA7 and MA13) were classified under L_3 . The highest degree of similarity was recorded by MA12 ($S_{max} = 0.86994$), followed by MA11 ($S_{max} = 0.824776$) and MA4 ($S_{max} = 0.791546$), indicating that these items represent the most dominant sources of mathematics anxiety among lower secondary students.

Table 3: Degree of Similarity MA between Fuzzy Set F for Lower Secondary Students

Attribute	L_1	L_2	L_3	L_4	L_5	S_{max}	$L_{S_{ma}}$	Rank
MA1	0.445148	0.518612	0.667943	0.654456	0.561608	0.667943	L_3	15
MA2	0.469096	0.587963	0.790014	0.610288	0.47907	0.790014	L_3	4
MA3	0.421999	0.498736	0.660274	0.771316	0.553854	0.771316	L_4	6
MA4	0.413799	0.483026	0.641551	0.791546	0.576442	0.791546	L_4	3
MA5	0.427359	0.503119	0.66343	0.750069	0.563123	0.750069	L_4	7
MA6	0.575135	0.74778	0.641988	0.506794	0.433167	0.747780	L_2	8
MA7	0.473542	0.585958	0.771813	0.615988	0.485246	0.771813	L_3	5
MA8	0.509029	0.660273	0.740983	0.555184	0.453872	0.740983	L_3	10
MA9	0.432235	0.520358	0.724958	0.701926	0.523534	0.724958	L_3	14
MA10	0.472009	0.564706	0.729064	0.581847	0.501967	0.729064	L_3	13
MA11	0.411286	0.47941	0.628009	0.824776	0.57342	0.824776	L_4	2
MA12	0.397351	0.454325	0.582344	0.86994	0.621966	0.869940	L_4	1
MA13	0.438653	0.531586	0.742236	0.682514	0.51558	0.742236	L_3	9
MA14	0.433193	0.503629	0.641035	0.734425	0.583647	0.734425	L_4	11
MA15	0.434964	0.513861	0.675861	0.732513	0.551908	0.732513	L_4	12

The results indicate that an overwhelming majority of the items are most similar to linguistic variable L_3 (*Neutral*) and L_4 (*Agree*). For example, the attribute MA12 (“I fear I won’t be able to get an ‘A’ in my mathematics course”) had a similarity degree of 0.869940 with L_4 . This suggests that students strongly identified with anxiety regarding their grades in that particular item, which potentially suggests underlying emotional distress or pressure. In contrast, certain items show lower levels of anxiety. For example, MA6 “I feel stressed when listening to mathematics instructors in class” showed the highest similarity in L_2 (Disagree), with a value of similarity of 0.747780. This suggests that students generally do not feel stressed when studying, implying that the learning environment itself is not a significant source of stress for the majority of students. Overall, while responses were primarily neutral, high anxiety was measured in specific situations, particularly those involving outcomes or performance in math. This suggests that although students might appear generally unscathed, certain aspects of learning mathematics still contribute to anxiety.

Table 4: Degree of Similarity MA between Fuzzy Set F for Upper Secondary Students

Attribute	L_1	L_2	L_3	L_4	L_5	S_{max}	L_{S_m}	Rank
MA1	0.435916	0.517840	0.691366	0.713279	0.547439	0.713279	L_4	14
MA2	0.502749	0.671804	0.766474	0.525674	0.431850	0.766473	L_3	7
MA3	0.429797	0.503300	0.643488	0.758051	0.573720	0.758050	L_4	10
MA4	0.405483	0.460364	0.579720	0.801234	0.644980	0.801233	L_4	3
MA5	0.416453	0.473074	0.583465	0.771671	0.639558	0.771670	L_4	6
MA6	0.586579	0.758918	0.628596	0.499841	0.429843	0.758918	L_2	8
MA7	0.456205	0.549937	0.715054	0.667241	0.525457	0.715054	L_3	13
MA8	0.540536	0.728650	0.692806	0.513045	0.430290	0.728650	L_2	11
MA9	0.429070	0.512896	0.701828	0.723503	0.535103	0.723503	L_4	12

MA10	0.428746	0.504240	0.652731	0.758467	0.565639	0.758466	L_4	9
MA11	0.412388	0.471517	0.593830	0.800029	0.625648	0.800028	L_4	4
MA12	0.407557	0.467111	0.596868	0.820335	0.619554	0.820335	L_4	2
MA13	0.405719	0.464131	0.591019	0.828103	0.624178	0.828102	L_4	1
MA14	0.435843	0.520655	0.706606	0.709094	0.535853	0.709093	L_4	15
MA15	0.414510	0.477819	0.614654	0.792682	0.605872	0.792681	L_4	5

Similarly, Table 4 indicates that the upper secondary students predominantly agreed with mathematics anxiety attributes, with most attributes exhibiting the highest similarity with L_4 . Eleven out of fifteen attributes (MA1, MA3, MA4, MA5, MA9, MA10, MA11, MA12, MA13, MA14 and MA15) were classified under L_4 , while MA2 and MA7 corresponded to L_3 , and MA6 and MA8 corresponded to L_2 . The highest-ranked attribute was MA13 ($S_{max} = 0.828102$), followed by MA12 ($S_{max} = 0.820335$), and MA4 ($S_{max} = 0.801233$). The lowest similarity value was observed for MA14.

For upper secondary school students, attribute MA13 showed the most significant effects, indicating that students agreed they worry about their ability to perform well in the mathematics course. This revealed that the majority of students are concerned about their learning outcomes and academic performance. Several other attributes, including MA12, MA4, MA11, MA11, and MA15 also showed high values for similarity with L_4 , further supporting the finding that students are concerned about their capability to master mathematics-related tasks. In contrast, MA2 (“I get nervous when having to use mathematics outside school”) and MA7 (“I get nervous when asking questions in class”) were most similar to L_3 , suggesting moderate or situational anxiety in social and practical context, such as using mathematics outside school or asking questions in class. Meanwhile, MA6 had its highest similarity value with L_2 (Disagree) indicating that students generally do not feel stressed when listening to mathematics instruction in class. For the most part, the results showed that mathematics anxiety among upper secondary school students is directly linked to performance-oriented concerns about course success, grades, and learning outcomes.

Overall, both lower and upper secondary students demonstrated relatively high levels of mathematics anxiety, as reflected by the predominance of L_4 (Agree). However, some differences were observed. MA13 was ranked ninth among lower secondary students but emerged as the most prominent anxiety attribute among upper secondary students. Likewise, MA1 changed from L_1 among lower secondary students to L_4 among upper secondary students, suggesting that certain aspects of mathematics anxiety become more pronounced as students advance to higher levels of schooling.

Mathematics Self-Efficacy

Table 5 presents the degree of similarity between the fuzzy set FFF and the linguistic values for mathematics self-efficacy among lower secondary students. The results indicate that six attributes (SE1, SE2, SE5, SE6, SE8, and SE9) attained the highest similarity with L_4 (Agree), whereas the remaining attributes were associated with L_3 (Neutral). The highest similarity value was recorded by SE3 followed by SE8 ($S_{max} = 0.842679$), and SE6 ($S_{max} = 0.838286$), suggesting that these items reflect the strongest aspects of students' confidence in mathematics. Conversely, SE11 exhibited the lowest similarity value.

Table 5: Degree of Similarity SE between Fuzzy Set F for Lower Secondary Students

Attribute	L_1	L_2	L_3	L_4	L_5	S_{max}	L_{S_m}	Rank
SE1	0.419689	0.486991	0.626541	0.785679	0.591585	0.785679	L_4	6
SE2	0.417772	0.494035	0.680255	0.750398	0.549044	0.750398	L_4	8
SE3	0.402409	0.463422	0.598368	0.860969	0.604171	0.860969	L_4	1
SE4	0.463455	0.581381	0.828722	0.602198	0.472808	0.828722	L_4	4
SE5	0.400961	0.456784	0.583385	0.825698	0.634976	0.825698	L_4	5
SE6	0.409258	0.476417	0.620063	0.838286	0.577218	0.838286	L_4	3
SE7	0.437597	0.524820	0.721283	0.695586	0.529472	0.721283	L_3	13
SE8	0.402666	0.463052	0.600536	0.842679	0.608896	0.842679	L_4	2
SE9	0.424766	0.506169	0.682666	0.746913	0.536935	0.746913	L_4	9
SE10	0.426358	0.515233	0.740557	0.693892	0.512184	0.740557	L_3	10
SE11	0.429040	0.513943	0.707461	0.719334	0.531210	0.719334	L_4	14
SE12	0.438452	0.537182	0.781882	0.657272	0.496890	0.781882	L_3	7
SE13	0.511470	0.681482	0.740260	0.535860	0.440477	0.740260	L_3	11
SE14	0.432235	0.520358	0.724958	0.701926	0.523534	0.724958	L_3	12

The dominant perception for all attributes is primarily told within the L_3 (Neutral) and L_4 (Agree). Specifically, for the linguistic categories “agree” level, self-efficacy items indicated that the majority of the responses were associated with the highest membership value. For example, SE3, SE8 and SE6. The attributes SE3, SE8 and SE6 indicate students’ self-belief in doing coursework, learning, and understanding mathematics which are integral components of academic self-efficacy. Similarly, SE5 and SE1 also showed high values under L_4 which means that students are confident in applying mathematics to their future careers and in asking questions in class. This shows that their self-efficacy extends beyond exams, encompassing the application of their mathematical abilities in future contests. Conversely, attributes such as SE4 (“I think I am the type of person who is good at mathematics”), along with SE10, SE12, SE13, and SE14, showed the highest similarity with L_3 (Neutral). These items are largely related to identity-based self-efficacy, such as perceiving oneself as naturally good at mathematics or identifying as a “mathematics person”. Overall, the findings show that students demonstrate stronger mathematics self-efficacy in effort-based activities such as studying, doing homework, and understanding lessons. However, their confidence is relatively lower in identity-based beliefs, such as perceiving themselves as naturally good at mathematics.

Table 6 shows that upper secondary students exhibited a similar pattern. Seven attributes (SE1, SE2, SE5, SE6, SE7, SE8, and SE11) attained the highest similarity with L_4 , while the remaining attributes were associated with L_3 . Among all attributes, SE8 recorded the highest degree of similarity ($S_{max} = 0.897783$), followed by SE5($S_{max} = 0.852933$), and SE4 ($S_{max} = 0.846053$). The attribute SE10 had the lowest similarity value and ranked thirteenth.

Table 6: Degree of Similarity of SE between Fuzzy Set for Upper Secondary Students

Attribute	L_1	L_2	L_3	L_4	L_5	S_{max}	L_{S_m}	Rank
SE1	0.439257	0.530978	0.732980	0.687568	0.520165	0.732980	L_3	11

SE2	0.422179	0.496977	0.655426	0.772732	0.562078	0.772731	L_4	6
SE3	0.424291	0.500123	0.665834	0.756168	0.559907	0.756168	L_4	9
SE4	0.466355	0.591184	0.846054	0.586257	0.463611	0.846053	L_3	3
SE5	0.400570	0.458224	0.586622	0.852934	0.622504	0.852933	L_4	2
SE6	0.418084	0.495492	0.671913	0.764886	0.545887	0.764885	L_4	8
SE7	0.437217	0.517093	0.680048	0.714383	0.554981	0.714382	L_4	14
SE8	0.397199	0.457062	0.588910	0.897784	0.601387	0.897783	L_4	1
SE9	0.431355	0.521877	0.746475	0.686600	0.513327	0.746475	L_3	10
SE10	0.427491	0.514874	0.719706	0.710785	0.520436	0.719706	L_3	13
SE11	0.411909	0.481044	0.633901	0.812241	0.574530	0.812240	L_4	4
SE12	0.427566	0.513187	0.724916	0.704908	0.525117	0.724916	L_3	12
SE13	0.479445	0.608927	0.802562	0.583779	0.467814	0.802562	L_3	5
SE14	0.429211	0.521927	0.769215	0.670721	0.501697	0.769214	L_3	7

The upper secondary students have high confidence levels, particularly in students' belief in their capability to learn and perform mathematics. Most of the items had the highest similarity values on L_4 (Agree) and L_3 (Neutral), reflecting a tendency towards positive self-representation in mathematical contexts. Attribute SE8 ("I believe I can learn well in a mathematics course") showed the highest similarity. This indicates that upper secondary students are very confident in their ability to succeed in mathematics. Similarly, SE5 ("I believe I will be able to use mathematics in my future career when needed") ranks second with a similarity score. This reflects students' confidence in the long-term application of mathematics in real-life situations. SE11 ("I feel that I will be able to do well in future mathematics courses"), SE2, SE6, and SE3 are some other items that have high similarity under L_4 . All of these attributes reflect students' confidence in their ability to succeed and understand mathematical concepts well.

The results reveal that both lower and upper secondary students generally possessed moderate to high level of mathematics self-efficacy, with most classified under either L_3 or L_4 . In particular, SE13 showed a notable increase, moving from rank 11 among lower secondary students to rank 5 among upper secondary students. Meanwhile, SE7 shifted from L_3 to L_4 indicates that the confidence level in mathematics increases as students progress through upper secondary education.

Relationship between Mathematics Anxiety and Mathematics Achievement

Table 7 reveals a very weak positive correlation between mathematics anxiety and mathematics achievement ($\rho = 0.0187$), with the coefficient of determination indicating that mathematics anxiety accounts for only 0.04% of the variance in achievement. This finding suggests that mathematics anxiety has a negligible influence on students' academic performance in mathematics. Although previous studies have generally reported a negative relationship between mathematics anxiety and achievement (Hembree, 1990; Ashcraft, 2002), the present finding indicates that students with higher levels of anxiety did not necessarily perform worse in mathematics.

One possible explanation is that moderate levels of anxiety may function as a motivating factor that encourages students to exert greater effort and prepare more thoroughly for examinations. In addition, students may possess coping mechanisms that enable them to manage their anxiety effectively, thereby reducing its detrimental impact on academic performance. This finding also

supports the notion that mathematics achievement is influenced by multiple factors beyond anxiety, including prior knowledge, learning strategies, family support, teaching approaches, and self-regulatory skills. Furthermore, the post-pandemic cohort investigated in this study may exhibit unique characteristics resulting from altered learning experiences and assessment practices, which could explain the absence of the commonly reported negative relationship.

Table 7: Correlation Between MA And Mathematics Achievement

Variables	Spearman’s rho (ρ)	Interpretation	Percentage
MA and Mathematics Achievement	0.0187	Weak positive correlation	0.04%

Relationship between Self-Efficacy and Mathematics Achievement

Table 8 shows a weak positive correlation between mathematics self-efficacy and mathematics achievement ($\rho = 0.1808$), with self-efficacy explaining approximately 3.27% of the variance in achievement. This result indicates that students who possess greater confidence in their mathematical abilities tend to achieve slightly better academic outcomes. The positive relationship is consistent with Bandura's (1997) Social Cognitive Theory, which suggests that individuals' beliefs in their capabilities influence their motivation, effort, persistence, and performance.

The present finding is also in agreement with previous studies that have identified mathematics self-efficacy as an important predictor of achievement (Pajares & Miller, 1994; Fast et al., 2010; Yang et al., 2024). Students who believe in their ability to solve mathematical problems are generally more likely to engage actively in learning activities, persevere when encountering difficulties, and adopt effective learning strategies. Nevertheless, the relatively weak correlation observed in this study suggests that self-efficacy alone is insufficient to explain students' achievement. Other factors, such as mathematical ability, instructional quality, parental support, and learning environments, may contribute substantially to academic performance.

Taken together, the findings imply that both mathematics anxiety and self-efficacy exhibit limited associations with mathematics achievement among the respondents. While self-efficacy appears to exert a more meaningful influence than anxiety, neither variable explains a substantial proportion of students’ performance. These results suggest that mathematics achievement is a multidimensional construct influenced by a complex interaction of cognitive, affective, and environmental factors. Therefore, interventions aimed at improving mathematics performance should not only focus on reducing anxiety and strengthening self-efficacy but should also consider broader aspects of teaching and learning that support students’ overall mathematical development.

Table 8: Correlation Between Self-Efficacy And Mathematics Achievement

Variables	Spearman's rho (ρ)	Interpretation	Percentage
SE and Mathematics Achievement	0.1808	Weak positive correlation	3.27%

Relationship between Mathematics Anxiety and Self-Efficacy

The obtained Spearman's rho value of **-0.1484** in Table 9 indicates a **weak negative correlation** between mathematics anxiety and self-efficacy. This finding implies that an increase in mathematics anxiety is associated with a slight decrease in mathematics self-efficacy among the respondents. Furthermore, the coefficient of determination of **2.2%** suggests that mathematics anxiety accounts for only a small proportion of the variability in mathematics self-efficacy. Hence, the relationship between mathematics anxiety and mathematics self-efficacy is weak, indicating that additional factors may contribute more substantially to students' confidence in learning mathematics.

Table 9: Correlation between MA and SE

Variables	Spearman's rho (ρ)	Interpretation	Percentage
MA and SE	- 0.1484	Weak negative relationship	2.2%

Discussion

The findings of this study indicate that both lower and upper secondary school students experienced mathematics anxiety, particularly in relation to examinations, grades, and academic performance. Both lower and upper secondary school students at SMK Ketereh showed significant anxiety. Lower secondary school students were more concerned about the examination results, whereas upper secondary school students were more worried about the learning process. However, they also showed high levels of self-efficacy. They believed that they could perform tasks, understand mathematical learning, and apply it in their future lives or careers. This study suggests that students with high mathematical anxiety may also have high self-efficacy. High anxiety does not necessarily indicate a lack of self-confidence. These students may worry because they care about performance and want to succeed. In this case, the anxiety may come from high motivation and self-expectations, not because they are weak in math.

Similar to the findings of Dağdelen & Yildiz (2022) and Pérez-Fuentes et al. (2020) indicate a significant moderate positive relationship between students' overall mathematical anxiety and their mathematics self-efficacy. This suggests that students who are more anxious about mathematics may also believe in their ability to understand and apply mathematical concepts. However, Gopal et al. (2020), Rozgonjuk et al. (2020), Zhang et al. (2019), Ablian & Parangat (2022), and Chikampa et al. (2023) have proved in their study that mathematics anxiety was negatively related to mathematics self-efficacy. This is due to the generally negative attitudes that students have towards mathematics. The research indicates the combination of low self-confidence and high fear can significantly hinder learning outcomes.

To investigate the interrelation among mathematics anxiety (MA), self-efficacy (SE), and mathematics achievement, Spearman's rank correlation analysis was employed. There is a weak positive correlation between the MA and mathematics achievement. The correlation is close to zero ($\rho = 0.0187$), indicating no meaningful relationship between the variables. The results obtained from Spearman's Rank correlation analysis are consistent with those from the Fuzzy Conjoint Analysis. Both methods indicate a positive relationship between mathematics anxiety and mathematics self-efficacy. In addition, some studies have reported that higher levels of anxiety may be associated with better academic performance. However, this is often accompanied by reduced motivation and may not represent an optimal learning condition. Other literature suggests that moderate levels of anxiety are generally associated with better academic outcomes, indicating a possible non-linear relationship between anxiety and performance (Majali, 2020; Shin et al., 2023). However, Zhang et al. (2019) and Chikampa et al. (2023) reported a negative correlation effect on MA and mathematics achievement. Ablian & Parangat (2022) results showed a significant relationship between students' perceptions of mathematics anxiety and their academic performance in Mathematics. The inverse correlation suggests that higher levels of anxiety are associated with lower mathematics achievement. As a result, their degree of mathematical anxiety is negatively related to their academic performance in Mathematics.

A weak positive correlation between SE and mathematics achievement ($\rho = 0.1808$). The results show that students with high self-efficacy tend to achieve better scores in the subject. The result is supported by Ablian & Parangat (2022) and Roslan & Maat (2019) have a significant relationship between perceived Mathematics self-efficacy and the academic performance of students in Mathematics. Although the strength of the correlation is weak, it supports the theoretical framework that self-efficacy plays a role in motivating students to perform better. Chikampa et al. (2023), Ducay & Alave, (2021) also hypothesized that mathematics self-efficacy is positively related to perceived mathematics performance. The positive relationship signifies that the increase in the mathematics self-efficacy of the students will improve the students' performance in Mathematics.

The fuzzy conjoint analysis showed a positive relationship between mathematics anxiety and self-efficacy. This means that students with higher anxiety also believed in their ability to do mathematics. However, the result from the Spearman correlation analysis showed a different outcome. The result showed a correlation coefficient between MA and SE is $\rho = -0.1484$, which indicates a weak negative relationship between the two variables. This suggests that students who reported higher levels of mathematics anxiety tend to have slightly lower levels of self-efficacy. This finding is supported by Chikampa et al. (2023), Cuevas & Berou (2016), Ablian & Parangat (2022), and Ardi et al. (2019), who reported that mathematics self-efficacy significantly influences mathematics anxiety. These studies highlight that higher levels of self-efficacy are associated with lower levels of mathematics anxiety. Although the relationship found in this study is weak, it supports previous research suggesting that enhancing students' self-efficacy could be an effective approach to reducing mathematics anxiety.

Conclusion and Recommendations

The application of the Fuzzy Conjoint Analysis (FCA) method to data collected from students at SMK Ketereh yielded several important findings concerning the relationship between mathematics anxiety (MA), self-efficacy (SE), and mathematics achievement. The results indicated that lower and upper secondary school students experienced comparable levels of

mathematics anxiety and self-efficacy. Nevertheless, the sources of their anxiety and confidence differed. Lower secondary school students were mainly concerned about their examination outcomes, whereas upper secondary school students were more concerned about the process of learning mathematics and mastering mathematical concepts.

A Spearman's Rank Correlation indicated a slight negative relationship between mathematics anxiety and self-efficacy ($\rho = -0.1484$), meaning that students with higher anxiety tend to feel less confident. Conversely, there were weak positive correlations between mathematics anxiety and achievement ($\rho = 0.0187$), as well as between self-efficacy and achievement ($\rho = 0.1808$). Together, these results suggest that students can still experience math anxiety even if they are confident in their abilities.

Importantly, all interpretations must be understood within the specific sample context of 62 students at SMK Ketherh rather than generalized across all Malaysian secondary students. Several limitations should be noted: the study examined a modest sample ($N=62$) from a single rural secondary school. Future research should incorporate larger multi-school samples, longitudinal tracking, and qualitative interviews to explore underlying coping mechanisms in post-pandemic educational transitions.

Furthermore, since the present study focused primarily on mathematics anxiety, mathematics self-efficacy, and mathematics achievement, future research should consider additional variables that may influence mathematics performance, including learning motivation, self-regulated learning, parental involvement, teacher support, classroom climate, socioeconomic background, and prior mathematical knowledge. Investigating these factors may provide a more comprehensive understanding of students' mathematical experiences and contribute to the development of more effective interventions to enhance mathematics learning outcomes. In addition, the coexistence of high mathematics anxiety and high mathematics self-efficacy observed in this study warrants further investigation. Qualitative approaches, such as interviews and focus group discussions, could provide deeper insights into students' perceptions, coping strategies, and emotional experiences related to mathematics. Future studies may also compare post-pandemic cohorts with pre-pandemic cohorts to determine whether changes in learning environments and assessment practices have influenced students' psychological responses towards mathematics.

Finally, further applications of fuzzy-based approaches, including Fuzzy Conjoint Analysis (FCA), Fuzzy Cognitive Maps (FCMs), and hybrid statistical models, are recommended to better capture the uncertainty and subjectivity inherent in students' responses and to complement conventional statistical techniques. Such approaches may provide a richer understanding of the complex relationships among psychological and educational factors affecting mathematics achievement.

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