

# A Fuzzy Conjoint Analysis of Mathematics Anxiety and Self-Efficacy among Pre-Diploma Students

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## ARTICLE INFO

### Article history:

Received 30 June 2025  
Revised 21 February 2026  
Accepted 21 February 2026  
Online first  
Published 1 March 2026

### Keywords:

Mathematics Anxiety  
Self-Efficacy  
Fuzzy Conjoint Analysis  
Pre-Diploma Students  
Academic Performance  
Educational Psychology

### DOI:

10.24191/jcrinn.v11i1.568

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## ABSTRACT

Many Pre-Diploma students at University Teknologi MARA (UiTM) previously underperformed in Mathematics in the Sijil Pelajaran Malaysia (SPM) examination, often due to mathematics anxiety and low self-efficacy. However, limited empirical evidence on the relationship between these factors among Pre-Diploma students constrains the development of targeted interventions. This study examines mathematics anxiety and self-efficacy among 144 Pre-Diploma students enrolled for the October 2024 to February 2025 semester at UiTM Perlis Branch using the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) and Fuzzy Conjoint Analysis. The MSEAQ comprises 29 attributes: 15 measuring mathematics anxiety and 14 assessing self-efficacy. The findings reveal predominantly neutral (L3) responses for anxiety attributes, with higher anxiety related to grade achievement than to attending lessons or completing homework, suggesting performance-based anxiety. Self-efficacy levels ranged from moderate (L3) to high (L4), indicating confidence in performing mathematical tasks, though lower confidence was observed in asking questions and test-taking comfort. The coexistence of unclear anxiety and relatively strong self-efficacy suggests that students believe in their abilities but may not fully recognize anxiety's impact on their learning. Educators should therefore reinforce students' confidence while addressing latent anxiety through clear goals, constructive feedback, and supportive classroom practices.

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## 1. INTRODUCTION

Universiti Teknologi MARA (UiTM) offers a Pre-Diploma program designed to provide academic support and foundation for students who do not meet the minimum entry requirements for diploma-level studies. This bridging program primarily serves students from underserved or academically disadvantaged

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backgrounds, equipping them with the necessary skills, knowledge, and academic mindset to succeed in higher education. Among the key areas emphasized in the program is mathematics, which is essential across various diploma fields. However, many students entering the Pre-Diploma program have a history of poor mathematics performance, often reflected in low grades such as D or E in their Sijil Pelajaran Malaysia (SPM) examinations.

This underachievement in mathematics is frequently linked to affective factors such as mathematics anxiety and mathematics self-efficacy. Mathematics anxiety is defined as feelings of tension, fear, or apprehension that interfere with math performance (Ashcraft & Kirk, 2001). It can hinder cognitive processing, reduce working memory capacity, and ultimately lead to avoidance of math-related tasks. On the other hand, mathematics self-efficacy refers to a student's belief in their own ability to successfully perform mathematical tasks (Bandura, 1997). Students with high self-efficacy are more likely to engage with challenging material, persist through difficulties, and achieve better academic outcomes.

Understanding the interplay between these two psychological factors is particularly important in the context of Pre-Diploma students, who may be in a transitional phase of academic recovery and self-discovery. Despite their prior academic struggles, many begin to develop renewed motivation and confidence within the structured and supportive environment of UiTM's Pre-Diploma program. Therefore, evaluating their levels of math anxiety and self-efficacy is crucial in designing targeted interventions to support their learning journey. Besides, the structured and supportive environment of UiTM's Pre-Diploma program aims to facilitate academic recovery and personal growth; the extent to which students' math anxiety and self-efficacy interact within this context remains insufficiently explored. A lack of empirical evidence on the relationship between math anxiety and self-efficacy among Pre-Diploma students limits educators' ability to design targeted and evidence-based interventions. Without a clear understanding of these psychological factors, support strategies may fail to address the underlying emotional and cognitive barriers that hinder mathematical performance. Therefore, there is a need to investigate the levels of math anxiety and self-efficacy among Pre-Diploma students and to examine the relationship between these two constructs. Understanding this interplay is crucial for developing effective academic support mechanisms that enhance students' confidence, reduce anxiety, and ultimately improve their mathematical achievement and overall academic progression.

The study of mathematics anxiety and self-efficacy is appropriate to use the fuzzy conjoint analysis because both constructs are inherently subjective and often expressed in vague or linguistic terms rather than precise numerical values. Students typically describe their feelings using expressions such as "slightly anxious", "moderately confident", or "very confident", which involve uncertainty and ambiguity. Traditional method approaches or measures of central tendency, tend to convert these perceptions into numerical scores, potentially losing important information about the range and intensity of students' responses. In contrast, the fuzzy conjoint analysis is capable of representing these imprecise judgements using fuzzy numbers, thereby preserving the uncertainty inherent in human perceptions. Moreover, mathematics anxiety and self-efficacy consist of multiple attributes, and the fuzzy conjoint allows the researchers to analyze the relative importance and trade-offs among these attributes simultaneously.

In this study, fuzzy conjoint analysis is applied to evaluate the degrees of mathematics anxiety and self-efficacy among Pre-Diploma students at UiTM. This method enables the modelling of subjective and vague responses using fuzzy logic, making it particularly suitable for educational and psychological assessments involving subjective perceptions, judgements, attitudes, and evaluations. By interpreting students' fuzzy feelings, perceptions, attitudes, and self-efficacy towards learning mathematics, the study aims to provide insights into how emotional and cognitive perceptions influence mathematical readiness, and how institutions can better support at-risk learners.

## 2. LITERATURE REVIEW

Mathematics anxiety and mathematics self-efficacy are two prominent constructs influencing students' performance and engagement in mathematical learning. These psychological dimensions are particularly critical at the pre-diploma level, where students transition into more rigorous academic expectations. This literature review synthesizes current research on mathematics anxiety, self-efficacy, and fuzzy-based conjoint analysis, highlighting gaps and opportunities addressed in this study.

### 2.1 Mathematics anxiety: Definition and impact

Mathematics anxiety is generally defined as a feeling of tension, worry, and apprehension that disrupts the manipulation of numbers and the process of solving mathematical problems in both academic and everyday situations (Ashcraft & Ridley, 2005). This form of anxiety develops through the interaction of environmental, societal, and personal factors. Environmental influences are closely linked to the learning context, including instructional methods that may not cater to diverse student needs, high-stakes testing environments, and classroom practices that emphasize speed and correctness over understanding. Parental attitudes and expectations toward mathematics also play a significant role, as negative parental beliefs or pressure can transmit anxiety to children (Luttenberger et al., 2018). At the societal level, persistent stereotypes and misconceptions, such as the belief that mathematical ability is an inborn talent rather than a skill that can be developed, can discourage students and contribute to feelings of inadequacy (Mutodi & Ngirandi, 2014). Personal factors further intensify mathematics anxiety and are associated with individual cognitive and affective characteristics. These include limited problem-solving strategies, difficulties in working memory, and poor foundational skills (Beilock & Maloney, 2015). Students with low self-confidence, negative self-perceptions, or previous experiences of failure in mathematics are more likely to develop anxious responses when confronted with mathematical tasks (Geist, 2015). Over time, these experiences may lead to avoidance behaviours, reduced participation, and a decline in mathematical performance. Consequently, the combined effects of environmental, societal, and personal influences can amplify anxiety levels, which in turn negatively affect students' academic achievement, motivation, persistence, and overall engagement in mathematics learning.

Numerous studies have documented a negative relationship between mathematics anxiety and academic performance. Early foundational work by Hembree (1990) revealed that higher levels of mathematics anxiety are consistently associated with lower mathematics achievement across various age groups and educational settings. Ma (1999) further confirmed, through a meta-analysis, the existence of a moderate yet statistically significant negative correlation, demonstrating that mathematics anxiety affects students across educational levels, from primary through tertiary education. More recent meta-analyses and large-scale reviews have reinforced these findings, showing that increased mathematics anxiety is linked with poorer mathematical outcomes (Namkung et al., 2019; Zhang et al., 2019; Barroso et al., 2021).

Research indicates that the relationship between mathematics anxiety and performance is not simply unidirectional but reciprocal in nature. Carey et al. (2016) proposed a cyclical model in which poor mathematical performance heightens anxiety, and increased anxiety in turn further impairs performance, creating a self-reinforcing cycle. Empirical studies support this bidirectional framework: Ramirez, Shaw, and Maloney (2018) found that early experiences of mathematics anxiety can predict later achievement difficulties, particularly when combined with cognitive constraints such as limited working memory capacity. Additionally, Foley et al. (2017) reported that mathematics anxiety is associated with avoidance behaviours, reduced persistence, and lower performance over time, reinforcing the idea that anxiety and achievement influence each other in complex ways. Together, these findings highlight that mathematics anxiety not only coexists with lower academic performance but also plays a causal and cyclical role in shaping students' mathematical development, motivation, and long-term engagement.

## 2.2 Mathematics self-efficacy and academic outcomes

Self-efficacy refers to an individual's belief in their ability to perform a specific task (Bandura, 1997). In the context of mathematics, it encompasses students' confidence in solving math problems, completing assignments, and succeeding in examinations. Zimmerman (2000) emphasized that self-efficacy influences not only academic performance but also learning strategies, persistence, and resilience. Pajares and Graham (1999) further found that mathematics self-efficacy is a more powerful predictor of math achievement than past performance or anxiety levels.

Despite its significance, much of the existing literature treats efficacy and anxiety as distinct constructs rather than interrelated factors that jointly influence learning outcomes. Additionally, many assessment tools in current use lack the capability to analyse these constructs interactively. By utilising a fuzzy conjoint approach, the present research attempts to model these traits simultaneously, providing a richer understanding of student profiles.

Recent empirical research continues to underscore the significant role of mathematics self-efficacy as a robust predictor of academic performance in mathematics. Studies consistently demonstrate that students' belief in their ability to succeed in mathematical tasks strongly correlates with their achievement, often more so than prior performance or anxiety levels (Al Umairi, 2024; Yang et al., 2024). This consistent finding, further supported by the foundational theories of Bandura (1997) and the insights of Pajares and Graham (1999), highlights self-efficacy as a critical motivational construct influencing students' engagement, persistence, and overall success in mathematics.

## 2.3 Interrelation between mathematics anxiety and self-efficacy

The inverse relationship between mathematics anxiety and self-efficacy is well-documented, with students demonstrating higher self-efficacy often reporting lower anxiety levels (Hoffman, 2010). This interplay significantly influences motivation and academic choices. However, traditional empirical tools frequently fall short in precisely quantifying this complex relationship, particularly in acknowledging the inherent subjectivity and gradation in student responses. As Caviola et al. (2017) argue, conventional psychometric models tend to oversimplify these affective constructs, limiting the actionable insights derived. This recognized limitation thus motivates the integration of fuzzy set theory, which enables researchers to assign degrees of membership to psychological states rather than forcing binary or scalar categorizations. The fuzzy conjoint method, as proposed in the current study, directly addresses this need for more nuanced analytical tools in educational psychology.

Recent research, such as a 2025 study by Shimizu utilizing PISA 2022 data from Japan, further underscores this core dynamic, revealing a strong negative connection between a student's self-efficacy and their mathematics anxiety, both of which are linked to behavioural engagement and overall achievement. This evidence suggests that fostering students' perceived capabilities in mathematics may be more effective than solely focusing on anxiety reduction (Shimizu, 2025).

## 2.4 Fuzzy set theory in educational assessment

Fuzzy logic provides a mathematical framework for dealing with uncertainty and imprecision (Zadeh, 1965). In educational contexts, fuzzy methods have been used to evaluate performance, decision-making processes, and cognitive assessments. For instance, Subbotin et al. (2004) introduced fuzzy logic models to assess student learning outcomes, showing that such models offer more adaptable and precise results than classical techniques.

Recent research by Kahraman et al. (2020) applied fuzzy logic in multi-criteria decision-making to rank students' preferences in course selections, demonstrating its utility in capturing subjective judgments. However, the integration of fuzzy methods with conjoint analysis, particularly for modelling affective factors like anxiety and efficacy, remains underexplored. The present study fills this gap by developing a fuzzy conjoint model tailored to the educational affective domain.

Continuing this trend of addressing imprecision, recent work by Ahmed and Hossain (2025) proposed a fuzzy-logic-based student learning assessment system specifically designed for Outcome-Based Education (OBE). This system aims to overcome the inherent vagueness and uncertainty in traditional assessment methods by utilizing fuzzy logic to map every assessment activity directly to Course Outcomes and Program Outcomes. The authors argue that this fuzzy-based approach results in a fairer, more reliable, and unbiased evaluation of student attainment, offering valuable insights for continuous improvement within OBE frameworks.

## **2.5 Conjoint analysis in educational research**

Conjoint analysis is a decompositional technique that derives individual preferences from responses to attribute-combined scenarios. In education, it has been used to explore factors influencing teacher effectiveness (Marshall, 2012), curriculum preferences, and student motivations. Despite its strength in preference modelling, traditional conjoint methods assume crisp values, limiting their application in affective assessment. To overcome this, fuzzy conjoint analysis integrates fuzzy logic into the conjoint framework, allowing for the inclusion of linguistic variables and uncertainty in student preferences (Tzeng & Huang, 2011). This hybrid method has seen applications in marketing and health sciences but remains novel in educational psychology. By applying fuzzy conjoint analysis to assess mathematics anxiety and self-efficacy, the current study pioneers a methodological advancement in student profiling.

The reviewed literature establishes the significance of mathematics anxiety and self-efficacy in academic outcomes and the need for innovative tools to assess them effectively. While existing research has provided valuable insights, the limitations of traditional psychometric instruments in capturing the complexity of affective traits are evident. The integration of fuzzy set theory and conjoint analysis offers a promising approach to model subjective and interrelated constructs. This study extends prior work by applying a fuzzy conjoint framework to pre-diploma students, addressing a methodological gap and enhancing the precision of psychological assessment in educational settings.

Recent academic inquiries employing conjoint analysis have provided valuable insights into student preferences for online learning, particularly in the wake of the COVID-19 pandemic. Studies by Yandug et al. (2023) and Ong et al. (2021) with engineering students, alongside research by Cano (2023) focusing on senior high school learners, consistently highlight the importance of various online learning attributes. These studies collectively indicate that factors such as interaction, flexibility, and effective assessment methods significantly contribute to student satisfaction and perceived performance in online environments. Furthermore, platform characteristics, including user-friendliness and accessibility, also emerge as crucial elements influencing overall online learning preferences across different educational levels and disciplines.

## **3. METHODOLOGY**

### **3.1 Data collection method**

The Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ), developed by May (2009), was used as the primary instrument to collect data from a sample of 144 students enrolled in the Pre-Diploma in Commerce program at Universiti Teknologi MARA (UiTM) Perlis Branch for the October 2024 to February 2025 semester. These students did not meet the minimum academic requirements, based on their Sijil Pelajaran Malaysia (SPM) results, to enter diploma-level programs directly. More than 70% of the

respondents had obtained grades of D or E in Mathematics in the 2024 SPM examination, indicating generally low prior achievement in the subject. Table 1 presents the demographic profile of the respondents. Nevertheless, students who successfully complete the six-month Pre-Diploma program are eligible to progress to diploma-level studies at UiTM.

Table 1: Respondents' demographic

| Mathematics Grade | Male      | Female    | Total      | Percents   |
|-------------------|-----------|-----------|------------|------------|
| A+                | 0         | 0         | 0          | 0.00       |
| A                 | 4         | 8         | 12         | 8.33       |
| A-                | 0         | 2         | 2          | 1.39       |
| B+                | 0         | 3         | 3          | 2.08       |
| B                 | 1         | 7         | 8          | 5.56       |
| B-                | 0         | 0         | 0          | 0.00       |
| C+                | 3         | 2         | 5          | 3.47       |
| C                 | 5         | 6         | 11         | 7.64       |
| C-                | 0         | 0         | 0          | 0.00       |
| D+                | 0         | 0         | 0          | 0.00       |
| D                 | 28        | 33        | 61         | 42.36      |
| E                 | 17        | 24        | 41         | 28.47      |
| F                 | 0         | 1         | 1          | 0.69       |
| <b>Total</b>      | <b>58</b> | <b>86</b> | <b>144</b> | <b>100</b> |

The MSEAQ consists of 29 attributes, with 15 attributes (A1 to A15) measuring mathematics anxiety and 14 attributes (A16 to A29) assessing mathematics self-efficacy (refer to Table 2). The instrument demonstrated high internal consistency, with an overall reliability index of 0.94. The Cronbach's alpha values for mathematics self-efficacy and anxiety subscales were 0.90 and 0.91, respectively (May, 2009).

Table 2: Attributes of MSEAQ.

| Code | Attributes  |
|------|---|
| A1   | I get tense when I prepare for a mathematics test.                                      |
| A2   | I get nervous when I have to use mathematics outside of school.                         |
| A3   | I worry that I will not be able to use mathematics in my future career when needed.     |
| A4   | I worry that I will not be able to get a good grade in my mathematics course.           |
| A5   | I worry that I will not be able to do well on mathematics tests.                        |
| A6   | I feel stressed when listening to mathematics instructors in class.                     |
| A7   | I get nervous when asking questions in class.   |
| A8   | Working on mathematics homework is stressful for me.                                    |
| A9   | I worry that I do not know enough mathematics to do well in future mathematics courses. |
| A10  | I worry that I will not be able to complete every assignment in a mathematics course.   |
| A11  | I worry I will not be able to understand the mathematics.                               |
| A12  | I worry that I will not be able to get an "A" in my mathematics course.                 |
| A13  | I worry that I will not be able to learn well in my mathematics course.                 |
| A14  | I get nervous when taking a mathematics test.   |
| A15  | I am afraid to give an incorrect answer during my mathematics class.                    |
| A16  | I feel confident enough to ask questions in my mathematics class.                       |
| A17  | I believe I can do well on a mathematics test.  |
| A18  | I believe I can complete all of the assignments in a mathematics course.                |

|     |  |
|-----|--|
| A19 | I believe I am the kind of person who is good at mathematics.                |
| A20 | I believe I will be able to use mathematics in my future career when needed. |
| A21 | I believe I can understand the content in a mathematics course.              |
| A22 | I believe I can get an “A” when I am in a mathematics course.                |
| A23 | I believe I can learn well in a mathematics course.                          |
| A24 | I feel confident when taking a mathematics test.                             |
| A25 | I believe I am the type of person who can do mathematics.                    |
| A26 | I feel that I will be able to do well in future mathematics courses          |
| A27 | I believe I can do the mathematics in a mathematics course.                  |
| A28 | I feel confident when using mathematics outside of school.                   |
| A29 | I believe I am the type of person who can do mathematics.                    |
| A30 | I feel confident when taking a mathematics test.                             |
| A25 | I believe I am the type of person who can do mathematics.                    |
| A26 | I feel that I will be able to do well in future mathematics courses.         |
| A27 | I believe I can do the mathematics in a mathematics course.                  |
| A28 | I feel confident when using mathematics outside of school.                   |
| A29 | I believe I am the type of person who can do mathematics.                    |

The respondents rated all the attributes using a five-point likert scale corresponding to the linguistic variables, *L*, of agreement and pre-defined fuzzy set (Yahaya & Mohamad, 2011) as shown in Table 3.

Table 3: Likert scale and linguistic variable and pre-defined fuzzy set

| Likert scale | Linguistic Variable, <i>L</i> | 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 analyse 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.

### 3.2 Fuzzy conjoint analysis

Conjoint analysis is a statistical technique used in market research to understand how people make choices when faced with different product or service options. It helps determine the relative importance of various product attributes (like price, features, brand) in influencing consumer decisions. Fuzzy conjoint analysis developed by Turken and Willson (1994), a fuzzified conjoint vector is a method that extends traditional conjoint analysis by incorporating fuzzy logic to handle uncertainty and vagueness in preference data, particularly when dealing with linguistic terms or subjective judgments. The fuzzy set, *F*, represented the values of the criterion evaluated by the respondents.

The degree of membership  $\mu_{Fi}(y_j, A_m)$  for each element,  $y_j$  in the fuzzy set,  $F$ , was defined as follows:

$$\mu_{Fi}(y_j, A_m) = \sum_{i=1}^j W_i(r_i, A_m) U_{Li}(x_j, A_m) \quad (1)$$

where

- $\mu_{Fi}(x_j, A_m)$  is the estimated membership degree of  $x_j$  for attribute  $A_m$ .
- $y_j$  and  $x_j$  represent the domain elements and  $j$  is the number of linguistic variables,  $j = 1, 2, 3, 4, 5$ .
- $A_m$  refers to  $m^{\text{th}}$  attribute and  $m$  is the number of attributes,  $m = 1, 2, 3, \dots, M$ ,  $M = 15$  for mathematics anxiety attributes and  $M = 14$  for mathematics self-efficacy.
- $U_{Li}(x_j, A_m)$  is the linguistic rating's membership at a given linguistic level of  $x_j$  for attribute  $A_m$  (refer to Table 3)
- $r_i$  is the crisp weight obtained from the frequency of students' rating on the attribute,  $r_i = 1, 2, 3, 4, 5$ .
- $W_i(r_i, A_m)$  refers to weight for the response (linguistic rating) to attribute  $A_m$  and

$$W_i(r_i, A_m) = \frac{r_i}{\sum r_i} \quad (2)$$

where  $r_i$  is the number of students' particular rating on the attribute  $A_m$  and  $\sum r_i$  is the sum of the ratings across attribute  $A_m$ .

The degree similarity is then calculated using the total Euclidean distance that compares the fuzzy set  $F$  with the standard fuzzy set of  $L_{k_j}$ ,  $k=1, 2, 3, 4, 5$  using the formula:

$$S(F_j, L_{k_j}) = \frac{1}{1 + \sqrt{\sum_{j=1}^5 [\mu_F(y_j, A_m) - \mu(L_{k_j})]^2}} \quad (3)$$

The Euclidean distance is commonly used in fuzzy analysis to determine the degree of similarity between fuzzy numbers representing linguistic variables. By measuring the geometric distance between the components of two triangular fuzzy numbers, the method quantifies how close a given fuzzy response is to a predefined linguistic category. A smaller Euclidean distance indicates greater similarity, while a larger distance reflects greater dissimilarity. This distance is often transformed into a similarity degree using a normalization formula, allowing values to range between 0 and 1. Consequently, the linguistic term with the highest similarity degree is considered the most representative interpretation of the fuzzy response.

The following are the steps illustrated in computing process of fuzzy conjoint analysis for attribute seven, A17 which is the statement “I believe I can do well on a mathematics test”.

**Step 1:** Calculate the frequency of each rating for each attribute.

From the survey, the ratings of A17 are found as the following:

$$r_1 = n(L_1) = 0; \quad r_2 = n(L_2) = 3; \quad r_3 = n(L_3) = 44; \quad r_4 = n(L_4) = 69; \quad r_5 = n(L_5) = 28$$

$$\sum r_i = r_1 + r_2 + r_3 + r_4 + r_5 = 144$$

**Step 2:** Compute the weight for each attribute using Equation (2).

$$W_{r_1} = \frac{0}{144}; \quad W_{r_2} = \frac{3}{144}; \quad W_{r_3} = \frac{44}{144}; \quad W_{r_4} = \frac{69}{144}; \quad W_{r_5} = \frac{28}{144}$$

**Step 3:** Determine the membership degree for each element in fuzzy set  $F$  using Equation (1).

$$\begin{aligned} \mu_F(y_1) &= W_{r_1} \cdot \mu_{L_1}(x_1) + W_{r_2} \cdot \mu_{L_2}(x_2) + W_{r_3} \cdot \mu_{L_3}(x_3) + W_{r_4} \cdot \mu_{L_4}(x_4) + W_{r_5} \cdot \mu_{L_5}(x_5) \\ &= 0(1) + \frac{3}{144}(0.5) + \frac{44}{144}(0) + \frac{69}{144}(0) + \frac{28}{144}(0) = 0.0104 \end{aligned}$$

Similarly, the membership degree for  $\mu_F(y_2)$ ,  $\mu_F(y_3)$ ,  $\mu_F(y_4)$  and  $\mu_F(y_5)$  were calculated, resulting in 0.2934, 0.7778, 0.7830, and 0.4340, respectively.

**Step 4:** Calculate the similarity degree between set  $F$  and set  $L$  using Equation (3).

$$\begin{aligned} S(F_1) &= \frac{1}{1 + \sqrt{(\mu_F(y_1) - \mu_{L_1}(y_1))^2 + (\mu_F(y_2) - \mu_{L_2}(y_2))^2 + (\mu_F(y_3) - \mu_{L_3}(y_3))^2 + (\mu_F(y_4) - \mu_{L_4}(y_4))^2 + (\mu_F(y_5) - \mu_{L_5}(y_5))^2}} \\ &= \frac{1}{1 + \sqrt{(0.0104 - 1)^2 + (0.2934 - 0.75)^2 + (0.7778 - 0.5)^2 + (0.7830 - 0)^2 + (0.4340 - 0)^2}} = 0.4705 \end{aligned}$$

Similarly, the similarity degree for  $S(F_2)$ ,  $S(F_3)$ ,  $S(F_4)$  and  $S(F_5)$  were computed, yielding values of 0.4760, 0.6248, 0.8111, and 0.5895, respectively

**Step 5:** Identify the highest similarity degree and draw a conclusion.

The highest similarity degree is  $S(F_4) = 0.8111$ , corresponding to the linguistic term “agree”. The value of 0.8111 (on a scale 0 to 1) indicates a high-level self-efficacy of believing that they can do well on the mathematics test, but not complete certainty. There may still be a slight overlap with nearby linguistic categories (such as “strongly agree” or “neutral”). Since it is the highest similarity degree, “agree” is considered the dominant or most representative linguistic response for that attribute.

## 4. RESULT AND DISCUSSION

Fuzzy Conjoint Analysis was successfully applied to measure mathematics anxiety and mathematics self-efficacy among 144 registered pre-diploma students at the UiTM Perlis Branch during the October 2024 to February 2025 semester using survey instrument called MSEAQ. The results of the analysis are presented in Tables 4 and 5.

### 4.1 Mathematics anxiety (Items A1–A15)

Table 4 displays the fuzzy conjoint analysis results indicate that the majority mathematics anxiety attributes (A1-A15) achieved the maximum membership degree or similarity values or at L3 (Neutral), representing neither agreed nor disagreed with the anxiety-related statements as displayed on Table 2. This suggests that students are not taking a strong stance, which may be due to several factors. They may feel uncertain or ambivalent about their emotional reactions to mathematics, or they may have mixed experiences in which feeling anxious in some situations but not in others. Additionally, this neutrality may reflect a lack of emotional self-awareness or difficulty articulating their feelings, especially among students with low prior academic achievement.

Among all attributes, A6 (feel stress when listening to mathematics instruction in class) recorded the highest maximum similarity value (0.8339) at L2 (disagree), indicating strong consensus among respondents toward a relatively lower anxiety level for this particular item. This suggests that although overall anxiety is moderate, students feel comparatively more confident or less anxious in the context measured by A6. In contrast, attribute A4 (worry of not getting good grade in mathematics) achieved its maximum similarity at L4 (agree), reflecting comparatively higher anxiety tendencies for those specific mathematical situations. These items may represent more challenging or evaluative contexts, such as examinations or problem-solving under pressure.

Table 4: Similarity degree between fuzzy set f and linguistic variable l for mathematics anxiety

| Attribute | Fuzzy Set | L1     | L2            | L3            | L4            | L5     | Max Similarity | L (Max Similarity) |
|-----------|-----------|--------|---------------|---------------|---------------|--------|----------------|--------------------|
| A1        | F1        | 0.5035 | 0.5975        | <b>0.7083</b> | 0.5302        | 0.4558 | <b>0.7083</b>  | L3                 |
| A2        | F2        | 0.4808 | 0.5989        | <b>0.8152</b> | 0.5722        | 0.4592 | <b>0.8152</b>  | L3                 |
| A3        | F3        | 0.4752 | 0.5989        | <b>0.8005</b> | 0.5950        | 0.4730 | <b>0.8005</b>  | L3                 |
| A4        | F4        | 0.4457 | 0.5299        | 0.6899        | <b>0.7034</b> | 0.5412 | <b>0.7034</b>  | L4                 |
| A5        | F5        | 0.4727 | 0.5812        | <b>0.7388</b> | 0.6304        | 0.4997 | <b>0.7388</b>  | L3                 |
| A6        | F6        | 0.6350 | <b>0.8339</b> | 0.5811        | 0.4574        | 0.4015 | <b>0.8339</b>  | L2                 |
| A7        | F7        | 0.4950 | 0.6258        | <b>0.7633</b> | 0.5781        | 0.4690 | <b>0.7633</b>  | L3                 |
| A8        | F8        | 0.5466 | <b>0.7292</b> | 0.6899        | 0.5091        | 0.4290 | <b>0.7292</b>  | L2                 |
| A9        | F9        | 0.4585 | 0.5678        | <b>0.7890</b> | 0.6297        | 0.4891 | <b>0.7890</b>  | L3                 |
| A10       | F10       | 0.4874 | 0.6173        | <b>0.7809</b> | 0.5825        | 0.4677 | <b>0.7809</b>  | L3                 |
| A11       | F11       | 0.4672 | 0.5813        | <b>0.7850</b> | 0.6179        | 0.4848 | <b>0.5813</b>  | L3                 |
| A12       | F12       | 0.4442 | 0.5346        | <b>0.7299</b> | 0.6836        | 0.5220 | <b>0.7299</b>  | L3                 |
| A13       | F13       | 0.4600 | 0.5669        | <b>0.7872</b> | 0.6292        | 0.4925 | <b>0.7872</b>  | L3                 |
| A14       | F14       | 0.4557 | 0.5574        | <b>0.7669</b> | 0.6455        | 0.5026 | <b>0.7669</b>  | L3                 |
| A15       | F15       | 0.4467 | 0.5406        | <b>0.7380</b> | 0.6750        | 0.5168 | <b>0.7380</b>  | L3                 |

## 4.2 Mathematics self-efficacy (Items A16–A29)

The results for the mathematics self-efficacy attributes (A16–A29) indicate that the maximum similarity values are concentrated at linguistic levels L3 and L4, representing moderate to high mathematics self-efficacy as displayed on Table 5. This pattern suggests that pre-diploma students generally possess a moderate level of confidence in their mathematical abilities. Several attributes, such as A17, A18, A20, A21, A23, A25, and A29, fall under L4, indicating that students tend to agree that they can handle certain mathematical tasks. Meanwhile, the remaining attributes are classified under L3, reflecting only moderate agreement and suggesting some uncertainty or inconsistency in their confidence levels. Notably, none of the attributes reach L5, which implies that students do not exhibit very high self-efficacy, while the absence of L1 and L2 indicates that very low confidence is not dominant among them. Overall, the findings reveal that students' mathematics self-efficacy is at a moderate to moderately high level, but there is still room for improvement through supportive instructional strategies and confidence-building learning experiences.

Table 5: Similarity degree between fuzzy set *f* and linguistic variable *l* for mathematics self-efficacy

| Attribute | Fuzzy Set | L1     | L2     | L3            | L4            | L5     | Max Similarity | L(Max Similarity) |
|-----------|-----------|--------|--------|---------------|---------------|--------|----------------|-------------------|
| A16       | F16       | 0.4306 | 0.5156 | <b>0.7199</b> | 0.7041        | 0.5306 | <b>0.7199</b>  | L3                |
| A17       | F17       | 0.4705 | 0.4760 | 0.6248        | <b>0.8111</b> | 0.5895 | <b>0.8111</b>  | L4                |
| A18       | F18       | 0.4101 | 0.4759 | 0.6264        | <b>0.8118</b> | 0.5873 | <b>0.8118</b>  | L4                |
| A19       | F19       | 0.4660 | 0.5814 | <b>0.8081</b> | 0.6085        | 0.4807 | <b>0.8081</b>  | L3                |
| A20       | F20       | 0.4163 | 0.4904 | 0.6635        | <b>0.7714</b> | 0.5576 | <b>0.7714</b>  | L4                |
| A21       | F21       | 0.4177 | 0.4934 | 0.6755        | <b>0.7570</b> | 0.5507 | <b>0.7570</b>  | L4                |
| A22       | F22       | 0.4387 | 0.5270 | <b>0.7219</b> | 0.6950        | 0.5276 | <b>0.7219</b>  | L3                |
| A23       | F23       | 0.4138 | 0.4828 | 0.6379        | <b>0.7999</b> | 0.5764 | <b>0.7999</b>  | L4                |
| A24       | F24       | 0.4379 | 0.5316 | <b>0.7636</b> | 0.6692        | 0.5085 | <b>0.7636</b>  | L3                |
| A25       | F25       | 0.4248 | 0.5053 | 0.6990        | <b>0.7288</b> | 0.5389 | <b>0.7288</b>  | L4                |
| A26       | F26       | 0.4294 | 0.5142 | <b>0.7193</b> | 0.7082        | 0.5284 | <b>0.7193</b>  | L3                |
| A27       | F27       | 0.4352 | 0.5255 | <b>0.7760</b> | 0.6483        | 0.4867 | <b>0.7760</b>  | L3                |
| A28       | F28       | 0.4481 | 0.5546 | <b>0.8351</b> | 0.6199        | 0.4825 | <b>0.8351</b>  | L3                |
| A29       | F29       | 0.4290 | 0.5091 | 0.6938        | <b>0.7270</b> | 0.5441 | <b>0.7270</b>  | L4                |

The finding shows that students showed high confidence in their ability to succeed in math tests (A17), complete assignments (A18), and use math in real-world situations (A20, A29). Items expressing belief in long-term math success (e.g., A23, A25) also showed high fuzzy values, indicating a generally positive self-concept in mathematics. Moderate self-efficacy was observed in items related to asking questions (A16), academic identity (A19, A28), and test-taking confidence (A24), revealing areas where confidence may still be developing. These self-efficacy levels, from moderate to high, indicate that students cognitively believe that they are capable of learning mathematics.

## 5. CONCLUSION AND RECOMMENDATION

The combination of neutral or unclear responses on math anxiety attributes and high levels of math self-efficacy psychological carries important implications for both students and educators. This finding reflects a complex and educational condition that warrants careful and strategic attention. High self-efficacy indicates that students believe in their ability to succeed in mathematics, which is widely recognized as a strong predictor of academic persistence and future performance. Even if students are uncertain about their emotional responses to mathematics, their confidence in their capabilities can positively influence motivation, effort, and resilience. However, the prevalence of neutral responses on anxiety items may also suggest a lack of emotional awareness or clarity, which can be problematic. Students may not fully recognize when anxiety is affecting their learning, leading to invisible obstacles such as test anxiety, avoidance behaviours, or procrastination. This emotional ambiguity can delay early intervention or prevent students from seeking appropriate academic or psychological support. Furthermore, students may overestimate their abilities or experience a disconnect between their self-perceptions and actual performance, particularly if they have a history of low achievement. In such cases, misattribution of poor outcomes to external factors, rather than recognizing internal challenges, can impede meaningful self-reflection and growth.

To effectively support students who exhibit high self-efficacy but unclear or neutral responses regarding math anxiety, teachers can implement several targeted strategies. One important approach is to leverage students' confidence by designing challenging yet achievable tasks that allow them to experience success. This helps maintain motivation while building competence. Teachers should also provide constructive and specific feedback that emphasizes progress and effort, thereby reinforcing students' belief in their abilities. In addition, establishing short-term, attainable learning goals can foster a sense of accomplishment and support long-term academic growth.

Equally important is the need to encourage emotional reflection and expression. Since many students may be unsure or unaware of their anxiety, teachers can introduce reflective activities such as self-assessment tools to help students better understand and articulate their emotional responses. Creating a classroom environment where math anxiety is normalized as a common and manageable experience can further reduce stigma and encourage openness. A supportive and psychologically safe learning space enables students to express concerns without fear of judgment or embarrassment.

Furthermore, teachers should be mindful that students with high self-efficacy may still experience hidden or masked anxiety. It is important to observe subtle indicators of stress, such as task avoidance, inconsistent performance, or repeated excuses. In such cases, educators should offer non-judgmental support and incorporate low-stakes, confidence-building practices such as collaborative problem-solving, mindfulness exercises, or informal assessments to help students manage anxiety while maintaining engagement.

Several improvements can be considered to enhance future studies on mathematics anxiety and mathematics self-efficacy. First, the research design may be strengthened by increasing the diversity and size of the sample. Including students from different programmes, academic levels, or institutions would improve the generalizability of the findings. In addition, a longitudinal approach could be adopted to examine changes in anxiety and self-efficacy over time, rather than relying solely on cross-sectional data. Second, the measurement instruments could be enhanced by incorporating well-established and validated scales for mathematics anxiety and self-efficacy. The integration of qualitative data, such as interviews or open-ended responses, would also provide deeper insights into students' experiences and perceptions of mathematics learning. This mixed-methods approach could help explain the underlying reasons behind the observed levels of anxiety and self-efficacy. Third, future studies should consider including additional variables that may influence mathematics anxiety and self-efficacy. These may include cognitive factors such as prior achievement and problem-solving ability, affective factors such as motivation and attitudes

toward mathematics, and environmental factors such as teaching methods, classroom climate, peer influence, and parental support. Examining these variables would provide a more comprehensive understanding of the determinants of mathematics anxiety and self-efficacy. Moreover, the analytical approach could be expanded by comparing the results of fuzzy conjoint analysis with conventional statistical techniques, such as correlation analysis, regression, or structural equation modelling. Such comparisons would help validate the findings and strengthen the robustness of the study. Finally, future research could incorporate an intervention component, such as problem-solving workshops, confidence-building activities, or mathematics support programmes. Measuring students' anxiety and self-efficacy before and after the intervention would provide valuable insights into the effectiveness of such strategies. Overall, these improvements would contribute to a more comprehensive, reliable, and practically relevant investigation of mathematics anxiety and mathematics self-efficacy.

## 6. ACKNOWLEDGEMENTS/FUNDING

The authors would like to acknowledge the support of Universiti Teknologi Mara (UiTM) Perlis Branch, Arau Campus, Perlis, and Faculty of Computer and Mathematical Sciences, UiTM Perlis Branch, Arau Campus, Perlis, for providing the facilities for this research.

## 7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders. The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

## 8. AUTHORS' CONTRIBUTIONS

**Jasmani Bidin:** Conceptualisation, methodology, formal analysis, investigation, and writing-original draft; **Mohamad Najib Mohamad Fadzil:** Introduction and literature review on mathematics anxiety; **Ku Azlina Ku Akil:** Writing abstract, review, and editing; **Norpah Mahat:** Results and discussion; **Izleen Ibrahim:** Abstract and editing; **Sharifah Fahriyah Syed Abas:** Introduction and literature review on Mathematics self-efficacy; **Siti Fatimah Abdul Rahman:** Data collection and editing; **Noorzila Sharif:** Review and validation.

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