**Al-Ishlah: Jurnal Pendidikan**
Vol.17, 3 (September, 2025), pp. 5228-5241
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v17i3.7082

# An Exploratory Rasch Model Investigation of Mathematics Anxiety Among Students

**Tatan Zenal Mutakin[1], Munali[2], Shinta Dewi [3]**

[1] Universitas Indraprasta PGRI, Jakarta, Indonesia; zmtatan74@gmail.com
[2] Universitas Indraprasta PGRI, Jakarta, Indonesia; munalilutfi22@gmail.com
[3] Universitas Indraprasta PGRI, Jakarta, Indonesia; shintadewi1979@gmail.com

**ARTICLE INFO**

***Keywords:***

mathematics anxiety;
exploratory research;
Rasch model;
student attitudes;
education levels

***Article history:***

Received 2025-02-01
Revised 2025-03-03
Accepted 2025-09-30

**ABSTRACT**

Mathematics anxiety is a significant barrier to students' academic achievement and engagement with mathematical content. This study aims to explore the key aspects influencing mathematics anxiety among students at various educational levels in Indonesia. An exploratory quantitative approach was employed involving 256 students from elementary, junior high, and senior high schools across West Java, Banten, and the Special Region of Jakarta. Data were collected using a 49-item questionnaire administered via Google Forms. Rasch model analysis was conducted using Winsteps version 4.4.7 to assess item-person fit, followed by inferential statistical analysis using SPSS version 24. After Rasch calibration, 117 student responses and 33 items were deemed valid and reliable for further analysis. The findings identified the attitudinal and psychological aspects as the most influential in contributing to students' mathematics anxiety. Key indicators included avoidance of mathematics-related tasks, negative perceptions of mathematics, and low self-confidence. Female students, particularly at the junior and senior high school levels, exhibited the highest levels of anxiety. To mitigate mathematics anxiety, it is recommended that educators implement engaging, real-life-based learning approaches, and foster positive beliefs about the role and accessibility of mathematics. Despite its valuable insights, the study is limited by its small, non-random sample and narrow geographic scope. Future research should involve a broader and more diverse population to strengthen generalizability.



**Corresponding Author:**
Munali
Universitas Indraprasta PGRI, Jakarta, Indonesia; munalilutfi22@gmail.com

## 1. INTRODUCTION

Mathematics is one of the most important subjects and is widely used in daily life (Hadanova & Nocar, 2016). Mathematics is taught at all educational levels, from early childhood, primary and secondary education, to higher education (Yaman et al, 2015). The phenomenon shows that students consider mathematics a difficult subject, leading them to have negative perspectives towards mathematics (Mariamah et al, 2020). This negative perception has caused anxiety during mathematics learning, which impacts students' low mathematics achievement (Serin, 2023). The 2021 National Assessment Report states that students' numeracy/mathematical literacy abilities have only reached 33% (DetikEdu, 2021). Meanwhile, the PISA 2022 survey results indicate that Indonesian students' mathematical literacy abilities only achieved an average score of 366, still below the OECD average score of 472 (OECD, 2022). Other research results mention that students' ability to answer fourth-grade mathematics questions in DKI Jakarta has only reached 33% and is classified as low ability (Mutakin, 2023).

Many factors cause students' low mathematics learning outcomes, including the anxiety students feel when learning mathematics. Students with high anxiety levels tend to avoid mathematics (Espino et al, 2017). Mathematics anxiety refers to students' difficulty in solving mathematics problems, characterized by panic, helplessness, and mental disorganization that emerge when solving mathematical problems (Olango, 2016). Mathematics anxiety can also be marked by physiological symptoms such as cold sweats, stomach aches, and others, as well as psychological symptoms such as difficulty thinking, nervousness, lack of concentration, negative self-perception, and other uncomfortable feelings (Eid and Ahmed, 2013). Bad experiences with mathematics and mathematics phobia can cause mathematics anxiety. This impacts the decrease in students' interest in mathematics (Mutodi and Ngirande, 2014).

Several research results explain that mathematics anxiety can occur in all students; both in terms of gender aspects (Ulfah et al, 2023; Galiano et al, 2023) and educational levels (Zhou, 2023). Based on the background, theoretical studies, and results of previous research, the researcher intends to study in depth: 1) what factors cause students' high levels of mathematics anxiety in terms of gender and educational level? 2) What efforts have been made to reduce students' mathematics anxiety levels?

## 2. METHODS

This research uses an exploratory approach. Exploratory research aims to understand social phenomena by establishing facts, collecting new data, and determining relatively unknown research themes with the hope of gaining new insights about the phenomena being studied (Tomas & Lawal, 2020; Stebbins, 2011). The research respondents consisted of 256 students from elementary, secondary, and higher education levels from the regions of West Java, the Region of Jakarta, and Banten. The sampling technique used was purposive sampling; research samples were selected according to research criteria (Etikan et al, 2015). Specifically, the sample respondents were taken from students under the guidance of teachers who were acquaintances of the researcher. This is done to make it easier for researchers to obtain data. The respondents who became samples based on gender and education level consisted of Elementary School students, Junior High School students, Senior High School students, and First-Year Mathematics Education Program students at a Private University in Jakarta. The instruments that will be given to respondents must first be tested by experts to determine their suitability. From the results of expert testing, the 49 items of the instrument developed have a high level of validity and are suitable for use. The details of the developed instrument grid are written in Table 1 below:

**Table 1.** Grid of Students' Mathematics Anxiety Level Questionnaire

| Number | Indicator | Aspect | Item Number | Number of Items | Scale |
|---|---|---|---|---|---|
| 1 | Negative Emotional Reactions | Psychological | 1 – 6 | 6 | 1 - 5 |
| 2 | Avoidance Attitude | Attitude | 7 – 15 | 9 | 1 - 5 |
| 3 | Physical Symptoms | Physiological | 16 – 21 | 6 | 1 - 5 |
| 4 | Decreased Self-Confidence | Psychological | 22 – 27 | 6 | 1 - 5 |
| 5 | Decline in Academic Performance | Behavior | 28 – 33 | 6 | 1 - 5 |
| 6 | Negative Thoughts about Mathematics | Attitude | 34 – 39 | 6 | 1 - 5 |
| 7 | Dependence on Others | Behavior | 40 – 45 | 6 | 1 - 5 |
| 8 | Difficulty Concentrating | Psychological | 46 – 49 | 4 | 1 - 5 |
| | | | | 49 | |

Based on this grid, the researchers developed instruments according to the indicators. The 49 statement items were distributed to research respondents through Google Forms. The instrument validation process through data reduction occurred simultaneously with the data analysis process. Data analysis used the Rasch model using the Winstep version 4.4.7 program. The use of the Rasch model in this research is based on the validation process being carried out not only on instrument items, but also on respondents. Because the principle of the Rasch model is that the probability of a respondent's answer is influenced by the respondent's ability and the level of difficulty of the instrument. In the Rasch model the validation process is carried out on respondents and instrument items. Rasch model analysis aims to select the suitability of people and items with the model as a data reduction process, measuring the level of instrument reliability, measuring the level of difficulty of items, etc. (Sumintono & Widhiarso, 2015). These data analysis stages are simply explained in Figure 1 below:

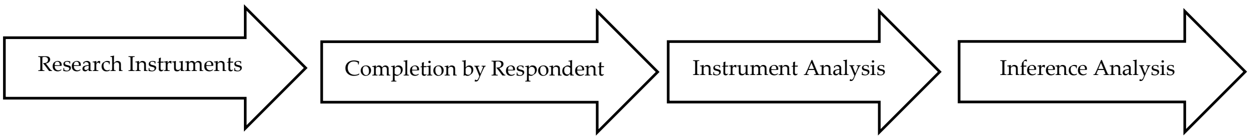


**Figure 1.** Data Analysis Stages

Based on Figure 1, there are four stages in this research, namely: First, developing an instrument for students' mathematics anxiety. At this stage the instrument being developed refers to the indicators that have been determined, the instrument that has been created is tested by experts to determine the feasibility of the instrument. Second, after the instrument developed was declared feasible by experts, the instrument was distributed to respondents via Google Form. Third, after the data from Google Form was collected, the data was analyzed using the Rasch model. Data analysis includes testing item validity and reliability, test unidimensionality, item difficulty level, and item bias. Fourth, referring to the instrument items that have been analyzed, then inference testing is carried out which aims to determine the level of students' mathematics anxiety in terms of gender and students' educational level.

## 3. FINDINGS AND DISCUSSION

### *3.1. Findings*

#### 3.1.1. Respondent Characteristics

Respondent characteristics in psychological research play an important role in providing a clear picture of the research subjects and the context behind the research results (Creswell, 2014; Patton, 2015). The background of the respondents in this study consisted of gender and education level aspects. A summary of the background of the research respondents is explained in Table 2 below:

**Table 2.** Characteristics of Research Respondents After Reduction Process

| Level of education | Male | Female | Number of Respondents |
|---|---|---|---|
| Elementary level | 8 | 3 | 11 |
| Junior high school level | 6 | 7 | 13 |
| Senior high school level | 19 | 50 | 69 |
| First-level mathematics education students | 5 | 19 | 24 |
| Total | 38 | 79 | 117 |

Table 2 explains that the majority of respondents consisted of senior high school and First-level mathematics education students (79.48%). This is understandable because the media used in collecting data is technology-based media, namely Google Form. Lower grade students (elementary and junior high school) are not yet accustomed to using technology in filling out questionnaires via Google Form, in contrast to higher grade students (high school and college students). Meanwhile, in terms of gender, the respondents who filled out the most were women (67.52%). The locations of respondents who filled out the instrument came from West Java, the Special Region of Jakarta, and Banten.

### 3.1.2. Instrument Analysis

Instrument analysis aims to determine item validity (Cohen & Swerdlik, 2018), instrument reliability (Tavakol & Dennick. 2011), identify problematic items (Bond & Fox, 2015), item bias (Osterlind & Everson, 2009), and measurement accuracy (Bryman, 2015). In this study, the results of the instrument analysis will be explained as follows:

#### *3.1.2.1. Instrument Validity*

Item validity aims to measure the extent to which items in an instrument can measure the concept to be measured precisely or accurately (Cohen & Swerdlik, 2018; Anastasi & Urbina, 1997; Messick, 1995). In this study, the validity test uses the Rasch model, where item validity is measured according to the criteria set by the model, both for person and item. Item validity in the Rasch model is carried out in two stages, namely: person suitability and item suitability to the model (Bond & Fox, 2015; Linacre, 2012). A summary of the results of the person and item validity tests in this study is explained in Table 3 below:

**Table 3.** Summary of Person and Item Validity Test Results

| Data | Before calibrating | After calibrating | Not fit with the model |
|---|---|---|---|
| Person | 256 | 117 | 139 |
| Item | 49 | 33 | 16 |

*(Source: Winstep Output Version 4.4.7, processed December 2024)*

Table 3 shows that the number of respondent data points prior to calibration was 256. However, following the calibration process, only 117 respondent data points aligned with the model. Similarly, the number of items was reduced from 49 to 33 after calibration. These calibrated data represent valid person and item measures and were used in subsequent analyses.

#### *3.1.2.2. Instrument Reliability*

Instrument reliability measures the extent to which an instrument is consistent when used at different times and places, and is an indicator of the trustworthiness of a measurement tool (Creswell, 2014; Fraenkel & Wallen, 2012). Instrument reliability in this study uses the Alpha Cronbach KR-20 criteria as described in the summary of Table 4 below:

**Table 4.** Summary of Instrument Reliability Analysis Results

| Data | Cronbach's Alpha Value | Criteria |
|---|---|---|
| Person | 0,94 | Very high |
| Item | 0,98 | Very high |

*(Source: Winstep Output Version 4.4.7, processed December 2024)*

Table 4 explains that the reliability values of respondents and items are included in the very high criteria. This provides information that the instrument developed has a very high consistency and level of trust as a measurement tool.

### *3.1.2.3. Unidimensional Test*

The unidimensional test aims to determine whether a measurement instrument only measures one particular construct or dimension (DeVellis, 2017; Kline, 2015). Specifically, the unidimensional test aims to determine whether all items or statements in the instrument focus on the same aspect and are not mixed with other aspects or dimensions. The results of the unidimensional test of this study are summarized in Table 5 below:

Table 5. Summary of Instrument Unidimensional Test Results

| Raw Variance Value Explained by Measures | Eligibility Limits | Reception |
|---|---|---|
| 51.9 % | > 40 % | Unidimensional |

*(Source: Winstep Output Version 4.4.7, processed December 2024)*

Table 5 explains that the Raw Variance Explained by Measures value of the unidimensional test results is 51.9% greater than the minimum limit set, which is 40% (Bond, & Fox, 2015). These results explain that all statement items in the instrument are on the same aspect/construct and are not mixed with other aspects/constructs (unidimensional).

### *3.1.2.4. Item Difficulty Level Analysis*

Item difficulty analysis is the process of assessing respondents on whether an instrument item (test or questionnaire) is easy or difficult to answer. In the Rasch model concept, this item difficulty level refers to a parameter that describes how high an individual's ability is needed to answer the item correctly. In general, difficult items will require a high level of ability, while easier items can be answered correctly by individuals with lower abilities (Wright & Linacre, 1994). The item difficulty analysis in this study is explained in the summary of Table 6 below:

**Table 6.** Summary of Item Difficulty Levels

| Serial Number | Item Number | Logit Value | Serial Number | Item Number | Logit Value |
|---|---|---|---|---|---|
| 1 | P10 | 3.08 | 18 | P21 | -0.16 |
| 2 | P37 | 2.05 | 19 | P22 | -0.25 |
| 3 | P14 | 1.64 | 20 | P2 | -0.37 |
| 4 | P38 | 1.53 | 21 | P34 | -0.71 |
| 5 | P27 | 1.46 | 22 | P4 | -0.75 |
| 6 | P8 | 1.33 | 23 | P47 | -0.83 |
| 7 | P9 | 0.93 | 24 | P16 | -0.85 |
| 8 | P36 | 0.63 | 25 | P41 | -0.88 |
| 9 | P3 | 0.57 | 26 | P43 | -0.96 |
| 10 | P35 | 0.53 | 27 | P20 | -0.98 |
| 11 | P15 | 0.42 | 28 | P49 | -1.06 |
| 12 | P13 | 0.12 | 29 | P26 | -1.22 |
| 13 | P6 | 0.1 | 30 | P48 | -1.25 |
| 14 | P18 | 0.1 | 31 | P33 | -1.28 |
| 15 | P19 | 0.01 | 32 | P40 | -1.37 |
| 16 | P12 | -0.02 | 33 | P32 | -1.48 |
| 17 | P11 | -0.11 | | | |

*(Source: Winstep Output Version 4.4.7, processed December 2024)*

Table 6. explains that there are 33 items that fit the Rasch model. The data has been sorted from the most difficult (top order) to the easiest (bottom order). The criteria for the difficulty and ease of the items are seen from the Measure value (logit). The description of the statement items considered the most difficult by respondents, based on Table 6 is explained in Table 7 below:

**Table 7.** Summary of description of statement items considered most difficult

| Aspect | Indicator | Item Number | Statement Indicator |
|---|---|---|---|
| Attitude | Avoidance Attitude | 10 | Avoiding activities related to mathematics, such as assignments, discussions, or exams. |
| Attitude | Negative Thoughts about Mathematics | 37 | Developing the perception that mathematics is not important or relevant to life. |
| Attitude | Avoidance Attitude | 14 | Delaying or ignoring math homework. |
| Attitude | Negative Thoughts about Mathematics | 38 | Developing the perception that mathematics is not important or relevant to life. |
| Psychological | Decreased Self-Confidence | 27 | Comparing oneself negatively to friends who are better at math. |
| Attitude | Avoidance Attitude | 8 | Avoiding activities related to mathematics, such as assignments, discussions, or exams. |

Table 7 explains that of the four aspects of mathematics anxiety explained, there are two dominant aspects that influence students' mathematics anxiety levels, namely attitude and psychological aspects. The dominant indicators of mathematics anxiety include avoidance attitudes (items 10, 14, and 8), negative thoughts about mathematics (items 37 and 38), and decreased self-confidence (item 27).

### *3.1.2.5. Item Bias Analysis*

Item bias analysis aims to measure the functioning of an instrument based on different groups. Item bias is often referred to as Differential Item Functioning (DIF). DIF occurs when respondents with the same ability have different probabilities of answering an item correctly due to differences in groups, such as gender, age, race, or others (Ohiri et al, 2024). In this study, the item bias analysis studied was related to the gender and education level of respondents.

**Based on Gender**

Instrument item bias due to gender differences often occurs. Even though they have the same abilities, it is possible that gender roles will affect the probability of respondents answering items correctly (Susongko et al, 2021). The results of the item bias analysis based on gender are explained in the summary of Table 8 below:

**Table 8.** Summary of Item Bias Analysis by Gender

| Serial Number | Item Number | Probability Value | Serial Number | Item Number | Probability Value |
|---|---|---|---|---|---|
| 1 | P2 | 0.6422 | 18 | P22 | 0.0235 |
| 2 | P3 | 0.1793 | 19 | P26 | 0.0133 |
| 3 | P4 | 0.9184 | 20 | P27 | 0.4674 |
| 4 | P6 | 0.718 | 21 | P32 | 0.7611 |
| 5 | P8 | 0.1724 | 22 | P33 | 0.2797 |
| 6 | P9 | 0.4951 | 23 | P34 | 0.6298 |
| 7 | P10 | 0.8948 | 24 | P35 | 0.008 |
| 8 | P11 | 0.0444 | 25 | P36 | 0.4412 |
| 9 | P12 | 0.0137 | 26 | P37 | 0.6516 |

| | | | | | |
|---|---|---|---|---|---|
| 10 | P13 | 0.3073 | 27 | P38 | 0.3769 |
| 11 | P14 | 0.0002 | 28 | P40 | 0.0295 |
| 12 | P15 | 0.1621 | 29 | P41 | 0.6355 |
| 13 | P16 | 0.6957 | 30 | P43 | 0.2937 |
| 14 | P18 | 0.1829 | 31 | P47 | 0.2633 |
| 15 | P19 | 0.2208 | 32 | P48 | 0.3949 |
| 16 | P20 | 0.4715 | 33 | P49 | 0.1118 |
| 17 | P21 | 0.5208 | | | |

*(Source: Winstep Output Version 4.4.7, processed December 2024)*

Table 8 explains that there are 7 bias items between male and female answers. The criteria for bias items can be seen from their probability values. If the probability value is <0.05, then the item is declared biased (Susongko et al, 2021). The description of the statement items that are considered biased by respondents, based on Figure 3, is explained in the summary of Table 9 below:

**Table 9.** Description of Bias Items Reviewed from the Gender Aspect

| Item Number | Probability Value | Statement Items |
|---|---|---|
| 11 | 0.0444 | I was passive during math lessons |
| 12 | 0.0137 | I don't want to ask questions related to mathematics even though there are materials that I don't understand. |
| 14 | 0.0002 | I don't do math assignments |
| 22 | 0.0235 | I feel like I won't be able to learn mathematics. |
| 26 | 0.0133 | I feel inferior to friends who are good at math |
| 35 | 0.0080 | In my opinion, mathematics is a scary subject. |
| 40 | 0.0295 | Every time I have math homework, I ask my friends for help. |

Table 9 explains that there are 7 bias items in the instrument given to respondents. This means that with the same ability, the questionnaire questions given to male and female respondents have different answer tendencies.

**Based on Education Level**

In addition to gender aspects, item bias can also occur due to differences in education levels. In this study, the majority (79.48%) who responded to the questionnaire were senior high school students and first-level mathematics education students. In terms of age, respondents had a level of understanding that was not much different. There were 20.25% of respondents consisting of elementary and junior high school students. The results of the item bias analysis based on education level are explained in the summary of Table 10 below:

**Table 10.** Summary of Item Bias Analysis Results Based on Education Level

| Serial Number | Item Number | Probability Value | Serial Number | Item Number | Probability Value |
|---|---|---|---|---|---|
| 1 | P2 | 0.6332 | 18 | P22 | 0.2375 |
| 2 | P3 | 0.1716 | 19 | P26 | 0.4065 |
| 3 | P4 | 0.8506 | 20 | P27 | 0.4455 |
| 4 | P6 | 0.8128 | 21 | P32 | 0.4179 |
| 5 | P8 | 0.0408 | 22 | P33 | 0.109 |
| 6 | P9 | 0.4494 | 23 | P34 | 0.4903 |
| 7 | P10 | 0.9116 | 24 | P35 | 0.2814 |
| 8 | P11 | 0.037 | 25 | P36 | 0.0583 |

| | | | | | |
|---|---|---|---|---|---|
| 9 | P12 | 0.1769 | 26 | P37 | 0.0818 |
| 10 | P13 | 0.1627 | 27 | P38 | 0.1293 |
| 11 | P14 | 0.1375 | 28 | P40 | 0.8298 |
| 12 | P15 | 0.1868 | 29 | P41 | 0.1535 |
| 13 | P16 | 0.1751 | 30 | P43 | 0.3801 |
| 14 | P18 | 0.4336 | 31 | P47 | 0.4915 |
| 15 | P19 | 0.3262 | 32 | P48 | 0.7109 |
| 16 | P20 | 0.1802 | 33 | P49 | 0.57 |
| 17 | P21 | 0.2536 | | | |

*(Source: Winstep Output Version 4.4.7, processed December 2024)*

Table 10 explains that there are 2 bias items in students' answers based on education level. The criteria for bias items can be seen from their probability value. If the probability value is <0.05, then the item is declared biased (Susongko et al, 2021). The description of the statement items considered biased by respondents, based on Figure 4 is explained in the summary of Table 11 below:

**Table 11.** Uraian Butir Bias Ditinjau dari Tingkat Pendidikan

| Item Number | Probability Value | Statement Items |
|---|---|---|
| 8 | 0.0408 | I just collect math assignments for free |
| 11 | 0.0370 | I was passive during math lessons |

Table 11 explains that there are 2 bias items in the instrument given to respondents. This means that by ignoring the ability factor, the questionnaire questions given to respondents based on education level have a tendency to have different answers.

### 3.1.3. Inferential Analysis

Inference analysis is a process carried out to draw a conclusion or make an assumption based on existing data or information. The main purpose of inference analysis is to obtain in-depth and reliable conclusions about information derived from the data obtained. In this study, inference analysis was carried out to determine the relationship between statement items and respondent identity, namely: gender and education level.

#### *3.1.3.1. Relationship between Students' Mathematics Anxiety Aspects and Gender*

The developed instrument of students' mathematics anxiety level consists of four aspects, namely: physiological, psychological, attitude, and behavior. To deepen the findings of previous analyses, an inferential analysis was conducted on the developed instrument. The first inferential analysis was to determine the relationship between the developed aspects of students' mathematics anxiety and gender. The results of the analysis are explained in the summary of Table 12 below:

**Table 12**. Summary of Results of Analysis of the Relationship between Instrument Aspects and Gender

| Number | Aspect | $F_{hitung}$ | Sig value. | Conclusion (error = 5%) | Average Score | |
|---|---|---|---|---|---|---|
| | | | | | Male | Female |
| 1. | Physiological | 6.006 | .016 | Significant | 13.51 | 15.21 |
| 2. | Psychological | 14.942 | .000 | Significant | 26.71 | 30.82 |
| 3. | Attitude | 2.634 | .107 | Not Significant | 29.29 | 31.36 |
| 4. | Behavior | 2.893 | .092 | Not Significant | 16.15 | 17.13 |

*(Source: SPSS Output version 24, processed December 2024)*

Table 12. explains that there are two aspects of students' math anxiety that have a significant relationship with gender, namely: physiological and psychological aspects. This means that there is a significant difference in the level of math anxiety between male and female students from the aspects of physiological and psychological symptoms. Female students are more likely to have higher levels of anxiety than male students.

#### *3.1.3.2. Relationship between Students' Mathematics Anxiety Level Indicators and Gender*

The next inference analysis is the relationship between indicators of students' math anxiety levels and gender. Indicators of students' math anxiety levels consist of eight indicators, namely: negative emotional reactions, avoidance attitudes, physical symptoms, decreased self-confidence, decreased academic performance, negative thoughts about math, dependence on others, and difficulty concentrating. The inference analysis of the relationship between indicators of students' math anxiety levels and gender is explained in the summary of Table 13 below:

**Table 13.** Summary of Results of Analysis of the Relationship between Students' Mathematics Anxiety Level Indicators and Gender

| Number | Indicator | $F_{hitung}$ | Sig value. | Conclusion (error = 5%) | Average Score | |
|---|---|---|---|---|---|---|
| | | | | | **Male** | **Female** |
| 1. | Negative Emotional Reactions | 6.072 | .015 | Significant | **10.37** | **11.64** |
| 2. | Avoidance Attitude | .144 | .705 | Not Significant | 18.51 | 18.82 |
| 3. | Physical Symptoms | 6.006 | .016 | Significant | **13.51** | **15.21** |
| 4. | Decreased Self-Confidence | 15.096 | .000 | Significant | **7.37** | **8.83** |
| 5. | Decline in Academic Performance | 2.152 | .145 | Not Significant | 6.63 | 7.05 |
| 6. | Negative Thoughts about Mathematics | 8.492 | .004 | Significant | **10.78** | **12.54** |
| 7. | Dependence on Others | 2.486 | .118 | Not Significant | 9.51 | 10.08 |
| 8. | Difficulty Concentrating | 13.175 | .000 | Significant | **8.98** | **10.34** |

*(Source: SPSS Output version 24, processed December 2024)*

Table 13. explains that there are five indicators of students' math anxiety that have a significant relationship with gender, namely: negative emotional reactions, physical symptoms, decreased self-confidence, negative thoughts about math, and difficulty concentrating. This means that there is a significant difference in the level of math anxiety between male and female students when viewed from the five indicators. Female students are more likely to have higher levels of anxiety than male students.

#### 3.1.3.3. Relationship between Aspects of Students' Mathematics Anxiety Levels and Education Levels

The next inference analysis was conducted to measure the level of students' mathematics anxiety in terms of education level, namely: elementary school, junior high school, senior high school, and early semester mathematics students. This analysis aims to determine the relationship between aspects of students' mathematics anxiety levels, consisting of physiological, psychological, attitudinal, and behavioral aspects, with students' education level. The results of the analysis are described in the summary of Table 14 below:

**Table 14**. Summary of Results of Analysis of the Relationship between Aspects of Students' Mathematics Anxiety Levels and Students' Education Levels

| Number | Indicator | $F_{hitung}$ | Sig value. | Conclusion (error = 5%) | Average Score | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Elementary School | Junior High School | Senior High School | Undergraduate Students |
| 1. | Physiological | 1.811 | 0.149 | Not Significant | 12.55 | 15.92 | 14.61 | 14.88 |
| 2. | Psychological | 2.362 | 0.075 | Not Significant | 25.73 | 29.77 | 30.26 | 28.29 |
| 3. | Attitude | 2.634 | 0.053 | Not Significant | 27.18 | 31.69 | 31.71 | 28.54 |
| 4. | Behavior | 3.473 | 0.018 | Significant | 15.82 | 16.00 | 17.51 | 15.58 |

*(Source: SPSS Output version 24, processed December 2024)*

Table 14. explains that there is one aspect of students' math anxiety levels that has a significant relationship with students' education levels, namely: behavioral aspects. This means that there is a significant difference in the level of math anxiety between elementary school, junior high school, and senior high school students, and first-level mathematics education students in terms of behavioral symptoms. Junior and senior high school students are more likely to have higher levels of anxiety than elementary school and first-level mathematics education students.

**3.1.3.4. Relationship between Students' Mathematics Anxiety Level Indicators and Education Level**

The final inference analysis aims to measure indicators of students' math anxiety levels in terms of their education level. These indicators consist of: negative emotional reactions, avoidance attitudes, physical symptoms, decreased self-confidence, decreased academic performance, negative thoughts about math, dependence on others, and difficulty concentrating. The results of the analysis of the relationship between indicators of students' math anxiety levels and their education level are described in the summary of Table 15 below:

**Table 15.** Summary of Results of Analysis of Students' Mathematics Anxiety Indicators Reviewed by Students' Education Level

| Number | Indicator | $F_{hitung}$ | Sig value. | Conclusion (error = 5%) | Average Score | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Elementary School | Junior High School | Senior High School | Undergraduate Students |
| 1. | Negative Emotional Reactions | 1.239 | .299 | Not Significant | 9.82 | 11.38 | 11.46 | 10.96 |
| 2. | Avoidance Attitude | 1.589 | .196 | Not Significant | 16.64 | 19.38 | 19.16 | 18.00 |
| 3. | Physical Symptoms | 1.811 | .149 | Not Significant | 12.55 | 15.92 | 14.61 | 14.88 |
| 4. | Decreased Self-Confidence | **2.870** | **.040** | Significant | 7.00 | 8.15 | 8.71 | 7.88 |
| 5. | Decline in Academic Performance | 1.967 | .123 | Not Significant | 6.73 | 6.23 | 7.16 | 6.63 |
| 6. | Negative Thoughts about Mathematics | **3.272** | **.024** | Significant | 10.55 | 12.31 | 12.55 | 10.54 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7. | Dependence on Others | 4.424 | .006 | Significant | 9.09 | 9.77 | 10.35 | 8.96 |
| 8. | Difficulty Concentrating | 1.553 | .205 | Not Significant | 8.91 | 10.23 | 10.09 | 9.46 |

*(Source: SPSS Output version 24, processed December 2024)*

Table 15. explains that there are three indicators of students' math anxiety in terms of education level, namely: decreased self-confidence, negative thoughts about math, and dependence on others. This means that there is a significant difference in the level of math anxiety between elementary school, junior high school, and senior high school students and first-level mathematics education students in terms of the three indicators. Junior and senior high school students are more likely to have higher levels of anxiety than elementary school and first-level mathematics education students.

### *3.2. Discussion*

Mathematics is often referred to as the "queen of all sciences" due to its foundational role in supporting the development of various scientific disciplines (Anbazhagan, 2016). Within the field of education, mathematics plays a critical role in fostering students' logical reasoning, analytical thinking, and problem-solving skills, which are essential for addressing complex challenges in everyday life (Kurniawati et al., 2022; Pradana & Noer, 2023). Consequently, mathematics is designated as a core subject across all levels of primary and secondary education (Mailizar et al., 2014). Despite its importance, mathematics is frequently perceived as a difficult and anxiety-inducing subject by students, leading to a decline in mathematics learning achievement (Langoban, 2020; Yulita & Ain, 2021).

Numerous studies have identified mathematics anxiety as one of the primary contributing factors to poor student performance in mathematics (Bodongan, 2022; Mangkuwibawa et al., 2024; Wardani, 2022). Mathematics anxiety is characterized by emotional distress, feelings of helplessness, and cognitive dissonance when confronted with mathematical tasks (Mutodi & Ngirande, 2014; Olango, 2016). This condition manifests in the form of negative attitudes and low motivation toward learning mathematics, which further impairs academic achievement (Salifu & Bakari, 2022). Empirical findings consistently indicate an inverse relationship between mathematics anxiety and mathematics achievement: students experiencing high levels of anxiety tend to perform poorly, while those with lower anxiety levels demonstrate better outcomes (Anjasari et al., 2022; Wardani, 2022; Zanabazar et al., 2023).

The present study sought to explore the multidimensional nature of students' mathematics anxiety by examining four major aspects: physiological, psychological, attitudinal, and behavioral. Each aspect was assessed through specific indicators—physical symptoms for the physiological aspect; negative emotional reactions, low self-confidence, and difficulty concentrating for the psychological aspect; avoidance behaviors and negative beliefs about mathematics for the attitudinal aspect; and decreased academic performance and dependency on others for the behavioral aspect. In addition, the study considered respondent characteristics such as gender and educational level (Santoso & Ariyanti, 2023; Sara, 2022).

The findings indicate that the psychological and attitudinal aspects are the most prominent in students experiencing high levels of mathematics anxiety. Psychologically, students demonstrated reduced self-confidence in solving mathematical problems. This finding aligns with prior research asserting that self-confidence is positively correlated with students' mathematics achievement (Ciftci & Yildiz, 2019; Wahyuni et al., 2024). Attitudinally, students showed clear avoidance behaviors, including reluctance to engage in homework, classroom discussions, and mathematics assessments. Furthermore, many students perceived mathematics as irrelevant to their daily lives. These patterns are consistent with earlier studies suggesting that negative perceptions and attitudes toward mathematics contribute significantly to lower learning outcomes (Aguilar, 2021; Salifu & Bakari, 2022).

The analysis also revealed that mathematics anxiety is prevalent across both genders and at all educational levels. However, female students exhibited higher levels of anxiety, particularly in the physiological and psychological domains. These findings support previous research showing that female students are more susceptible to experiencing mathematics anxiety (Galiano et al., 2023; Komson et al., 2024; Ulfah et al., 2023). The common symptoms reported include physical distress, emotional discomfort, decreased self-confidence, and concentration difficulties. With regard to educational levels, the highest levels of mathematics anxiety were observed among secondary school students, especially within the behavioral domain, evidenced by lower academic performance and increased reliance on others. This trend corroborates prior research indicating that mathematics anxiety affects learners at all stages of schooling and can severely hinder academic achievement (Komson et al., 2024; Zhou, 2023).

Taken together, these findings reinforce the conclusion that mathematics anxiety plays a significant role in diminishing students' mathematics learning achievement. The impact of mathematics anxiety is multifaceted, influencing students physiologically, psychologically, attitudinally, and behaviorally. Observable indicators of this anxiety include physical symptoms, emotional distress, low self-confidence, impaired concentration, avoidance of mathematics-related tasks, negative beliefs about the subject, reduced academic performance, and a tendency to depend on others. These results highlight the urgent need for targeted interventions to address mathematics anxiety in educational settings in order to enhance student learning outcomes and long-term academic success.

## 4. CONCLUSION

This study aimed to explore students' mathematics anxiety through the Rasch model, focusing on four theoretical aspects: physiological, psychological, attitudinal, and behavioral. The findings revealed that the attitudinal and psychological aspects were the most significant contributors to students' mathematics anxiety, particularly indicators such as avoidance of mathematics learning, negative perceptions of the subject, and low self-confidence. The research also found that female students at the junior and senior high school levels exhibited higher levels of mathematics anxiety. These results highlight the need for targeted interventions, including designing engaging and context-based mathematics instruction, promoting students' belief in the relevance of mathematics for real-life problem solving, and boosting student confidence in their mathematical abilities. However, the study is limited by the relatively small sample size and restricted research locations, which may affect the generalizability of the findings. Future research should expand the respondent pool and geographic coverage to validate and refine the current results, as well as further test the developed instruments across diverse educational contexts.

## REFERENCES

Aguilar, J. J. (2021). High school students' reasons for disliking mathematics: The intersection between teacher's role and student's emotions, belief and self-efficacy. *International Electronic Journal of Mathematics Education, 16*(3), em0658. https://doi.org/10.29333/iejme/10980

Anastasi, A., & Urbina, S. (1997). *Psychological testing* (7th ed.). Prentice Hall.

Anbazhagan, N. (2016). Mathematics is the queen of sciences. *Alu Maths News, 1*(4).

Anjasari, T., Sujadi, I., & Isnarto, I. (2022). How does math anxiety affect students' problem-solving ability? A case of ill-structured mathematics problem. *Journal of Mathematical Pedagogy, 3*(2), 98–113. https://doi.org/10.37303/jmp.v3i2.102

Bodongan, E. B. (2022). Math anxiety, learning engagement and perceived usefulness of technology as predictors to mathematics performance of students. *International Journal of Trends in Mathematics Education Research, 5*(1), 12–18. https://doi.org/10.33122/ijtmer.v5i1.135

Bond, T. G., & Fox, C. M. (2015). *Applying the Rasch model: Fundamental measurement in the human sciences* (3rd ed.). Routledge.

Bryman, A. (2015). *Social research methods* (5th ed.). Oxford University Press.

Ciftci, Ş. K., & Yildiz, P. (2019). The effect of self-confidence on mathematics achievement: The meta-analysis of Trends in International Mathematics and Science Study (TIMSS). *International Journal of Instruction, 12*(2), 683–698. https://doi.org/10.29333/iji.2019.12243a

Cohen, R. J., & Swerdlik, M. E. (2018). *Psychological testing and assessment: An introduction to tests and measurement* (9th ed.). McGraw-Hill Education.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage Publications.

Detikedu. (2021, December 31). Yang ditunggu, ini hasil lengkap asesmen nasional 2021. *Detik.com*. https://www.detik.com/edu/edutainment/d-6011654/yang-ditunggu-ini-hasil-lengkap-asesmen-nasional-2021

DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). Sage Publications.

Eid, G. A., & Helal, A. M. (2013). Maths anxiety in college students across majors: A cross-cultural study. *Educationalfuture, 5*(2).

Espino, M., Baltazar, M. L. D., & Rivera, R. M. (2017). Mathematics anxiety and its impact on the course and career choice of Grade 11 students. *International Journal of Education, Psychology and Counseling, 2*(5), 99–119.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2015). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Fraenkel, J. R., & Wallen, N. E. (2012). *How to design and evaluate research in education* (8th ed.). McGraw-Hill Education.

Galiano, M. J. J., et al. (2023). Gender stereotypes about math anxiety: Ability and emotional components. *Learning and Individual Differences*. https://doi.org/10.1016/j.lindif.2023.102223

Hadanova, J., & Nocar, D. (2016). Mathematics importance in our life. In *Proceedings of INTED 2016 Conference* (pp. 4813–4819). IATED. https://library.iated.org/view/HADANOVA2016MAT

Kline, P. (2015). *Psychometrics: A practical approach*. Sage Publications.

Komson, D., et al. (2024). Investigating the level of mathematics anxiety among junior high school pupils. *Mathematics Education Journals, 8*(2).

Kurniawati, I., et al. (2022). Mathematics problem-solving ability of elementary school students in solving HOTS type of mathematics problems. *Journal of Education and Learning Mathematics Research, 3*(2), 118–129.

Langoban, M. A. (2020). What makes mathematics difficult as a subject for most students in higher education? *International Journal of English and Education, 9*(3).

Linacre, J. M. (2012). *A user's guide to WINSTEPS Rasch-model computer programs*.

Mailizar, M., et al. (2014). A historical overview of mathematics curriculum reform and development in modern Indonesia. *Teaching Innovations, 27*(3), 58–68.

Mangkuwibawa, H., et al. (2024). The effect of math anxiety on students' literacy. *Mudarrisa: Jurnal Kajian Pendidikan Islam, 16*(1).

Mariamah, M., et al. (2020). Analysis of students' perceptions of mathematics subjects: Case studies in elementary schools. *Journal of Physics: Conference Series, 1933*(1), 012074. https://doi.org/10.1088/1742-6596/1933/1/012074

Messick, S. (1995). Validity of psychological assessment: Validation of inferences from persons' responses and performances as scientific inquiry into score meaning. *American Psychologist, 50*(9), 741–749. https://doi.org/10.1037/0003-066X.50.9.741

Mutakin, T. Z. (2023). *Dissertation, Educational Research and Evaluation Program*, Postgraduate Program, Jakarta State University, Indonesia.

Mutodi, P., & Ngirande, H. (2014). The influence of students' perceptions on mathematics performance: A case of a selected high school in South Africa. *Mediterranean Journal of Social Sciences, 5*(3), 431–445. https://doi.org/10.5901/mjss.2014.v5n3p431

OECD. (2022). *PISA 2022 results: The state of learning and equity in education (Vol. 1)*. OECD Publishing. https://doi.org/10.1787/14bfa2db-en

Ohiri, S. C., et al. (2024). Differential item functioning detection methods: An overview. *International Journal of Research Publication and Reviews, 5*(2), 1555–1564.

Olango, M. (2016). Mathematics anxiety factors as predictors of mathematics self-efficacy and achievement among freshmen science and engineering students. *African Educational Research Journal, 4*(3), 109–123.

Osterlind, S. J., & Everson, H. T. (2009). *Differential item functioning*. SAGE Publications.

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE Publications.

Pradana, K. C., & Noer, S. H. (2023). Critical thinking and mathematical problem-solving skills of students through Schoology-assisted blended learning models. *Mathline: Jurnal Matematika dan Pendidikan Matematika, 8*(3), 313–322.

Salifu, A. S., & Bakari, A. (2022). Exploring the relationship between students' perception, interest and mathematics achievement. *Mediterranean Journal of Social & Behavioral Research, 6*(1), 13–20.

Santoso, F. G., & Ariyanti, G. (2023). Student anxiety level when going to college in the mathematics education study program with mathematics scores. *Mosharafa: Jurnal Pendidikan Matematika, 12*(3), 357–370.

Sara, J. A. (2022). Anxiety analysis of students taking distance learning in mathematics learning in junior high schools. *Journal of Mathematics and Mathematics Education, 12*(2), 152–164.

Serin, H. (2023). Mathematics anxiety: Overcoming challenges and achieving success. *International Journal of Social Sciences & Educational Studies, 10*(2), 83–89.

Stebbins, R. A. (2011). *Exploratory research in the social sciences*. SAGE Publications.

Sumintono, B., & Widhiarso, W. (2015). *Aplikasi model Rasch untuk penelitian ilmu-ilmu sosial* (2nd ed.). Trim Komunikasi.

Susongko, P., et al. (2021). Determination of gender differential item functioning in Tegal-students' scientific literacy skills with integrated science (Slisis) test using Rasch model. *Jurnal Pendidikan IPA Indonesia, 10*(2), 270–281. https://doi.org/10.15294/jpii.v10i2.30638

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Thomas, O. O., & Lawal, O. R. (2020). Exploratory research design in management sciences: An X-ray of literature. *Annals of "Dunarea de Jos" University of Galati, 26*(2), 53–61.

Ulfah, S., et al. (2023). Gender differences in mathematics anxiety and learning motivation of students during the COVID-19. *Jurnal Elemen, 9*(1), 256–270.

Wardani, N. (2022). The effect of mathematics anxiety on students' learning outcomes in class X high school. *Nucleus, 3*(2), 45–54.

Wahyuni, R., et al. (2024). How do math anxiety and self-confidence affect mathematical problem solving? *EM Journal, 13*(1), 550–560.

Wright, B. D., & Linacre, J. M. (1994). Reasonable mean-square fit values. *Rasch Measurement Transactions, 8*(3), 370.

Yaman, H., et al. (2015). An evaluation of UNESCO publications on mathematics education: From 1989 to 2013. *International Journal of Education in Mathematics, Science and Technology, 3*(1), 64–76.

Yulita, & Ain, S. Q. (2021). Analysis of students' learning difficulties in learning mathematics at elementary schools. *Al-Ishlah: Jurnal Pendidikan, 13*(3), 1700–1710.

Zanabazar, A., et al. (2023). The relationship between mathematics anxiety and mathematical performance among undergraduate students. *Jurnal Ilmiah Peuradeun, 11*(1), 115–132. https://doi.org/10.26811/peuradeun.v11i1.1080

Zhou, Y. (2023). Mathematics anxiety in school children. In *Advances in Social Science, Education and Humanities Research (ASSEHR), 752*, 851–856.