Original Research Article

Impact of Grade 11 Students’ Anxiety and Self--Efficacy on their Mastery of General Mathematics

.

ABSTRACT

|  |
| --- |
| **Aims:** This study examined the predictive influence of mathematics anxiety and self-efficacy on Grade 11 students’ mastery of rational functions and their graphs at Palawan State University Laboratory Senior High School.  **Study design:** Anchored in Bandura’s theory of self-efficacy and supported by literature on affective factors in mathematics learning, the research employed a descriptive-correlational design.  **Place and Duration of Study:** Palawan State University Laboratory Senior High School, between 2022 to 2023.  **Methodology:** Data were taken from 76 senior high school students using a teacher-constructed mastery test, a mathematics anxiety scale, and a self-efficacy questionnaire, all subjected to validity and reliability procedures.  **Results:** Results revealed that students demonstrated an overall average level of mastery in rational functions, with notable weaknesses in graphing and applying rational functions to real-life problems. Mathematics anxiety among the students was generally moderate, while self-efficacy was rated as average. Regression analysis indicated that self-efficacy significantly predicted overall mastery, as well as performance in competencies such as identifying domain and range, intercepts, zeroes, and asymptotes. In contrast, mathematics anxiety showed a significant negative effect only in solving rational equations and inequalities. For other competencies, including representing and graphing rational functions, neither variable showed significant predictive power, suggesting that additional cognitive or instructional factors may be influencing performance  **Conclusion**: The predictive power of self-efficacy is more consistent than that of anxiety, suggesting that confidence-building may be a more effective long-term intervention strategy. However, anxiety remains a key barrier in solving symbolic problems and must be addressed through supportive environments and process-oriented teaching. The lack of significant predictors in competencies involving representation and real-world application implies that mastery in these areas depends on more than just affective factors. Instructional strategies must also emphasize modeling skills, representational conversions, and contextual understanding. |

*Keywords: Mathematics Anxiety, Self-Efficacy, Rational Functions, Predictive Relationship, 7Es Inquiry-Based Learning, level of mastery*

1. INTRODUCTION

In today’s rapidly evolving world, education systems are being challenged to prepare learners not only for academic success but also for participation in a knowledge-based global economy. Yet, the structures of many education systems remain largely unchanged, often lacking a cohesive vision for systemic improvement (Bialeck et al., 2021). Central to 21st-century learning is the development of key competencies—knowledge, skills, character, and metacognition. Mathematics, as a universal language, plays a vital role in equipping learners with logical reasoning and problem-solving abilities necessary for civic, personal, and professional life.

Globally, the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2012) emphasized the growing need to develop mathematical literacy beyond basic computational skills. Unfortunately, misconceptions about mathematics—such as its perception as an isolated, purely deductive, and solitary activity—create barriers to quality mathematics education. These perceptions, compounded by limited real-world applications, minimal use of technology, and teacher-centered pedagogy, contribute to students' disengagement and underperformance. International assessments have consistently revealed alarming trends in mathematics performance, especially in developing countries. In the 2022 Programme for International Student Assessment (PISA), the Philippines ranked 75th in mathematics among 81 countries, with Filipino students scoring an average of 355, far below the OECD average of 472. Only 16% of Filipino students reached the baseline Level 2 proficiency in mathematics, compared to 69% OECD-wide. Similarly, in TIMSS 2023, although complete disaggregated data remains limited, trends indicate continued challenges in Filipino students’ performance in both mathematics and science.

This underachievement has prompted national concern. President Ferdinand R. Marcos Jr., in his 2022 State of the Nation Address, openly acknowledged the country’s lagging performance in STEM (Science, Technology, Engineering, and Mathematics), pledging to strengthen science and mathematics education as tools for national development. In response, the Department of Education (DepEd) (2022) and related bodies have intensified efforts toward systemic reforms. These include the passage of the proposed Equitable Access to Mathematics and Science Education Act, and the implementation of the Second Congressional Commission on Education (EDCOM 2) (2023) to assess and revamp basic education, particularly from Kindergarten to Grade 3 where foundational competencies are built.

Yet, despite these policy advances, a disconnect remains between curricular intent and actual learning outcomes. Research suggests that psychological factors such as mathematics anxiety and self-efficacy significantly influence students’ ability to learn and apply mathematical concepts (Zakariya, 2022). Mathematics anxiety, often described as a debilitating fear that interferes with performance, leads many students to avoid math-related tasks or view them as insurmountable (Ashcraft & Krause, 2007; Ramirez et al., 2018). Self-efficacy, on the other hand, pertains to a learner’s belief in their capability to succeed in specific tasks and is positively correlated with motivation, engagement, and academic achievement (Phan, 2012; Skrzypiec & Lai, 2017; Wang & Yu, 2023).

Studies (GradePower Learning, 2018) identify three main reasons why students struggle with math: (1) learning difficulties such as dyscalculia, (2) poor foundational skills, and (3) negative emotional reactions such as math anxiety. These factors, especially in secondary education, can significantly impact student performance in topics that require higher-order thinking—such as rational equations, functions, and their graphs.

Within the Philippine context, this issue is not unfamiliar. Despite being recognized as a Center of Excellence in Teacher Education in Region IV-B (MIMAROPA), Palawan State University (PSU) has consistently observed that many students underperform in mathematics. While some excel in STEM and pursue careers in science, engineering, or law, the majority struggle with math-intensive courses and often opt for degree programs with minimal mathematics content. These trends are also evident in the Palawan State University laboratory Schools, where rational equations and functions are among the most challenging topics for junior and senior high school students.

The researcher, having taught mathematics for over a decade, has observed persistent challenges among learners when it comes to understanding and mastering algebraic concepts. These observations have sparked reflection on whether existing pedagogical strategies sufficiently address students’ emotional and psychological needs. Questions arise: Are students merely memorizing formulas without grasping their meanings? Do teachers consider learners’ backgrounds, motivation, and learning preferences when designing lessons? Are learners equipped with the confidence and mindset to persist through mathematical difficulties?

Furthermore, educational literature underscores the importance of student-centered learning and growth mindset. Mathematics, unlike other subjects, requires perseverance and tolerance of failure—skills that are cultivated when learners believe they can improve through effort. Yet, many math classrooms still function as content-driven environments with limited attention to emotional factors.

**1.1 REVIEW OF RELATED LITERATURE AND STUDIES**

Mastery of rational functions and their graphical representations is a key component of the General Mathematics curriculum in Senior High School. According to DepEd Order No. 160, s. 2012, student mastery is evaluated using performance descriptors that guide instruction and remediation. This study evaluates mastery through six prescribed competencies: 1) Solving rational equations and inequalities; 2) Representing rational functions through tables, graphs, and equations; 3) Determining domain and range; 4) Identifying intercepts, zeroes, and asymptotes; Graphing rational functions; and 6) Solving real-life problems involving rational functions, equations, and inequalities.

Students frequently struggle with rational equations due to the complexity of variable-laden denominators. Misconceptions such as improper cancellation or ignoring restrictions often occur. Knuth (2006) found that students frequently misunderstand the meaning of the equal sign in algebraic contexts, often treating it as an instruction rather than an equivalence relation, leading to errors when manipulating expressions—an error pattern commonly seen in rational equations and he attributed these issues to a weak understanding of rational expressions, while Linchevski and Livneh (1999) argue that lack of procedural fluency hampers students’ ability to isolate variables and identify extraneous solutions effectively. He introduced the concept of “structure sense,” showing that students often fail to recognize and respect the structure of algebraic expressions—particularly in rational contexts—resulting in missteps like omitting parentheses, canceling terms prematurely, and overlooking domain restrictions.

Understanding rational functions requires more than symbolic manipulation—it demands cognitive flexibility in transitioning between symbolic, graphical, and tabular representations. This representational fluency is essential for interpreting domains, identifying asymptotes, and analyzing global function behavior. Duval (2006) proposed a semiotic framework that distinguishes between treatment (manipulation within a single representation) and conversion (transition between representations), emphasizing that students often struggle with the latter, leading to comprehension breakdowns. Dreyfus and Eisenberg (1996) similarly observed that students tend to rely heavily on symbolic forms while neglecting graphical or tabular interpretations, resulting in fragmented understanding—particularly in graphing tasks that demand integration of multiple perspectives. Recent empirical studies further support these findings, indicating that students with well-developed conversion skills exhibit stronger algebraic reasoning and function interpretation (Deliyianni et al., 2015; Gagatsis et al., 2016), reinforcing the need for instructional strategies that promote representational flexibility in the learning of rational functions.

Accurate determination of domain and range is critical, especially in rational functions where division by zero is a concern. Stylianides and Stylianides (2008) noted confusion between domain and range and emphasized that symbolic restrictions are often overlooked. Oehrtman (2008) suggested that integrating graphical and symbolic approaches improves student comprehension. Identifying Intercepts, Zeroes, and Asymptotes are essential features in analyzing and sketching graphs of rational functions. Herman (2007) observed that students often conflate x-intercepts with vertical asymptotes or misapply procedures to determine

Given this context, the present study seeks to examine the impact of mathematics anxiety and self-efficacy on Grade 11 students’ mastery of key topics in General Mathematics, specifically rational equations, functions, and their graphs. Despite existing reforms and institutional recognition, such as PSU’s designation as a Center of Excellence in Teacher Education, recurring challenges in student performance suggest a disconnect between curricular goals and actual learning outcomes. By focusing on the senior high school learners of Palawan State University Laboratory School, this research aims to address a local gap in understanding how psychological factors influence mathematical achievement. The findings aspire to inform more inclusive, responsive, and effective teaching strategies—ultimately contributing to efforts in fostering confident, capable, and resilient Filipino learners in mathematics.

**1.2** **STATEMENT OF THE PROBLEM**

Generally, this study aimed to examine the impact of mathematics anxiety and self-efficacy on the mastery of key General Mathematics topics—specifically rational equations, functions, and their graphs—among Grade 11 students at Palawan State University Senior High Laboratory School. More specifically, the study sought to answer the following questions:

1. What is the level of mastery of the respondents in rational functions and its graphs as reflected by their: a. overall scores, and b. performance across the six competencies prescribed in the curriculum guide?

2. What are the levels of mathematics anxiety and mathematics self-efficacy of the respondents in relation to rational functions and their graphs?

3. To what extent do the respondents’ mathematics anxiety and mathematics self-efficacy predict their performance in Mathematics, specifically in terms of their overall scores and their level of mastery across the six prescribed competencies in rational functions and their graphs?

The study was delimited to students officially enrolled in the General Mathematics subject under the Science, Technology, Engineering, and Mathematics (STEM) and Accountancy, Business, and Management (ABM) strands. It specifically covered the topic of rational functions and their graphs. Moreover, the investigation concentrated only on two affective variables—mathematics anxiety and mathematics self-efficacy—while other possible factors such as motivation, attitude, and learning styles were not within the scope. The findings were bounded by the defined context, the selected respondents, and the specified timeframe of the study.

The PSU Laboratory Senior High School (LSHS) stands to directly benefit from the results. The findings can inform efforts to refine pedagogical strategies, integrate psychological support mechanisms, and design targeted instructional materials that address learning gaps and emotional barriers—especially those related to mathematics anxiety and self-efficacy.

The College of Teacher Education (CTE), which oversees the Laboratory School, may use the study to enhance its teacher preparation programs. By integrating topics on managing math anxiety, fostering self-efficacy, and applying research-based strategies for teaching complex mathematical concepts, the CTE can better equip pre-service teachers with effective, learner-centered approaches.

2. METHOdology

This study employed a descriptive-correlational research design with a developmental component. Its primary aim was to examine the predictive relationship between mathematics anxiety, mathematics self-efficacy, and students’ mastery of rational functions and their graphs. It also aimed to develop a 7Es-based inquiry lesson exemplar informed by students’ learning gaps, with the intent of supporting future instruction in the General Mathematics curriculum.

The descriptive aspect of the research focused on determining the respondents’ levels of mastery in rational functions and their graphs, as well as their perceived levels of mathematics anxiety and self-efficacy. Meanwhile, the correlational component investigated the extent to which mathematics anxiety and mathematics self-efficacy predict students’ mastery in the specified competencies.

This study used a purposive sampling technique. From the two (2) sections under the Science, Technology, Engineering, and Mathematics (STEM) strand and one (1) section under the Accountancy, Business, and Management (ABM) strand, the researcher randomly selected one (1) STEM section and included the lone ABM section of Grade 11 students enrolled at Palawan State University Senior High School Laboratory during the School Year 2023–2024. These selected groups served as the sample frame for measuring, analyzing, and determining relationships among the key variables of the study—mathematics anxiety, mathematics self-efficacy, and mastery of rational functions and their graphs. This study utilized two research instruments: a researcher-made test on rational functions and their graphs, and Likert-scale questionnaires measuring mathematics anxiety and mathematics self-efficacy.

Part I is a 30 – item multiple choice survey test with 4 options adapted from Holy Trinity University Master’s thesis of Ms. Maylene G. Villarosa with reliability coefficient of 0.81 determined by the Kuder-Richardson Formula 21. This composed of items covering the competencies on rational functions and graphs outlined in the K to 12 Curriculum Guide of the Department of Education.

Part II is a researcher-made questionnaire on the respondents’ perception of their mathematics anxiety and mathematics self-efficacy, using the 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The perception on mathematics anxiety was classified according to the following range: Not at all anxious (1.00 – 1.50); fairly anxious (1.51 – 2.50); moderately anxious (2.51 – 3.50); very anxious (3.51 – 4.50); and extremely anxious (4.51 – 5.00), while the self – efficacy beliefs in mathematics were classified according to these ranges: very low (1.00 – 1.50); low (1.51 – 2.50); average (2.51 – 3.50); high (3.51 – 4.50); and very high (4.51 – 5.00). The internal reliability of the anxiety and self – efficacy questionnaires were tested using one (1) block of Grade 11 STEM students not participants of the study. The Cronbach’s Alpha reliability coefficients are 0.94 and 0.86, respectively.

The data collection process was carried out in three phases: Phase 1 – Administration of Research Instruments. The researcher coordinated with the General Mathematics teachers to schedule the administration of the three instruments. Students were first briefed on the study’s purpose, assured of confidentiality, and asked for informed consent. The Rational Functions Mastery Test and the Mathematics Anxiety and Self-Efficacy questionnaires were administered consecutively under standardized conditions; Phase 2 – Data Analysis and Identification of Gaps. Responses were encoded and analyzed to determine students’ overall and competency-specific mastery levels, and to measure the levels of mathematics anxiety and self-efficacy. The results guided the identification of specific learning gaps, which became the basis for developing the lesson exemplar; and Phase 3 – Development of the Inquiry-Based Lesson Exemplar. An inquiry-based lesson exemplar targeting the lowest-performing competencies was designed, integrating strategies to reduce anxiety and improve self-efficacy. The exemplar is intended for future use in General Mathematics instruction. Owing to limited space, the lesson exemplar will not be discussed in this article.

Results obtained were coded for data processing. In the analysis and interpretation of data, the following statistical tools and procedures were used in various consultations. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to summarize the levels of students' mastery on rational functions and graphs, mathematics anxiety, and mathematics self-efficacy.

Correlation analysis (Spearman’s rho) was initially conducted to examine the relationships among mathematics anxiety, mathematics self-efficacy, and students’ mastery of rational functions and their graphs. This was followed by multiple linear regression analysis to determine the extent to which mathematics anxiety and self-efficacy predict students’ overall mastery and performance across the six prescribed competencies. The processing of the data was done using Jamovi and other statistical software

3. results and discussion

3.1 Respondents’ Level of Mastery in Rational Functions and Its Graph

Tables 1–A and 1–B show the level of mastery of the Grade 11 students in rational functions and its graph as reflected by their overall scores, and performance across the six prescribed competencies in the curriculum guide, respectively.

It can be noted that majority of the Grade 11 students performed at an average level in rational functions and its graphs, with frequency count of 44 or 57.89 percent. Out of 76 Grade 11 students, 15 students (19.74 percent) are in “moving towards mastery” level, while the remaining 17 students (22.37 percent) have a low level of mastery in this topic in General Mathematics. No student achieved a level beyond “moving towards mastery,” nor did any fall below the low level of mastery.”

This result is consistent with PISA 2022 data, where the Philippines scored significantly below the OECD average in mathematics, with fewer than 30% of students achieving even basic proficiency levels (OECD, 2023). Similarly, earlier TIMSS reports (TIMSS 2019; TIMSS 2023 projections) showed that Filipino learners persistently underperform in algebra and graph-based tasks—core areas linked to rational functions. These international benchmarks underscore a systemic challenge in achieving mathematical mastery, especially in abstract and representational topics like rational functions. Furthermore, the findings support Knuth (2006) and Linchevski and Livneh (1999), who reported that students often misinterpret rational expressions and struggle with procedures due to limited structural understanding. The low scores observed also parallel Duval’s (2006) claim that many students experience difficulty in converting between symbolic, graphical, and tabular representations, which are essential to mastering rational functions.

The highest score obtained was 22 and the lowest score was 6. The mean score is 14.86, which is classified as average mastery with standard deviation of 4.56. Although the mean score is at an average level, the fact that 17 students or 22.37 percent have low level of mastery, this figure is very significant, highlighting an urgent need for immediate action to enhance performance of the topic and bring it up to at least an average level of mastery. The mean score also resonates with Dreyfus and Eisenberg’s (1996) assertion that over-reliance on symbolic manipulation leads to fragmented understanding and weak graph interpretation. Lastly, the underwhelming performance across the board justifies the need for instructional innovations like the inquiry-based lesson exemplar proposed in this study—especially when considered alongside studies like Ziatdinov and Valles (2022) and Yunianto et al. (2023), which demonstrated that dynamic tools and exploratory tasks significantly enhance understanding of function behavior.

**Table 1 - A**

**Level of Mastery of the Respondents in Rational Functions and Its Graph as Reflected by Their Overall Scores**

**(n = 76)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Level of Mastery\*** | **Test Score** | **Frequency** | **Percentage** |
| Mastered (96 – 100%)  Closely Approximating Mastery (86 – 95%)  Moving Towards Mastery (66 – 85%)  Average (35 – 65%)  Low (15 – 34%)  Very Low (5 – 14%)  Absolutely No Mastery (0 – 4%) | 29 – 30  26 – 28  20 – 25  11 – 19  5 – 10  2 – 4  0 – 1 | 0  0  15  44  17  0  0 | -  -  19.74  57.89  22.37  -  - |
| Highest Score  Lowest Score  Mean  Standard deviation | 22  6  14.86 (Average)  4.56 | | |

**\***DepEd Order 160, s. 2012

**3.2** **LEVEL OF MASTERY OF THE RESPONDENTS IN RATIONAL FUNCTIONS AND ITS GRAPHS** **BASED ON THE PRESCRIBED COMPETENCIES**

It can be observed from Table 1-B that the competency of Grade 11 students in General Mathematics, particularly focusing on rational functions and their graphs is evident that they excel most in determining the domain and range of these functions. This means they understand well what values the function can take and what values it can produce. This proficiency is indicated by a mean score of 2.24, equivalent to about 74.56 percent mastery and is classified as “moving towards mastery”.

However, when it comes to representing rational functions through tables, graphs, and equations, the students' performance is not as strong. They scored an average of 1.84, which translates to around 61.40 percent mastery. This suggests that students may struggle more with visualizing and understanding how these functions behave graphically and algebraically.

Similarly, while the students demonstrate an average level of proficiency in solving rational equations and inequalities, with a mean score of 3.46 (approximately 57.68 percent mastery), their understanding of intercepts, zeroes, and asymptotes of rational functions seems to be lacking. They scored 3.03 on this competency, representing a mean percent mastery of 50.44.

Moreover, when it comes to applying rational functions to real-world problems and equations, the students' performance is even lower. They achieved a mean score of 2.28, equivalent to about 37.94 percent mastery. This suggests they may struggle to translate their understanding of rational functions into practical problem-solving scenarios.

One notable area of concern is the graphing of rational functions, where the students scored particularly low. With a mean score of 2.01, corresponding to only about 33.55 percent mastery, many students find graphing these functions challenging and may need extra support in this area. Overall, while some competencies are at an average level, there is a significant need for improvement, particularly in graphing rational functions and applying them to real-world problems.

These findings echo patterns observed in several previous studies. The low to average mastery across competencies — especially in interpreting graphs, identifying asymptotes, and solving real-life problems involving rational functions — aligns with Dreyfus and Eisenberg’s (1996) observation that students tend to rely heavily on symbolic manipulation while neglecting graphical and contextual interpretations. Similarly, Ziatdinov and Valles (2022) emphasized the need for dynamic tools like GeoGebra, which have been shown to significantly improve graphing accuracy and conceptual understanding — a recommendation that directly addresses gaps revealed in this study. The results also reflect the concerns of Wijaya, van den Heuvel-Panhuizen, and Doorman (2015), who found that students often struggle to transfer mathematical concepts to real-world problems, a trend confirmed by the low scores in application-based items. Moreover, consistent with Knuth’s (2006) findings, errors in solving rational equations may stem from students' weak understanding of the structure of algebraic expressions and the meaning of the equal sign. Lastly, the relationship between representational fluency and performance, as supported by Deliyianni et al. (2015) and Gagatsis et al. (2016), further justifies the need for instructional interventions that promote cognitive flexibility in transitioning among graphs, tables, and equations — a strategy this study proposes through the design of an inquiry-based lesson exemplar.

**Table 1 - B**

**Level of Mastery of the Respondents in Rational Functions and Its Graph**

**Based on the Prescribed Competencies**

**(n = 76)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Competencies\*** | **Number of Items** | **Mean Score** | **Mean Percent** | **Level of Mastery** |
| 1. Solves rational equations and inequalities.   2. Represents a rational function through its: (a) table of values, (b) graph, and (c) equation.  3. Finds the domain and range of a rational function.  4. Determines the:(a) intercepts (b) zeroes; and (c) asymptotes of rational functions.  5. Graphs rational functions  6. Problems involving rational functions, equations, and inequalities. | 6  3  3  6  6  6 | 3.46  1.84  2.24  3.03  2.01  2.28 | 57.68  61.40  74.56  50.44  33.55  37.94 | Average  Average  Moving Towards Mastery  Average  Low  Average |

\* From K to 12 SHS Core Curriculum – Gen Math, May 2016

**3.3 LEVEL OF MATHEMATICS ANXIETY AND SELF-EFFICACY**

Tables 2–A and 2 – B present the level of mathematics anxiety and self – efficacy of the Grade 11students.

**3.3.1 Level of Mathematics Anxiety**

The data on Table 2-A below reveals a spectrum of anxiety levels among Grade 11 students regarding their experience with mathematics. Some students claimed feeling "not at all anxious," while others describe their anxiety as "extremely high."

Specifically, one (1) student, comprising 1.32 percent of the group, express extreme anxiety towards learning mathematics. Meanwhile, a significant portion, 24 students or 31.58 percent, identify as very anxious, followed by 28 students (36.84 percent) who consider themselves moderately anxious. Additionally, 18 students (23.68 percent) claimed feeling fairly anxious in their approach to learning mathematics. Only a small fraction, five (5) students or 6.58 percent, indicate they feel no anxiety at all.

The range of identified anxiety levels is diverse, with some students rating their anxiety as perfect 5.0, signifying extreme distress, while others rate it as a perfect 1.0, indicating complete lack of anxiety. Overall, the collective data points to a moderate level of anxiety surrounding mathematics, with a mean rating of 3.06 and a standard deviation of 0.94. This suggests that while anxiety levels vary among students, there exists a notable degree of apprehension towards the subject.

These findings support the earlier study of Ramirez et al. (2018), who emphasized that anxiety interferes with working memory and problem-solving efficiency. In the Philippine context, this trend echoes the findings of Estrada et al. (2022), which revealed that high school students frequently experience mathematics anxiety that impacts their classroom participation and confidence. It confirmed that math anxiety has a negative effect on performance in algebra-related topics—mirroring the “Average” mastery seen in rational functions in this study. These patterns reinforce the need for targeted strategies to reduce mathematics anxiety, such as confidence-building inquiry-based approaches, to promote greater engagement and mastery in abstract topics like rational functions.

**Table 2 - A**

**Level of Mathematics Anxiety of the Respondents**

**(n = 76)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Level of Mathematics Anxiety** | **Range** | **Frequency** | **Percentage** |
| Extremely Anxious  Very Anxious  Moderately Anxious  Fairly Anxious  Not at all Anxious | 4.51 – 5.00  3.51 – 4.50  2.51 – 3.50  1.51 – 2.50  1.00 – 1.50 | 1  24  28  18  5 | 1.32  31.58  36.84  23.68  6.58 |
| Maximum Rating  Minimum Rating  Mean Rating  Standard Deviation | 5.0  1.0  3.06 (Moderately Anxious)  0.94 | | |

**3.2.2 Level of Mathematics Self-Efficacy of the Respondents**

The self-efficacy levels of Grade 11 students in learning mathematics vary widely, spanning from low to very high. A small fraction, around 2.63 percent (2 students), exude extreme confidence in their mathematical abilities. Additionally, a slightly larger group, approximately 13.16 percent (10 students), perceive themselves as possessing high levels of confidence in mathematics. The largest portion, constituting 50.00 percent (38 students), fall into the category of average self-efficacy, indicating a moderate level of confidence in their mathematical skills. However, a significant number, 34.21 percent (26 students), express lower levels of confidence, signaling a pressing need for intervention to elevate their confidence to at least an average level.

Notably, no student rated himself as having very low self-efficacy in mathematics, suggesting an overall tendency among students to perceive themselves as at least somewhat capable in the subject. Student ratings range from a minimum of 1.6 to a maximum of 4.7, with an average rating of 2.90. This places the overall mathematics self-efficacy level as average, with a standard deviation of 0.65, indicating a moderate amount of variability in students' confidence levels.

The results align with Usher and Pajares (2009), who emphasized the role of students’ beliefs in their ability to succeed, especially in challenging tasks. According to Bandura (1997), self-efficacy is a key determinant of motivation and persistence—skills that are especially necessary when dealing with complex and symbolic mathematical content. The observed low-to-average efficacy levels may explain the students’ reluctance to engage with multi-step tasks or attempt challenging problems.

**Table 2 - B**

**Level of Mathematics Self - Efficacy of the Respondents**

**(n = 76)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Level of Self – Efficacy** | **Range** | **Frequency** | **Percentage** |
| Very High (4.51 – 5.00)  High (3.51 – 4.50)  Average (2.51 – 3.50)  Low (1.51 – 2.50)  Very Low (1.00 – 1.50) | 4.51 – 5.00  3.51 – 4.50  2.51 – 3.50  1.51 – 2.50  1.00 – 1.50 | 2  10  38  26  0 | 2.63  13.16  50.00  34.21  - |
| Maximum Rating  Minimum Rating  Mean Rating  Standard Deviation | 4.7  1.60  2.90 (Average)  0.65 | | |

**3.4 REGRESSION ANALYSIS ON THE PREDICTIVE INFLUENCE OF MATHEMATICS ANXIETY AND SELF-EFFICACY ON STUDENTS’ MASTERY OF RATIONAL FUNCTIONS AND THEIR GRAPHS**

Table 3 – A to Table 3 - F present the predictive influence of Mathematics Anxiety and Self Efficacy on students’ mastery in terms of their overall scores and their level of mastery across the six prescribed competencies in rational functions and their graphs. The results of the multiple linear regression indicate that mathematics anxiety and mathematics self-efficacy together account for 15.2% of the variance in students’ overall mastery scores in rational functions and their graphs (R² = 0.152; Adjusted R² = 0.129). This suggests that while the model explains a modest portion of the variability in mastery scores, other factors not included in the model may also contribute substantially to student performance.

**3.4.1 Regression Summary and Model Coefficients Predicting Mastery in Terms of Overall Scores in Rational Functions and their Graphs**

The intercept of the model was found to be statistically significant (B = 10.376, *p* = 0.039). This implies that when both predictors—mathematics anxiety and mathematics self-efficacy—are set to zero, the baseline predicted mastery score is approximately 10.38. While scores of zero for both variables are unlikely in practical settings, the significant intercept confirms that there is a non-zero level of expected performance even in the absence of measurable self-efficacy or anxiety, possibly reflecting prior knowledge or external support systems.

Among the predictors, mathematics self-efficacy emerged as the only statistically significant variable (B = 2.117, *p* = 0.049). This reinforces the critical role of students’ beliefs in their capabilities as a determinant of academic performance. This finding aligns closely with Bandura’s (1997) self-efficacy theory, which posits that self-perception of competence significantly influences motivation, persistence, and performance. Moreover, Ufer and Heinze (2021) emphasized that students with higher self-efficacy engage more meaningfully with cognitively challenging mathematical tasks, including rational functions that require flexible transitions among symbolic, graphical, and contextual representations.

On the other hand, mathematics anxiety did not show a statistically significant effect on students' mastery scores (B = –0.544, *p* = 0.460). This contrasts with earlier study (Ashcraft & Krause, 2007) that report a consistent negative relationship between anxiety and performance. The current findings may suggest that in this context, the influence of self-efficacy may override the disruptive effects of anxiety, or that supportive classroom environments and inquiry-based strategies helped mitigate its impact. This interpretation finds support in Santos & Boyon, (2020), who observed that exploratory learning environments—particularly those incorporating dynamic tools may help students manage anxiety by enabling them to visualize, test, and revise their thinking.

Taken together, the results affirm the centrality of mathematics self-efficacy in predicting performance and validate the study’s direction in developing an instructional intervention that prioritizes confidence-building, conceptual engagement, and student-centered inquiry. Emphasizing such strategies in General Mathematics instruction may lead to measurable improvements in the mastery of rational functions.

**Table 3 - A**

**Regression Summary and Model Coefficients Predicting Mastery in Terms of Overall Scores in Rational Functions and Their Graphs**

**(n = 76)**

|  |  |  |
| --- | --- | --- |
| **Correlation Coefficient R** | **R2** | **Adjusted R2** |
| 0.39 | 0.152 | 0.129 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients (Predictor)** | **B (Estimate)** | **SE** | **t-value** | **P- value** |
| Intercept  Mathematics Anxiety  Mathematics Self-Efficacy | 10.376  -0.544  2.117 | 4.943  0.734  1.059 | 2.099  -0.742  1.998 | 0.039\*  0.460  0.049\* |

\*\* - significant at

\* - significant at

**3.4.1 Regression Summary and Model Coefficients Predicting Mastery in Solving Rational Equations and Inequalities**

As shown in Table 3-B, the multiple regression analysis revealed a correlation coefficient of R = 0.572, indicating a moderate positive relationship between the combined predictors—mathematics anxiety and mathematics self-efficacy—and students’ mastery in solving rational equations and inequalities. The coefficient of determination (*R²* = 0.327) shows that approximately 32.7% of the variance in students’ scores on this competency is explained by the model, while the adjusted R² = 0.309 accounts for model complexity, still reflecting a substantial explanatory power compared to the overall model in Table 1-A. The intercept was statistically significant (B = 4.387, *p* = 0.002), indicating that when both predictors are at their minimum levels, students are still expected to score about 4.39 out of 6. This may suggest a baseline level of procedural recall or prior knowledge.

Among the predictors, Mathematics anxiety had a significant negative effect (B = –0.666, *p* = 0.002), confirming that higher anxiety levels are associated with lower performance in solving rational equations and inequalities. This supports earlier findings by Ashcraft & Kruase (2007), who asserted that anxiety disrupts working memory and impairs the ability to carry out multi-step algebraic procedures, particularly those involving variables in denominators. It also aligns with Knuth (2006) and Linchevski & Livneh (1999), who pointed out that students struggle with rational equations due to misconceptions and lack of procedural fluency—difficulties likely amplified by anxiety. Mathematics self-efficacy, however, did not reach statistical significance (B = 0.383, *p* = 0.202), suggesting that for this particular competency, confidence alone does not guarantee success. This may be due to the technical demands of solving rational equations, where errors often stem from structural misunderstandings or failure to apply domain restrictions—factors not easily offset by self-belief alone.

This result partially contrasts with the general findings of the overall model (Table 1-A), where self-efficacy was the only significant predictor. Here, mathematics anxiety emerges as a stronger determinant, suggesting that the nature of the task—procedural, rule-heavy, and error-prone—may make students more vulnerable to anxiety than to beliefs about capability.

This underscores the importance of targeted instructional strategies for this competency. For instance, conceptual scaffolding and the use of visual tools (error-checking in dynamic software or flowcharts) may help alleviate the cognitive overload associated with anxiety-inducing problems. It also points to the need for explicit teaching of restrictions, a known student difficulty noted by Stylianides & Stylianides (2008) and Oehrtman (2008).

In conclusion, to enhance mastery in solving rational equations and inequalities, interventions should reduce anxiety-inducing task features and reinforce step-by-step conceptual understanding, rather than relying solely on boosting self-efficacy.

**Table 3 - B**

**Regression Summary and Model Coefficients Predicting Mastery in Solving Rational Equations and Inequalities**

**(n = 76)**

|  |  |  |
| --- | --- | --- |
| **Correlation Coefficient R** | **R2** | **Adjusted R2** |
| 0.39 | 0.152 | 0.129 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients (Predictor)** | **B (Estimate)** | **SE** | **t-value** | **P- value** |
| Intercept  Mathematics Anxiety  Mathematics Self-Efficacy | 10.376  -0.544  2.117 | 4.943  0.734  1.059 | 2.099  -0.742  1.998 | 0.039\*  0.460  0.049\* |

\*\* - significant at

\* - significant at

**3.4.2 Regression Summary and Model Coefficients Predicting Mastery in Representing Rational Function Through Table of Values, Graph and Equation**

As shown in Table 3-C, the regression analysis for predicting students’ mastery in representing rational functions through tables, graphs, and equations yielded a low correlation coefficient (R = 0.139) and very weak explanatory power (R² = 0.019), with an adjusted R² of -0.008 is shown in Table 3-C. This suggests that mathematics anxiety and mathematics self-efficacy combined account for only 1.9% of the variance in students’ performance for this competency—essentially indicating no meaningful predictive relationship.

In terms of model coefficients, neither mathematics anxiety (B = 0.102, p = 0.544) nor mathematics self-efficacy (B = 0.280, p = 0.250) significantly predicted student scores in this area. Although self-efficacy showed a slightly stronger coefficient, its effect remained statistically insignificant.

This result appears to diverge from expectations based on literature that links representational fluency with both confidence and anxiety levels. For instance, Duval (2006) emphasized the cognitive demands of moving between symbolic, graphical, and tabular representations and suggested that students’ flexibility in switching between these formats is a key component of functional understanding. Similarly, Dreyfus and Eisenberg (1996) noted that many students overly rely on symbolic manipulation, often neglecting graphical and tabular interpretations, which undermines overall comprehension. More recent studies (Deliyianni et al., 2015; Gagatsis et al., 2016) also observed that representational fluency correlates with self-efficacy levels, especially when supported by effective instructional strategies.

The lack of significant results in this current analysis may point to other intervening factors, such as instructional gaps, unfamiliarity with visual and tabular formats, or the difficulty of the test items relative to students' prior exposure. Another possible explanation is that while self-efficacy might influence engagement, it does not directly translate into success in this specific type of task unless supported by explicit teaching of representational transitions.

Overall, this finding suggests that the mastery of representing rational functions may not be strongly shaped by students’ self-beliefs or anxiety levels alone but may depend more heavily on curricular emphasis, teacher scaffolding, and representational training—a direction also suggested by Gagatsis et al. (2016).

**Table 3 - C**

**Regression Summary and Model Coefficients Predicting Mastery in Representing Rational Function through Table of Values, Graph, and Equation**

**(n = 76)**

|  |  |  |
| --- | --- | --- |
| **Correlation Coefficient R** | **R2** | **Adjusted R2** |
| 0.139 | 0.0192 | -0.008 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients (Predictor)** | **B(Estimate)** | **SE** | **t-value** | **P- value** |
| Intercept  Mathematics Anxiety  Mathematics Self-Efficacy | 0.718  0.102  0.280 | 1.126  0.167  0.241 | 0.637  0.609  1.160 | 0.526  0.544  0.250 |

\*\* - significant at α= .01

\* - significant at α= .05

**3.4.3 Regression Summary and Model Coefficients Predicting Mastery in Finding the Domain and Range of a Rational Function**

The regression analysis on Table 3-D shows that mathematics anxiety and mathematics self-efficacy together accounted for 10.1% of the variance in students’ ability to determine the domain and range of rational functions (R = 0.319, R² = 0.101, Adjusted R² = 0.077). Although this suggests a small effect size, one variable—mathematics self-efficacy—emerged as a significant predictor of student performance in this competency (B = 0.5002, p = 0.026). In contrast, mathematics anxiety was not a significant predictor (B = 0.0521, p = 0.734).

This result aligns with Bandura’s (1997) self-efficacy theory, which posits that belief in one’s capabilities is a key driver of cognitive engagement and performance, especially in complex tasks such as determining domain and range—where understanding both symbolic restrictions (avoiding division by zero) and graphical cues (such as vertical asymptotes) is essential.

Furthermore, this finding supports the claim by Stylianides and Stylianides (2008) and Oehrtman (2008) that success in identifying domain and range improves when instruction connects symbolic reasoning with visual interpretations. The significance of self-efficacy in this case may stem from the confidence it provides learners to explore function behaviors symbolically and graphically—both of which are needed to accurately determine domain and range.

The non-significance of mathematics anxiety echoes patterns seen in other competencies where self-efficacy emerges as a more consistent predictor. This may imply that when students possess strong confidence in their mathematical skills, they can overcome anxiety or work through complex concepts despite emotional barriers. It also underscores that affective support alone may not be sufficient without corresponding development in students’ belief in their own mathematical reasoning.

In summary, the results for this competency affirm the predictive power of mathematics self-efficacy in mastering foundational concepts in rational functions, and they highlight the value of instructional strategies that strengthen both conceptual understanding and learner confidence.

**Table 3 - D**

**Regression Summary and Model Coefficients Predicting Mastery**

**in Finding the Domain and Range of a Rational Function**

**(n = 76)**

|  |  |  |
| --- | --- | --- |
| **Correlation Coefficient R** | **R2** | **Adjusted R2** |
| 0.319 | 0.101 | 0.077 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients (Predictor)** | **B(Estimate)** | **SE** | **t-value** | **P- value** |
| Intercept  Mathematics Anxiety  Mathematics Self-Efficacy | 0.6255  0.0521  0.5002 | 1.028  0.153  0.220 | 0.609  0.342  2.270 | 0.545  0.734  0.026\* |

\*\* - significant at

\* - significant at

**3.4.4 Regression Summary and Model Coefficients Predicting Mastery in Determining the Intercepts, Zeroes, and Asymptotes of Rational Function**

The regression results for Competency 4 show that mathematics anxiety and mathematics self-efficacy together explained 9.64% of the variance in students’ performance in identifying intercepts, zeroes, and asymptotes of rational functions (R = 0.310, R² = 0.0964, Adjusted R² = 0.071). While the overall model suggests a modest effect size, mathematics self-efficacy was found to be a significant predictor (B = 0.9232, p = 0.024), whereas mathematics anxiety was not (B = 0.1368, p = 0.624).

This result affirms prior research indicating that students’ belief in their mathematical competence plays a crucial role in their ability to interpret and analyze key graphical and algebraic features of rational functions. Carlson et al. (2010) advocated for conceptually rich instruction to build a deeper understanding of asymptotic behavior and intercepts, while Herman (2007) noted that procedural teaching often leads to student confusion—particularly in distinguishing between vertical asymptotes and x-intercepts.

The positive, significant coefficient for self-efficacy supports Bandura’s (1997) theory that students with stronger self-beliefs are more persistent and strategic in problem-solving, particularly in graph analysis tasks that involve multiple layers of abstraction (distinguishing between zeros of the numerator and points of discontinuity). Likewise, students with higher self-efficacy are more likely to engage meaningfully with function behavior, enhancing their ability to identify critical features like asymptotes, which are often misunderstood.

The non-significance of mathematics anxiety in this competency mirrors the trend observed in earlier competencies, suggesting that confidence may buffer the negative emotional effects of anxiety—or that anxiety plays a less dominant role when learners have internalized clear heuristics for interpreting function features.

Overall, these findings suggest that developing students' self-efficacy is more effective than anxiety reduction alone in improving performance in high-level graphical tasks involving intercepts and asymptotes. The results also validate the study's direction in creating an inquiry-based lesson exemplar that prioritizes conceptual understanding and student confidence-building.

Table 3 - E

**Regression Summary and Model Coefficients Predicting Mastery in Determining the Intercepts, Zeroes, and Asymptotes of Rational Function**

(n = 76)

|  |  |  |
| --- | --- | --- |
| **Correlation Coefficient R** | **R2** | **Adjusted R2** |
| 0.310 | 0.0964 | 0.071 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients (Predictor)** | **B(Estimate)** | **SE** | **t-value** | **P- value** |
| Intercept  Mathematics Anxiety  Mathematics Self-Efficacy | -0.0723  0.1368  0.9232 | 1.871  0.278  0.401 | -0.0386  0.4929  2.3026 | 0.969  0.624  0.024\* |

\*\* - significant at

\* - significant at

**3.5 Summary of Findings**

The overall level of mastery in rational functions and their graphs among the 76 Grade 11 students was found to be at the average level, with a mean score of 14.86 out of 30. Most students (57.89%) scored within the average range, while 19.74% were categorized as moving towards mastery. However, 22.37% exhibited low mastery, and no student reached a level of mastery higher than "moving towards mastery". The students performed best in determining the domain and range of rational functions, which was rated as moving towards mastery. Conversely, the lowest performance was observed in graphing rational functions and solving real-life problems involving rational expressions, both of which fell below the average mastery threshold.

The level of mathematics anxiety among students was moderate, with a mean rating of 3.06 on a 5-point scale. A significant number of students reported feeling moderately to very anxious when dealing with mathematics. On the other hand, the self-efficacy level was also average, with a mean of 2.90, indicating moderate confidence in their mathematical abilities. Only a small percentage of students rated themselves as highly confident, while over one-third reported low levels of self-efficacy.

Regression analysis revealed that mathematics self-efficacy significantly predicted students’ overall mastery of rational functions, accounting for a meaningful portion of the variance in scores. Specifically, self-efficacy significantly predicted performance in identifying the domain and range, as well as intercepts, zeroes, and asymptotes.

Mathematics anxiety, however, showed a significant negative influence only in solving rational equations and inequalities. This suggests that anxiety impairs performance in tasks that require multi-step procedures.

For competencies such as representing rational functions (via graphs, tables, and equations), graphing, and applying rational functions in real-world contexts, neither self-efficacy nor anxiety significantly predicted performance. These competencies may be influenced by other variables such as instructional quality, visual-spatial skills, or students’ prior exposure to graphing tools and modeling tasks.

In response to these findings, an inquiry-based lesson exemplar grounded in the 7Es model (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend) was developed. This exemplar is specifically designed to strengthen students' conceptual understanding, build confidence, and reduce anxiety in learning rational functions—especially in graphing and real-life problem-solving tasks, which were identified as the most challenging.

**4. CONCLUSION**

Mastery of rational functions and graphs among Grade 11 students is generally low to average, with significant difficulty observed in graphing and application-based competencies. This mirrors national and international trends, emphasizing the need for targeted instructional support in these areas.

Students exhibit moderate mathematics anxiety and average self-efficacy, which affect their performance differently across competencies. While self-efficacy consistently predicts mastery in conceptual and visual tasks (domain and range, asymptotes), anxiety significantly hinders performance in procedural tasks (solving rational equations).

The predictive power of self-efficacy is more consistent than that of anxiety, suggesting that confidence-building may be a more effective long-term intervention strategy. However, anxiety remains a key barrier in solving symbolic problems and must be addressed through supportive environments and process-oriented teaching.

The lack of significant predictors in competencies involving representation and real-world application implies that mastery in these areas depends on more than just affective factors. Instructional strategies must also emphasize modeling skills, representational conversions, and contextual understanding.

Consent

Since the respondents were minors, an informed consent was obtained from the students prior to the conduct of the study. Confidentiality of data and anonymity of the students in the writing of the study were ensured. .A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal."

**REFERENCES**

1. Ariyadi, W., van den Heuvel-Panhuizen, M., Doorman, M. Opportunity-to-Learn context-based tasks provided by mathematics textbooks. Educational Studies in Mathematics, 2015. 89(1) p41-65.
2. Ashcraft, M. H., & Krause, J. A. (2007). *Working memory, math performance, and math anxiety*. Psychonomic Bulletin & Review, 14(2), 243–248. <https://doi.org/10.3758/BF03194059>
3. Ashcraft, Mark H. (2002). Math Anxiety: Personal, Educational, and Cognitive Consequences. Sage Journal, Vol 11, Issue 5, 2002, doi.org/10.1111/1467-8721.00196. (Journals.Sagepub.com) Asian Journal of Education (2019). Mathematics Anxiety of Senior High School Students in Calculus. Asian Journal of Education, Vol. 07, 2019 ([www.researchgate.net](http://www.researchgate.net))
4. Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman.
5. Bialeck, Maya et al (2021). Mathematics for the Modern World. Center for Curriculum Redesign, 2021(<https://.www.curriculumredesign.org>)
6. Carlson, M., Jacobs, S., Coe, E., Larsen, S., & Hsu, E. (2010). Applying covariational reasoning while modeling dynamic events: A framework and a study. *Journal for Research in Mathematics Education, 41*(5), 432–463.  
   <https://doi.org/10.5951/jresematheduc.41.5.0432>
7. Department of Education. (2012, September 10). *DepEd Memorandum No. 160, s. 2012: Maximizing utilization of the National Achievement Test (NAT) results to raise the achievement levels in low‑performing schools* [Memorandum]. Department of Education. <https://www.deped.gov.ph/?p=dm160s2012>
8. Department of Education (DepEd). (2022). *Proposed Equitable Access to Mathematics and Science Education Act*.
9. Deliyianni, E., Gagatsis, A., Elia, I., & Panaoura, A. (2015). Fostering representational flexibility in the mathematical working space. *Bolema: Revista de Educação Matemática, 30*(54), 287–307. http://dx.doi.org/10.1590/1980-4415v30n54a14
10. Dreyfus, T., & Eisenberg, T. (1996). *Visual representations in algebra for elementary teachers: An experimental study*.
11. Duval, R. (2006). *A cognitive analysis of problems of comprehension in a learning of mathematics*. *Educational Studies in Mathematics, 61*(1‑2), 103–131. https://doi.org/10.1007/s10649-006-0400-z
12. Estrada, R. L., & Villanueva, J. C. (2022). Reducing math anxiety and enhancing self-efficacy through inquiry-based learning with visualization tools. *Philippine Journal of Education and Human Development, 14*(2), 45–59.
13. Gagatsis, A., Elia, I., Panaoura, A., Deliyianni, E., & Michael, E. (2016). The impact of students’ beliefs and attitudes on learning mathematics. In D. J. Clements, J. Sarama, & A. DiGisi (Eds.), *Research on Teaching and Learning Mathematics* (pp. 23–38). University of Nicosia Press.
14. GradePower Learning. (2018). *Why students struggle with math and how to help*. <https://www.gradepowerlearning.com/why-students-struggle-with-math/>
15. Herman, G. L. (2007). Students’ difficulties with the concept of function. *Proceedings of the 29th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, 1, 47–54.
16. Knuth, E. J. (2006). Learning about equivalence in middle school mathematics: Connecting to the equation. *Mathematics Teaching in the Middle School, 11*(6), 284–290.
17. Knuth, E. J., Stephens, A., McNeil, N. M., & Alibali, M. W. (2006). Does an understanding of the equal sign matter? Evidence from solving equations. *Journal for Research in Mathematics Education*, 37(1), 1–10. <https://doi.org/10.1007/BF02655899>
18. Lactuan, Imelda R. et al. General Mathematics. Malabon City, Philippines: Jimczyville Publications, 2016
19. Lactuan, Leo L. et al. Mastering College Algebra Through Drills. Malabon City, Philippines: Mutya Publishing House, Inc., 2014
20. Linchevski, L., & Livneh, D. (1999). Structure sense: The concept of algebraic structure as reflected in the performance of secondary school students. *Journal of Research in Mathematics Education*, 30(2), 124–158. Retrieved from ERIC.
21. OECD. (2023). *PISA 2022 Results (Volume I): The State of Learning Outcomes in Mathematics*. OECD Publishing. https://doi.org/10.1787/6d2fd1f9-en
22. Oehrtman, M. (2008). Collapsing dimensions, physical limitation, and other student metaphors for limit concepts. *Journal for Research in Mathematics Education, 39*(3), 296–327.
23. Phan, H. P. (2012). The development of English and mathematics self-efficacy: A latent growth curve analysis. *The Journal of Educational Research*, 105(3), 196–209. <https://doi.org/10.1080/00220671.2011.552132>
24. Programme for International Student Assessment (PISA). (2022). *PISA 2022 Results*. OECD Publishing. <https://www.oecd.org/pisa/>
25. Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2018). *Math anxiety, working memory, and math achievement in early elementary school*. Journal of Cognition and Development, 19(1), 1–21. https://doi.org/10.1080/15248372.2017.1421538
26. Santos, J. C. D., & Boyon, M. C. L. (2020). *Effect of inquiry‑based lessons on STEM students’ learning competencies on Limits and Continuity.* *PEOPLE: International Journal of Social Sciences, 5*(3), 782–792. <https://doi.org/10.20319/pijss.2020.53.782792>
27. Second Congressional Commission on Education (EDCOM II). (2023). *EDCOM II mandate and focus areas*. <https://edcom2.gov.ph/>
28. Skrzypiec, G., & Lai, M. Y. (2017). Social psychology meets school mathematics in PISA 2012: An application of the theory of planned behaviour in Australia. *Psychology*, 8(13), 2146–2173. <https://doi.org/10.4236/psych.2017.813137>
29. Stylianides, A. J., & Stylianides, G. J. (2008). Students’ understanding of inverse functions in pre-calculus and calculus. *International Journal of Mathematical Education in Science and Technology, 39*(4), 421–436.  
    <https://doi.org/10.1080/00207390801986812>
30. TIMSS (Trends in International Mathematics and Science Study). (2023). *TIMSS 2023 Mathematics and Science Results*. IEA. https://timssandpirls.bc.edu/
31. Ufer, S., & Heinze, A. (2021). Fostering students’ competencies in mathematical modeling: A design research study. ZDM – Mathematics Education, 53, 157–169. https://doi.org/10.1007/s11858-020-01211-4
32. UNESCO. (2012). *Mathematical literacy for all: Preparing learners for the 21st century*. UNESCO Publishing. <https://unesdoc.unesco.org/>
33. Usher, E. L., & Pajares, F. (2017). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*(1), 89–101.
34. Wang, L., & Yu, Z. (2023). Gender-moderated effects of academic self-concept on achievement, motivation, performance, and self-efficacy: A systematic review. *Frontiers in Psychology, 14*, 1136141. <https://doi.org/10.3389/fpsyg.2023.1136141>
35. Wijaya, A., van den Heuvel-Panhuizen, M., & Doorman, L. M. (2015). Opportunity-to-learn context-based tasks provided by mathematics textbooks. *Educational Studies in Mathematics, 89*(1), 41–65. <https://doi.org/10.1007/s10649-015-9595-1>
36. Yunianto, M., Bautista, A., & Prahmana, R. C. I. (2023). Using GeoGebra applets to support students’ graphing skills and conceptual understanding of functions. *Journal on Mathematics Education, 14*(2), 233–248. https://doi.org/10.22342/jme.v14i2.pp233-248
37. Zakariya, Yusuf F. (2022). Improving Students’ Math Self- Efficacy: A Systemic Review of Intervention Studies. (www.ncbi.nim.nih.gov)
38. Ziatdinov, R., & Valles, J. R., Jr. (2022). *Synthesis of modeling, visualization, and programming in GeoGebra as an effective approach for teaching and learning STEM topics.* arXiv. <https://arxiv.org/abs/2202.01415>