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Productive disposition in mathematical problem solving of STEM students and its correlation to their mathematical achievement

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Abstract

The Philippines continues to struggle with low performance in Mathematics, as indicated by the latest findings from the 2022 Program for International Student Assessment (PISA). Despite efforts to implement reforms following disappointing results in 2018, less than a quarter of Filipino students reached the minimum proficiency level in Mathematics. The country's scores remain below the global average, with only 16 percent of students achieving basic proficiency in math. Despite ongoing reforms, the Philippines faces a significant challenge in improving student performance on a global scale. As a result, the main objective of this study is to improve the academic achievement of the students, particularly in Mathematics. The researcher used an explanatory sequential design, combining quantitative and qualitative methods to achieve comprehensive results. This approach involves analyzing quantitative data first, followed by qualitative insights to deepen understanding of the problem. The quantitative analysis revealed a non-significant correlation between productive disposition and mathematical achievement, challenging the presumption of a direct relationship between these variables. This suggests that factors beyond productive disposition alone influence academic performance in mathematics. To explore this further, qualitative analysis was conducted, identifying five key factors contributing to positive productive disposition: resilience, empowerment, relevance, adaptability, and ingenuity. These attributes collectively enhance students' success in learning mathematics. Additionally, participants perceived a significant impact of positive productive disposition on various aspects of mathematical learning, including enjoyment, persistence, performance, confidence, and relevance. This highlights the importance of fostering a positive disposition alongside developing knowledge and skills for substantial achievement in mathematics.

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Introduction

Many students find their study of Mathematics more challenging than other subjects. Research shows that the majority of students view Mathematics as their least favorite subject. Mahanta (2019) asserts that hard work and perseverance are essential for learning and understanding Mathematics, as it is not something that can be mastered easily or immediately. Despite its difficulty, Mathematics remains a critical component of curricula worldwide, valued not only in education but also in numerous areas of life and various careers.

The Philippines has consistently ranked poorly in international mathematics assessments. In the 2018 PISA (Programme for International Student Assessment), Filipino students had the lowest math scores among participating countries, with over half showing very low competency. The 2019 TIMSS also ranked the Philippines last among 58 countries. Despite educational reforms and the introduction of the K to 12 curriculum to improve problem-solving skills, the 2022 PISA showed minimal improvement, with only 16 percent of students reaching basic proficiency, leaving the country among the lowest of 81 participants.

Awofala (2020) suggests that low student performance in mathematics stems from teaching fundamentals separately from conceptual knowledge. The National Research Council (2001) outlines five strands of mathematical proficiency, with productive disposition—students' attitudes toward math—often overlooked. Abidin (2021) stresses the importance of developing productive disposition early, as it significantly influences students' performance.

As a result, the main objective of this study is to improve students' academic achievement in Mathematics by examining the relationship between productive disposition and mathematical performance. The unique contribution of this study lies in addressing the gap in research on the role of productive disposition in mathematical achievement, particularly among STEM students. Unlike prior studies that primarily focus on cognitive aspects, this research emphasizes the significance of attitudes and emotions in Mathematics learning. Additionally, the study seeks to explore how productive disposition in mathematical problem-solving influences achievement and to provide new insights into strategies that could enhance students' mathematical proficiency, potentially informing more effective educational practices and interventions. Specifically, the study sought answers to the following: (1) Quantitative analysis include: (1.1) How may the level of STEM students' productive disposition in mathematical problem solving be described in terms of: a) affect, b) beliefs; c) goals, d) identify; e) mathematical integrity, f) motivation, g) risk-taking; and h) self-efficacy? (1.2) How may the mathematical achievement of STEM students be described in terms of the result of the achievement examination? and (1.3) How significant is the relationship between STEM students' productive disposition and achievement in Mathematics?

(2) Qualitative analysis includes: (2.1) Central question, How may the key informants describe their perception of the association between their positive productive disposition and mathematics performance? And (2.2) Probing questions, (a) What is the importance of having a positive productive disposition?, and b) Do you think your positive productive disposition has something to do with your mathematical performance?

(3) Implication of the study, What educational program may be drawn from the findings of the study that will lead the researcher to propose a comprehensive strategy aimed at improving the students' mathematical achievement through productive disposition?

Literature Review

Mathematics is a fundamental subject that underpins the fields of science, technology, and engineering. Consequently, achieving a high level of proficiency in mathematics is essential for students to navigate future challenges effectively. To understand the factors that contribute to students' mathematical achievement, this literature review draws upon Bandura's self-efficacy theory (Clemente et al, 2024), which asserts that students' belief in their ability to perform specific tasks significantly impacts their success. Additionally, McLeod's theory (Ocal, 2021) on attitudes and beliefs in mathematics education provides a framework for examining how affective factors, such as productive disposition, influence students' attitudes and performance in mathematics. This theoretical perspective will guide the exploration of positive dispositions toward mathematics and contribute to enhancing students' overall achievement in the subject.

Productive Disposition

Productive disposition is defined as "the propensity to view Mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own

efficacy" (NRC, 2001, p. 131). Hlaing and Thein (2020) describe it as students' inclination and feelings towards Mathematics, emphasizing that it encourages viewing the subject not as mere memorization but as a system of interconnected concepts that can be mastered through perseverance and eagerness to learn (Awofala, 2020). In mathematical problem-solving, productive disposition encompasses students' ability to develop, evaluate, and operate their mathematical thinking processes (Awofala, 2017). This aspect of mathematical proficiency highlights the importance of nurturing students' capabilities not only to solve problems but also to effectively communicate their solutions in real life. In this study, productive disposition is defined as students' positive inclination towards Mathematics, reflecting their view of it as useful, logical, and beneficial.

Mathematical Problem-Solving

Problem solving is essential in mathematics education, involving high-level cognitive processes and strategies like Polya's four-step approach (Liljedahl & Cai, 2021; Simamora, Saragih, & Hasratuddin, 2018). Common strategies include drawing and arithmetic operations, with problem-solving methods often outperforming scientific approaches in enhancing skills (Zukaldi, 2021; Tambunan, 2019). Factors like mathematics anxiety and difficulties with word problems can hinder students' abilities, but approaches like Realistic Mathematics Education have shown positive impacts on achievement (Rusyda et al., 2021; Verschaffel et al., 2020).

Mathematical Achievement

Mathematical achievement is considered one of the learning abilities which reflects the result of what students learn in mathematics, additionally, it serves as a gauge of how well-effective and well-efficient a certain teaching technique or strategy is at enhancing and advancing the students' understanding of Mathematics (Jawad & Majeed, 2021). Maamin, (2020) also emphasized that mathematical achievement is vital for students' ongoing education and future employment opportunities. Strong mathematical skills indicate a country's proficiency in science, technology, and engineering, as mathematics serves as a foundational element in these fields. Furthermore, in today's globalized world, the ability to effectively apply mathematical knowledge in practical situations has become increasingly important for maintaining competitiveness.

Based on the extensive review of the literature of this study, it is essential to identify the prevalent characteristics that have a significant impact on students' performance, particularly in Mathematics. The gap in understanding the relationship between productive disposition and mathematical achievement among STEM students highlights the need for further investigation into the specific factors that contribute to this connection to inform effective practices and enhance student performance in Mathematics. Despite the different recommendations from the previous studies, this matter is still unsolved and suggestions are still limited. In other words, this issue needs more attention internationally and locally so that we can help the students in becoming globally competitive.

Methodology

The researcher employed an explanatory sequential design, first analyzing quantitative data before integrating qualitative insights for a comprehensive understanding. Participants for interviews were selected based on initial quantitative findings to explore research issues holistically. Correlational research linked participants' problem-solving disposition to their mathematical achievement, followed by in-depth interviews that complemented the quantitative results. Thematic analysis further enriched the understanding gained from the quantitative data.

Participants

The study involved Grade 12 STEM students from a private institution in City of Malolos, Bulacan. This school was chosen for its accessibility, student population, and the researcher's familiarity with the institution, aiming to explore the relationship between productive disposition in mathematical problem solving and mathematical achievement among STEM students.

Participant 1

Quantitative Phase: The study involved all 1,049 Grade 12 STEM students, and the researcher employed universal sampling to ensure the utmost accuracy of the data. This approach minimized sampling bias and enhanced the reliability and validity of the findings, aiming to provide meaningful insights into the relationship between productive disposition in mathematical problem solving and mathematical achievement among STEM students.

Participant 2

Qualitative Phase: The study used purposive sampling to select three participants from each of 20 sections, following Creswell's guidelines, which emphasize smaller and focused samples for in-depth exploration. This method allowed for the inclusion of individuals with valuable insights and relevant experiences. Criteria for selection included involvement in the subject matter, willingness to participate, and availability. Semi-structured interviews were conducted to gather detailed perspectives, with confidentiality and anonymity assured. This approach aimed to capture a comprehensive range of viewpoints to enrich the understanding of the study's focus.

Data Collection

Data gathering was done in three (3) phases: (1) Pilot Testing Procedure, (2) Mathematical Achievement Test and Mathematical Productive Disposition Assessment, and (3) Interview.

Pilot Testing Procedure: The pilot testing of the 40-item Mathematical Achievement Test was validated by three experts in mathematics education to ensure content validity. A representative sample of Grade 12 STEM students was selected, and the test was administered with approval from the school's Principal.

Mathematical Achievement Test and Mathematical Productive Disposition Assessment: Data were collected using a Likert Scale survey and achievement tests to measure STEM students' mathematical achievement and productive disposition. Approval was obtained from the Research Ethics Committee, the Principal, and Grade 12 advisers. Surveys were distributed to STEM classes, and results were analyzed for productive disposition. Achievement test results were reviewed for proficiency, and the data were then evaluated by a statistician.

Interview Procedure: Interviews provided valuable insights into participants' experiences. Approval was obtained from the Principal and advisers, and students were informed about their participation. A pre-session briefing established rapport and clarified expectations. Participants were given study details and signed consent forms to ensure confidentiality. Afterward, interviews were transcribed and analyzed manually for patterns and themes, ensuring coding consistency for reliable findings.

Data Analysis

Quantitative Phase: The study used a 24-item questionnaire by Jill M. Siegfried (2012) to measure productive disposition, rated on a 4-point Likert scale across eight factors: affect, beliefs, goals, identity, mathematical integrity, motivation, risk-taking, and self-efficacy. Reliability, confirmed by Cronbach's alpha (0.74 to 0.88), ensured the scale's validity. A 40-item mathematical achievement test was also developed and revised with expert input for reliability, achieving a Kuder-Richardson (KR-20) coefficient of 0.802. Data from the surveys were analyzed using SPSS Version 21, employing frequency counts, means, and Spearman's rho correlation to compare productive disposition with mathematical achievement at a significance level of 0.05.

Qualitative Phase: Data were collected through interviews and a Focused Group Discussion (FGD) to capture participants' insights. The interviews were transcribed, organized, and analyzed using thematic analysis, identifying recurring themes and patterns through systematic coding. These themes were synthesized into an eidetic model, visually representing their essence and interrelationships, thus providing a structured framework for understanding the phenomena. The researcher ensured rigor by adhering to established methodologies and accurately reflecting participants' perspectives throughout the analysis.

Results and Discussion

Productive Disposition:

As shown in Table 1, the mean scores of Grade 12 students across eight factors of productive disposition reveal a generally positive attitude towards mathematics, with an overall average score of 2.89, indicating an "Agree" disposition. Notably, Mathematical Integrity (3.25) received the highest score, followed by Identity (3.08), Goals (3.05), and Motivation (3.06), suggesting that students prioritize integrity in their mathematical work, identify with the subject, set related goals, and are motivated to engage with mathematical concepts.

Table 1 Eight Factors of Production Disposition

Domains	*SD*	*M*	Interpretation
1. Affect	0.87331	2.64	Agree
2. Beliefs	0.80479	2.66	Agree
3. Identity	0.70036	3.08	Agree
4. Mathematical Integrity	0.70791	3.25	Agree
5. Risk-taking	0.77874	2.88	Agree
6. Goal	0.76827	3.05	Agree
7. Motivation	0.76709	3.06	Agree
8. Self-efficacy	0.86874	2.46	Agree
Overall Average		2.89	Agree

However, the lower score in Self-efficacy (2.46) indicates that students may have reservations about their ability to perform well in mathematics, highlighting the need for interventions to boost self-efficacy. Other factors such as Affect (2.64), Beliefs (2.66), and Risk-taking (2.88) scored around the overall average, indicating moderate agreement and potential areas for improvement. Lastly, the relatively moderate standard deviations suggest that while there is some diversity in students' productive dispositions toward mathematics, the responses are not extremely dispersed. This consistency, particularly in factors like Identity and Mathematical Integrity, reflects shared attitudes, but factors with higher variability like Affect and Self-efficacy indicate areas where students' experiences and perceptions differ more widely. These findings align with Awofala (2017), who identified mathematical integrity as the strongest predictor of performance, followed by identity, risk-taking, goals, and beliefs, with self-efficacy being the least significant. In contrast, Awofala (2020) found that six out of eight predictors, including self-efficacy, identity, mathematical integrity, goals, beliefs, and risk-taking, significantly contributed to mathematical achievement, while affect and motivation did not. These insights highlight the need to address self-efficacy and other moderate factors to enhance Grade 12 students' mathematical disposition, performance, and engagement.

Mathematical Achievement:

Table 2 shows the mathematical achievement of Grade 12 STEM students in Calculus, with percentages ranging from 37.23 to 56.00 percent. While most groups fall under the "Progressing" category, variations among STEM groups highlight the need for targeted support and intervention. Strategies to improve students' math abilities include focusing on weaknesses, empowering self-assessment, enhancing teaching methods, and providing timely feedback. Overall, while students demonstrate a basic understanding of Calculus, tailored strategies are necessary to address varying learning needs and provide a supportive learning environment.

Correlation: Productive Disposition in Mathematical Problem-Solving and Mathematical Achievement

Table 3 investigates the correlation between productive disposition and mathematical achievement, utilizing Spearman's rank correlation coefficient due to non-normal distributions in both variables. The correlation coefficient obtained is -0.046, signifying a non-significant relationship between productive disposition and mathematical achievement. The significance level of 0.150 (>0.05) supports the idea that there is no correlation between these variables. However, other research suggests that productive disposition has a direct influence on academic performance (Ramdani et al., 2021). This relationship has been studied in various educational contexts, such as its correlation with students' mathematical achievement in Nigeria (Awofala, 2020).

The lack of a significant correlation between productive disposition and mathematical achievement, as indicated by the quantitative analysis, may suggest that other factors beyond disposition alone contribute to academic performance in mathematics. This finding is significant as it challenges conventional assumptions about the direct connection between positive productive disposition and performance in mathematics. The qualitative analysis aims to explore the underlying factors influencing productive disposition and its impact on mathematical achievement by investigating students' subjective experiences and perceptions, addressing discrepancies between quantitative findings and prevailing beliefs.

Table 2 The Mathematical Achievement of STEM Students

Grade & Section	Percentage	Interpretation
12 – STEM 1	47.71	Progressing
12 – STEM 2	50.61	Progressing
12 – STEM 3	52.31	Progressing
12 – STEM 4	55.17	Progressing
12 – STEM 5	56.00	Progressing
12 – STEM 6	53.13	Progressing
12 – STEM 7	50.56	Progressing
12 – STEM 8	42.15	Progressing
12 – STEM 9	48.91	Progressing
12 – STEM 10	48.16	Progressing
12 – STEM 11	45.40	Progressing
12 – STEM 12	49.27	Progressing
12 – STEM 13	48.03	Progressing
12 – STEM 14	38.44	Progressing
12 – STEM 15	37.23	Progressing
12 – STEM 16	45.23	Progressing
12 – STEM 17	46.53	Progressing
12 – STEM 18	42.99	Progressing
12 – STEM 19	45.47	Progressing
12 – STEM 20	44.29	Progressing
Overall Percentage	47.38	Progressing

Table 3 Correlation Between the Productive Disposition in Mathematical Problem Solving & Mathematical Achievement

Variables	Correlation Coefficient	*p* (2-tailed)
Productive Disposition Mathematical Achievement	-0.046	0.150

Perception of Positive Productive Disposition and Mathematical Performance:

Productive disposition refers to an individual's inclination to perceive value in a particular domain and to engage in purposeful and effective actions within that domain. In the context of education, productive disposition is considered a crucial component of proficiency in various subjects, including mathematics (Lynch-Arroyo et al., 2023).

This section examines the significance of having positive productive disposition and its relationship with students' mathematical performance and achievement.

Table 4 presents a clear picture of how a positive productive disposition significantly impacts the learning experience of Grade 12 STEM students. Based on the thematic analysis of the interview data, it unveils five (5) key factors that contribute to the positive productive disposition of Grade 12 STEM students towards mathematics. The analysis emphasizes subthemes such as resilience, empowerment, relevance, adaptability, and ingenuity, all of which wield significant influence in shaping students' attitudes and behaviors towards learning mathematics; Resilience is essential for overcoming mathematical challenges, involving perseverance through difficulties and learning from mistakes while staying motivated. Empowerment boosts students' success and self-esteem by fostering confidence and motivation in their mathematical abilities. Relevance enhances learning by linking mathematical concepts to real-life scenarios, making the subject more engaging and purposeful. Adaptability provides students with a growth mindset and the flexibility to approach complex problems confidently and creatively. Ingenuity drives excellence in STEM by encouraging creative thinking and innovative solutions, allowing students to thrive in environments that value such skills. Based on the study conducted by Fadillah and Wahyudin (2020), students with positive productive dispositions were able to effectively apply problem-solving strategies, while those with moderate dispositions struggled, and students with low dispositions had difficulty understanding the problems. These findings support the results of this study, highlighting the critical role of a positive productive disposition in mathematical achievement. Having a strong productive disposition not only enhances problem-solving abilities but also fosters a deeper understanding of mathematical concepts, ultimately leading to improved academic performance, particularly in Mathematics. In conclusion, maintaining a positive productive disposition is essential for success in the field of Mathematics. Educators can unlock a powerful tool for academic success, particularly in Mathematics. By cultivating resilience, empowerment, recognizing relevance, fostering adaptability, and encouraging ingenuity, students can enhance their understanding of different mathematical concepts, improve their problem-solving skills, and attain educational excellence. Furthermore, educators can create a learning environment that fosters engagement, promotes understanding, and equips students with the skills and confidence needed to excel in STEM fields. However, it is also acknowledged that a positive disposition should be coupled with actual knowledge and skills to achieve substantial success in mathematical achievement.

Table 4 Importance of Having a Positive Productive Disposition

Meaning Units	Condensed Meaning Units	Subthemes	Themes
2, 3, 8, 9, 14, 20, 24, 28, 35, 41, 51, 55	A positive outlook on mathematics helps students view it as less daunting and more approachable, fostering optimism towards learning and problem-solving.	Resilience: Overcoming Challenges with Persistence and Growth	Factors That Contribute to Positive Productive Disposition of Grade 12 STEM Students
12, 17, 25, 32, 33, 40, 42, 43, 46, 58	A positive disposition encourages students to persist through challenges, seek help when needed, and explore alternative learning strategies.		
3, 12, 17, 25, 32, 33, 42, 43, 46, 58	A positive productive disposition fosters resilience by encouraging students to persevere through difficulties, overcome setbacks, and maintain a proactive attitude towards learning.		
1, 4, 10, 22, 26, 37, 54, 57, 59, 60	Having a positive productive disposition serves as a motivator for students to engage actively in learning mathematics.	Empowerment: Confidence and Motivation in Solving Mathematical Problem	

Table 4 Continued

Meaning Units	Condensed Meaning Units	Subthemes	Themes
9, 15, 19, 23, 27, 31, 38, 49	This productive disposition contributes significantly to academic performance by instilling confidence, improving problem-solving skills, and enhancing understanding.		
4, 10, 18, 24, 28, 35, 41, 48, 51, 59	By promoting a growth mindset and a willingness to learn from mistakes, a positive disposition facilitates continuous improvement and mastery of mathematical concepts.		
1, 9, 22, 26, 37, 54, 55, 57, 60	It instills confidence in students' abilities to tackle mathematical challenges, leading to greater self-assurance and belief in their capacity to succeed.		
5, 6, 11, 16, 18, 30, 36, 44, 48, 52, 56	A positive attitude towards mathematics extends beyond academics, facilitating its application in real-life scenarios and promoting its relevance in everyday situations.	Relevance: Seeing Mathematics as Practical and Meaningful in Real-life Context	
3, 15, 19, 23, 27, 31, 37, 49	It leads to more effective learning outcomes by fostering resilience, adaptability, and a proactive approach to problem-solving.	Adaptability: Flexible Thinking for Diverse Problem-Solving	
7, 13, 21, 29, 34, 39, 45, 47, 50, 53	It enhances problem-solving abilities, critical thinking, and logical reasoning, thereby enriching students' overall learning experience.	Ingenuity: Creativity and Innovation in Mathematical Exploration	

Table 5 shows that a positive disposition towards mathematics has a significant impact on various aspects of learning and performing mathematics. Key themes that include enjoyment, persistence, performance, confidence, and relevance are being explored; Enjoyment in learning mathematics makes the experience more engaging and less stressful, promoting enthusiasm for the subject. Persistence helps students remain motivated and view challenges as growth opportunities, driven by a positive productive disposition. This positive disposition enhances performance by fostering interest, confidence, and a constructive mindset. Confidence is strengthened through a positive disposition, enabling students to tackle complex problems and persist despite uncertainties. Moreover, a productive disposition broadens students' perspectives on mathematics, encouraging them to link mathematical concepts with real-life applications, thereby increasing the relevance of the subject.

Similarly, Kusmaryono et.al. (2019) revealed a strong relationship between mathematical disposition and mathematical achievement. The result of the study showed that using mathematical knowledge in non-routine problems through reasoning, communication, and connections provides self-confidence and productive dispositions, which in turn strengthens mathematical power. Both studies emphasize the importance of a productive disposition in enhancing student engagement and problem-solving abilities. While the current study highlights the broad impact of a positive disposition on various learning aspects, Kusmaryono also highlights the role of disposition in building mathematical achievement and calls for teachers to monitor and sustain this disposition. The findings from both studies reinforce the need for fostering productive dispositions to improve mathematical learning and performance. In summary, this analysis provides strong evidence that cultivating a positive disposition towards mathematics can significantly enhance the learning experience and lead to better mathematical achievement. These themes collectively demonstrate the advantages and benefits of maintaining a positive productive disposition in Mathematics among STEM students. The researcher analyzed the subthemes of enjoyment, persistence, performance, confidence, and relevance to identify the overarching theme of expected outcomes on having a positive productive disposition. This thematic analysis highlights the transformative power of positive productive disposition in mathematics, shaping not only students' attitudes and behaviors but also their academic success and real-world problem-solving abilities.

Table 5 Relationship of Positive Production Disposition and Mathematical Performance

Meaning Units	Condensed Meaning Units	Subthemes	Themes
2, 26, 36, 40, 51, 59	Positive disposition contributes to finding math more enjoyable and less stressful, making learning math a more positive experience.	Enjoyment: Enhancing the Enthusiasm of Learning Mathematics	Expected Outcomes on Having Positive Productive Disposition
9, 13, 21, 29, 43, 47, 56	Positive productive disposition creates a more enjoyable and fun approach to learning math, enhancing the overall learning experience.		
3, 27, 31, 37, 57	A positive disposition helps in persistently finding answers and staying motivated in answering math equations.	Persistence: Fostering Resilient in Problem-Solving	
1, 34, 41, 52, 53, 58	Positive disposition enhances motivation, making it easier to tackle complex problems and persist in learning math.		
4, 8, 14, 17, 18, 19, 20, 22, 23, 24, 25, 30, 33, 35, 38, 42, 44, 45, 46, 48, 49, 50, 54, 55	Positive disposition leads to better performance in math by fostering interest, confidence, and a positive outlook.	Performance: Improving Mathematical Achievement	
6, 11, 28, 32, 39	Positive disposition fosters interest and turns weaknesses into strengths, encouraging the challenge of solving more math problems and enhancing problem-solving abilities.		
7, 10, 16, 31, 41, 56, 58, 59	Positive disposition changes mindset, making it easier to analyze problems, find solutions, and view math as worthwhile and enjoyable.		
5, 12, 47, 60	Positive disposition boosts self-confidence in approaching mathematical tasks and contributes to better mathematical performance.	Confidence: Boosting Self-Confidence in Mathematics	
27, 35, 40, 49, 52	Positive disposition helps understand how math is applicable in everyday life, providing a broader view of its importance and enhancing mathematical skills.	Relevance: Recognizing Math's Real-Life Importance	
9, 32	Positive disposition enables realization of the essence and importance of math, leading to motivation, progress, and a deeper understanding of mathematical concepts.		

From Qualitative Analysis to Eidetic Model Approach

Based on the interview results, the Eidetic Model (in Figure 1) provides a comprehensive framework for promoting positive productive disposition in students, highlighting five key contributing factors: Resilience, Empowerment, Relevance, Adaptability, and Ingenuity. These factors interact synergistically, shaping students' experiences in Mathematics and fostering holistic development and success. The model also illustrates how these elements are interconnected, represented by a knot that symbolizes the strong relationship between the factors and the expected outcomes. These outcomes—Enjoyment, Persistence, Performance, Confidence, and Relevance—are directly influenced by the positive productive disposition cultivated through the interaction of these key factors.

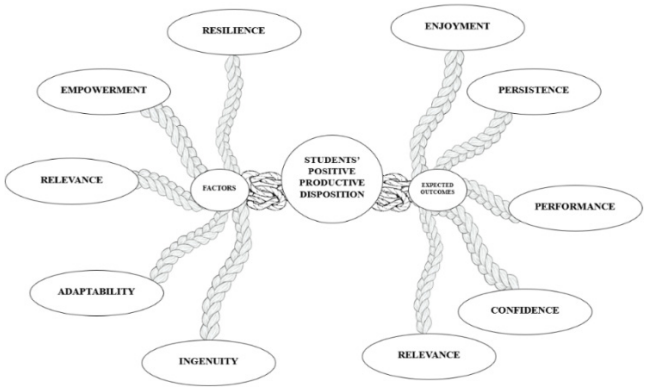

Figure 1 Interwoven Success: Essential Mathematical Knots for Cultivating Productivity and Achieving Positive Outcomes

In summary, the Eidetic Model is a useful framework for understanding the factors that contribute to a positive productive disposition in students. The model can be used by educators to develop instructional strategies that promote these factors and help students achieve positive outcomes in mathematics.

Educational Program Drawn from The Findings of the Study

This study identifies five key components of a positive productive disposition—Resilience, Empowerment, Relevance, Adaptability, and Ingenuity—and outlines how these factors contribute to the development of students' mathematical success. As shown in Figure 2, various activities and techniques can be employed to enhance these factors, such as challenge-based learning, workshops, real-world applications, and adaptive learning strategies. These methods are strategically aligned with each factor to maximize the desired outcomes. Moreover, Figure 2 visually represents how these techniques, when integrated into educational programs, can lead to the five key outcomes: Enjoyment, Persistence, Performance, Confidence, and Relevance, thereby enhancing students' overall academic achievement. These programs are:

1. Resilience Enhancement Program: Develops perseverance and motivation through workshops, challenge-based learning, and mentorship, helping students manage stress and learn from setbacks to boost persistence, confidence, and performance in mathematics.

2. Empowerment Initiative Program: Increases student confidence and motivation via leadership opportunities, self-efficacy workshops, and a feedback system to celebrate achievements, enhancing confidence, persistence, and enjoyment of mathematics.

3. Relevance Integration Program: Connects mathematical concepts to real-life applications through practical projects and career exploration, improving students' appreciation, enjoyment, and performance by demonstrating the real-world value of mathematics.

4. Adaptability Development Program: Promotes a growth mindset and flexible problem-solving with adaptive learning modules and varied strategies, aiming to improve flexibility, confidence, and engagement with complex mathematical tasks.

5. Ingenuity Promotion Program: Encourages creative problem-solving through innovation challenges and project-based learning, enhancing ingenuity, performance, and confidence by fostering novel applications of mathematical concepts.

Integrating these components into the curriculum not only addresses identified areas for improvement but also empowers students to succeed academically and personally. This approach reflects a commitment to provide a culture of mathematical excellence and equip students with essential skills for future success in their academic and professional endeavors.

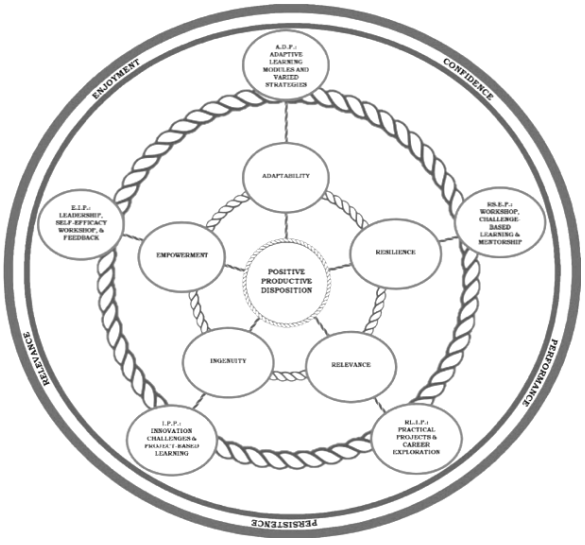

Figure 2 Positive Productive Disposition: Programs for Building Resilience, Empowerment, Relevance, Adaptability, and Ingenuity to Boost Student Success

Conclusion and Recommendations

Based on the findings of the study, the following conclusions were drawn:

1. The study emphasizes the importance of addressing Self-efficacy and fostering a positive affective domain to enhance students' overall mathematical disposition, guiding interventions for administrators and educators.

2. The data highlight Grade 12 students' overall positive progress in Calculus, yet the variability among STEM groups underscores the need for tailored strategies to create an inclusive and supportive learning environment, ensuring all students receive necessary support for mathematical achievement.

3. The results reveal a lack of significant correlation between productive disposition and mathematical achievement, prompting further exploration into the complexity of productive disposition to gain valuable insights for educators and researchers.

4. Interview findings identify resilience, empowerment, relevance, adaptability, and ingenuity as key factors contributing to Grade 12 students' productive disposition, enhancing motivation, problem-solving, and creativity crucial for academic success.

5. Cultivating a positive disposition towards mathematics, characterized by enjoyment, persistence, performance, confidence, and relevance, can significantly enhance the learning experience and lead to better mathematical achievement.

6. Educational programs that cultivate a productive disposition in students, addressing all five key components identified in the study, can lead to improved mathematical achievement, empowering students to succeed both academically and personally.

Based on the conclusion of the study, the researcher has suggested some recommendations for addressing the challenges identified:

1. Teachers should identify individual students' strengths and weaknesses in Calculus and tailor interventions such as additional practice sessions, differentiated instruction, or specialized tutoring to address their specific needs.

2. Integrating real-life applications into mathematics activities can provide meaningful learning experiences and deepen students' understanding of mathematical concepts, fostering a productive disposition towards the subject.

3. Mathematics teachers can enhance engagement by incorporating games, puzzles, and activities into lessons, connecting mathematical concepts to students' hobbies and interests to demonstrate real-world applications.

4. Administrators can support teachers by providing orientation, training, and seminars on productive disposition in mathematics, enabling teachers to integrate and contextualize it into their lessons and activities effectively.

5. Future research could explore additional factors influencing the relationship between productive disposition and mathematical achievement, while also encouraging continuous improvement of research methodology.

Conflict of Interest

The author declares that there is no conflict of interest.

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