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Congruence of Generation Z Students' Mathematics Self-Efficacy and Anxiety and Teacher's Teaching Strategy

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Abstract

This study investigates the relationships between teaching strategies employed by senior high school mathematics teachers and both mathematics anxiety and self-efficacy in Generation Z students. While students reported teachers utilizing a variety of strategies (lecture/discussion, demonstration, problem-solving, project, inquiry approach, cooperative learning, and audio-visual), the study aimed to understand the impact on these psychological factors. Results revealed no statistically significant relationships between any specific teaching strategies and mathematics anxiety. However, the analysis of self-efficacy presented a more nuanced picture. Statistically significant positive correlations emerged between lecture/discussion, demonstration, and project-based learning with mathematics self-efficacy. These findings suggest that incorporating these strategies, alongside effective implementation practices, may be beneficial for fostering student confidence in their mathematical abilities. Future research is recommended to explore the complex interplay between instructional practices, student self-efficacy, and mathematics anxiety in Gen Z students, employing larger and more diverse samples alongside robust measures. Investigating mediating variables, such as student engagement and classroom climate, could shed light on the mechanisms through which instructional practices influence student self-efficacy and potentially mitigate math anxiety. By continuing to explore these relationships, educators can be better equipped to create classrooms where all students can develop positive attitudes and strong foundational skills in mathematics.

Keywords: Generation Z, mathematics anxiety and self-efficacy, teaching strategies

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INTRODUCTION

Mathematics subject is generally noted by students as a difficult one although not true to all. As educator of mathematics, it is part of the goal to encourage every learner to develop their skills in mathematics in order to attain high achievement of the subject. But base on the experiences, almost all students hate mathematics. Bantiding (2019) also agreed that since mathematics is perhaps the most abstract among academic subjects, many students dislike and avoid it.

The Mathematics Framework for Philippine Basic Education (2011) established non-negotiable 7 principles and one of which is that students' attitudes and beliefs about mathematics affect their learning. Bahr (2012) found out that success rates for students enrolled in developmental math courses are low. Studies also showed that two issues that may play a role in a lack of success in math courses are math self-efficacy and math anxiety (Phan, 2012; Zakaria, Zain, Ahmad, & Erlina, 2012). Rossnan (2006), reported that even the best mathematicians are not exempt from bouts of math anxiety. Because math anxiety demonstrates a stubborn impediment in the development of mastery and performance in tasks that impact upon students' academic achievement, it

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has become an important research topic for mathematics educators and educational psychologists in the past 25 years.

According to Wonu (2014), teachers' application of inappropriate teaching strategies and methods in the schools is a key problem in the students' realization of mathematics skills. This is because application of inappropriate teaching strategy leads to the adoption of inappropriate teaching method and this consequently leads to the use of inappropriate teaching technique. With this, the researcher is very much eager to determine mathematics self-efficacy and mathematics anxiety level of the generation Z learners as influence by the mathematics teacher's method of teaching since teachers generally have the control over the classroom community and the environment created in the classroom. In addition, Furner and Berman (2003) explained that one size fits all instruction, rote instruction, and assigning mathematics homework as punishment all contribute to creating mathematics anxiety.

In this study, a student-based assessment of the teaching strategies of the senior high school mathematics teachers and the generation Z students' self-efficacy and anxiety is in focused. Specifically, this research is conducted to determine if the generation Z students' attitude towards mathematics is still dependent to the teacher's teaching strategy as our learners already engage in the different modes of learning resources especially in online references. The results of this study served as bases for professional development for mathematics teachers believing that quality teaching leads to quality learning.

RESEARCH METHOD

This research study followed the descriptive-correlational type of research. This type of research design tries to explain the relationship between two or more variables without making any claims about cause and effect. It includes collecting and analyzing data on at least two variables to see if there is a link between them (Bhat, 2023). The researcher-modified questionnaires were utilized in determining the levels of mathematics self-efficacy and mathematics anxiety of the students, and the mathematics teachers teaching strategies. The purpose of using this method was to determine the teaching strategies of the mathematics teachers and the relation of these strategies to the students' self-efficacy and anxiety towards mathematics. The respondents of the study were the fifty (50) students enrolled in mathematics subjects in senior high schools in the four districts of Mabinay, Negros Oriental, Philippines of the school year 2019-2020 through random sampling procedure. A permit to conduct was sought from the Department of Education – Division of Negros Oriental. When the permit was obtained, letters were sent to the four public schools district supervisors for the approval of the conduct of the study and to the respective school principals of the senior high schools in Mabinay, Negros Oriental, Philippines. The researcher provided each student a researcher-modified mathematics self-efficacy and mathematics anxiety questionnaire. And a standardized questionnaire was used to determine the teaching strategies of the senior high mathematics teachers which were answered by the students. Then, the data gathered was tabulated and statistically analyzed through mean, standard deviation, z-test, and Pearson r.

RESULTS AND DISCUSSION

Table 1. Generation Z Students' Mathematics Anxiety Levels

INDICATOR A	Mean	Description	Anxiety Level
1. I get tense when I prepare for a mathematics test.	4	Often	High
2. Mathematics makes me feel uneasy and confused.	3	Sometimes	Moderate
3. I get nervous when I have to use mathematics outside of school.	3	Sometimes	Moderate
4. I worry that I will not be able to use mathematics in my future career when needed.	3	Sometimes	Moderate
5. I have never liked mathematics, and it is my most dreaded subject.	3	Sometimes	Moderate
6. I worry that I will not be able to get a good grade in my mathematics course.	4	Often	High
7. I worry that I will not be able to do well on mathematics tests.	4	Often	High
8. I feel stressed when listening to mathematics instructors in class.	3	Sometimes	Moderate
9. I get nervous when asking questions in class.	4	Often	High
10. Working on mathematics homework is stressful for me.	3	Sometimes	Moderate
11. I worry that I do not know enough math concepts to do well in future mathematics courses.	4	Often	High

12. I worry that I will not be able to complete every assignment in a mathematics course.	4	Often	High
13. I worry I will not be able to understand the mathematics concepts.	4	Often	High
14. I worry that I will not be able to get better grades in my mathematics course.	4	Often	High
15. I worry that I will not be able to learn well in my mathematics course.	4	Often	High
16. I get nervous when taking a mathematics test.	4	Often	High
17. I am afraid I might give a wrong answer during my mathematics class.	4	Often	High
Over-all Mean	**4**	**Often**	**High Anxiety**

Table 1 showcases concerning data regarding math anxiety among Gen Z students. The overall mean score indicates a high anxiety level, with students frequently experiencing anxieties related to math. The data reveals prominent themes of test anxiety, fear of failure, and performance concerns within the student population. Statements like "I get nervous when taking a mathematics test" (Mean = 4) and "I worry that I will not be able to get a good grade in my mathematics course" (Mean = 4) highlight these anxieties (Bahr, 2012; Phan, 2012). These findings align with existing research on math anxiety, which identifies test anxiety and fear of failure as core features (Ashcraft & Moore, 2009). It's important to note that the utilized questionnaire employed a 5-point Likert scale, ranging from 1 (never) to 5 (often). The mean score of 4 signifies that students frequently experience these anxieties (McLeod, S. A., 2019). The findings on high math anxiety levels are concerning and resonate with prior research on Gen Z and the general student population (Balock et al., 2019; Ramirez et al., 2018). This consistency underscores the prevalence of math anxiety as a significant challenge in educational settings. While this study identifies high math anxiety levels, further investigation is needed to explore the potential causes behind these anxieties. Past negative experiences in math classes, coupled with teaching methods that emphasize rote memorization or performance pressure, could be contributing factors (Wonu, 2014).

Table 2. Generation Z Students' Mathematics Self-Efficacy Levels

INDICATOR B	Mean	Description	Self-Efficacy Level
1. I feel confident enough to ask questions in my mathematics class	3	Sometimes	Moderate
2. I believe I can do well on a mathematics test.	3	Sometimes	Moderate
3. Mathematics is enjoyable and stimulating to me.	3	Sometimes	Moderate
4. I believe I can complete all of the assignments in a mathematics course.	3	Sometimes	Moderate
5. I believe I am the kind of person who is good at mathematics.	2	Seldom	Low
6. I try to learn mathematics because it helps develop my mind and helps me think more clearly in general.	4	Often	High
7. I am interested and willing to acquire further knowledge of mathematics.	4	Often	High
8. I believe I will be able to use mathematics in my future career when needed.	4	Often	High
9. I believe I can understand the content in a mathematics course.	3	Sometimes	Moderate
10. I believe I can get better grades when I am in a mathematics course.	3	Sometimes	Moderate
11. I believe I can learn well in a mathematics course.	3	Sometimes	Moderate

12. I feel confident when taking a mathematics test.	3	Sometimes	Moderate
13. I believe I am the type of person who can do mathematics.	3	Sometimes	Moderate
14. I feel that I will be able to do well in future mathematics courses.	3	Sometimes	Moderate
15. I believe I can do the mathematics in a mathematics course.	3	Sometimes	Moderate
16. I feel confident when using mathematics outside of school.	3	Sometimes	Moderate
Over-all Mean	**3**	**Sometimes**	**Moderate**

Table 2 offers insights into Generation Z students' mathematics self-efficacy. The overall mean score indicates a moderate level of self-efficacy, but a deeper analysis reveals some interesting themes. Students demonstrate high self-efficacy when it comes to the value and usefulness of mathematics. Statements like "I try to learn mathematics because it helps develop my mind and helps me think more clearly in general" (Mean = 4) highlight this appreciation (Pajares & Miller, 1994). They also express a desire for further math knowledge ("I am interested and willing to acquire further knowledge of mathematics," Mean = 4) and believe math will be relevant in their future careers ("I believe I will be able to use mathematics in my future career when needed," Mean = 4). These findings align with research suggesting that students who view math as valuable are more likely to have positive self-efficacy beliefs (Tschannen-Moran et al., 1998). It's important to note that the utilized questionnaire employed a 5-point Likert scale, ranging from 1 (never) to 5 (often). A mean score of 3 signifies that students have a moderate self-efficacy belief in their specific math skills (McLeod, S. A., 2019). An interesting inconsistency emerges when examining student beliefs about their inherent mathematical ability. While students generally feel they can understand concepts (Mean = 3) and complete assignments (Mean = 3), their self-efficacy is lower regarding believing they are naturally "good" at math (Mean = 2). This suggests that students may value math and see its usefulness, but they might not perceive themselves as possessing inherent mathematical talent (Bandura, 1993). Further research is needed to explore the reasons behind this inconsistency. Considering negative past experiences or traditional teaching methods that emphasize rote memorization contribute to this perception. Understanding these factors can inform interventions designed to boost students' confidence in their mathematical abilities and foster a growth mindset around their mathematical capabilities (Dweck, 2006).

Table 3. Frequency of the Teaching Strategies of the Senior High School Mathematics Teachers as Assessed by the Students

Teaching Strategies	Mean	Description
A. Lecture/Discussion	4	Often
B. Demonstration	4	Often
C. Problem Solving	4	Often
D. Project	4	Often
E. Inquiry Approach	4	Often
F. Cooperative	4	Often
G. Audio-Visual	4	Often

Table 3 offers insights into the frequency of teaching strategies employed by senior high school mathematics teachers, as perceived by students. The data reveals a mean score of 4, suggesting all seven strategies (lecture/discussion, demonstration, problem-solving, project, inquiry approach, cooperative learning, and audio-visual) are reportedly used "often" (utilizing a scale likely ranging from 1 = rarely to 5 = always). This indicates that teachers may be incorporating a variety of instructional methods in their classrooms. This emphasis on diverse strategies aligns with recommendations from the National Council of Teachers of Mathematics (NCTM), which advocates for instruction that fosters active student engagement (National Council of Teachers of Mathematics, 2000). Research suggests that effective math instruction utilizes a variety of methods to cater to different learning styles and promote deeper understanding (Boaler, 2016). While all the listed strategies can be valuable, it's important to consider their potential benefits and drawbacks. Lecture-based approaches, for example, can be efficient for introducing new concepts but may limit opportunities for student participation and exploration (Kirschner et al., 2006). Project-based learning, on the other hand, encourages deeper understanding and application of knowledge but can be time-consuming to implement effectively (Sautter & Court, 1997). Further investigation is needed to explore how teachers are effectively combining these strategies to create engaging learning environments specifically tailored to Gen Z students. Understanding how these strategies are implemented in practice and the impact on student learning outcomes would provide valuable insights for educators.

Table 4. Significant Difference between Generation Z Students' Mathematics Anxiety and Self-Efficacy Levels

Indicator	Mean	SD	z-value	p-value
Mathematics Anxiety & Self-Efficacy Levels	0.18421	1.00956	1.125	0.268

Table 4 delves into the potential connection between mathematics anxiety and self-efficacy in Generation Z students. The statistical analysis yielded a mean difference of 0.18421 between the two measures, with a standard deviation (SD) of 1.00956. The p-value, a crucial element for interpreting this difference, is 0.268. However, the p-value of 0.268 surpasses the commonly accepted significance level of 0.05. In statistical hypothesis testing, failing to reject the null hypothesis occurs when the p-value is

greater than 0.05. In this context, it suggests no statistically significant difference between math anxiety and self-efficacy levels (Field, 2013).

While these findings seem to indicate that math anxiety doesn't influence self-efficacy and vice versa for Gen Z students, it's important to consider research suggesting a more complex relationship (Ashcraft & Moore, 2009). Studies have shown that high math anxiety can lead to negative self-beliefs about one's ability to perform well in math, potentially lowering self-efficacy (Pajares & Schunk, 2001). Conversely, students with high self-efficacy may be better equipped to manage their anxiety and approach math challenges with more confidence (Bandura, 1993).

Despite the inconclusive findings in this specific study, educators should acknowledge the potential influence of math anxiety on student self-efficacy. Creating positive and supportive learning environments that emphasize growth mindsets and promote a sense of belonging in math classrooms can be beneficial for all students (Boaler, 2016). Furthermore, incorporating strategies to reduce math anxiety, such as cooperative learning activities and anxiety-reduction techniques, can empower students and foster a more positive math learning experience (Malli & Gowri, 2018).

Table 5. Significant Relationship between Mathematics Anxiety of the Generation Z students and the Teaching Strategies of the Senior High School Mathematics Teachers

Teaching Strategies	Pearson r Correlation	p-value
Lecture/Discussion	0.88	0.597
Demonstration	-0.035	0.834
Problem-Solving	0.064	0.701
Project	0.158	0.344
Inquiry Approach	0.012	0.944
Cooperative	0.061	0.718
Audio-Visual	0.059	0.725

*significant if p-value<0.05.

Table 5 investigates the potential relationship between various teaching strategies employed by senior high school math teachers and the mathematics anxiety levels of Generation Z students. Pearson r correlation coefficients were utilized to assess the strength and direction of these relationships, with p-values indicating statistical significance. While none of the p-values reach the conventional significance level of 0.05, it's important to note the direction of the correlations. The correlation coefficient for lecture/discussion is positive (0.88), although not statistically significant. This suggests a trend where increased reliance on lecture may be associated with higher anxiety, but more research is needed for confirmation. The remaining correlations are all very weak and non-significant.

The lack of statistically significant findings in this study shouldn't lead to the conclusion that teaching strategies have no impact on math anxiety. Sample size, specific measures used, and other factors can influence correlation results. Research by Reyes (2019) highlights that math anxiety can be linked to various factors beyond instructional methods, including past experiences, emotional responses, and learning environment (Reyes, 2019). Further research is warranted to explore these relationships more comprehensively. Studies with larger and more diverse samples, employing robust measures of both teaching strategies and math anxiety, are recommended. Additionally, investigating mediating variables, such as student

perceptions of classroom environment, could shed light on the complex interplay between instructional practices and student anxiety (Murguia & Baloco, 2017).

Despite the limitations of this particular study, educators should strive to create positive and supportive learning environments that minimize math anxiety for their students. Incorporating a variety of teaching strategies, beyond solely relying on lecture, can foster engagement and promote a growth mindset around mathematics (Boaler, 2016). Ongoing research on effective pedagogies for reducing math anxiety can inform instructional practices and benefit all students.

Table 6. Significant Relationship between Mathematics Self-Efficacy of the Generation Z students and the Teaching Strategies of the Senior High School Mathematics Teachers

Teaching Strategies	Pearson r Correlation	p-value
Lecture/Discussion	0.384	0.017
Demonstration	0.379	0.019
Problem-Solving	0.220	0.185
Project	0.364	0.025
Inquiry Approach	0.312	0.056
Cooperative	0.131	0.432
Audio-Visual	0.315	0.054

*significant if p-value<0.05

Table 6 investigates the potential relationship between various teaching strategies used by senior high school math teachers and the mathematics self-efficacy of Generation Z students. Pearson r correlation coefficients were computed to assess the strength and direction of these relationships, with p-values indicating statistical significance. The findings reveal statistically significant positive correlations between lecture/discussion (0.384), demonstration (0.379), and project-based learning (0.364) with math self-efficacy (all p-values < 0.05). This suggests that these strategies, when implemented effectively, may be associated with increased student self-efficacy in mathematics.

The correlations for inquiry-based learning (0.312) and audio-visual aids (0.315) are positive but not statistically significant (p-values slightly above 0.05). While these findings are not conclusive, they warrant further investigation to explore potential benefits for math self-efficacy. The correlation for cooperative learning (0.131) is weak and not statistically significant (p-value > 0.05). The lack of a significant correlation for some strategies doesn't necessarily imply they have no impact on self-efficacy. Sample size, specific measures used, and other factors can influence correlation results. As research by Canonizado (2009) suggests, engaging learning experiences provided by teachers can promote student enjoyment and learning (Canonizado, 2009). Studies by Reyes (2019) highlight the connection between math self-efficacy, student effort, and teachers' instructional approaches (Reyes, 2019). Furthermore, Scarpello (2007) emphasizes the positive influence a supportive teacher can have on students' self-efficacy (Scarpello, 2007).

The results emphasize the potential benefits of incorporating a variety of teaching strategies beyond just lecture. While lecture/discussion can be a useful tool, findings suggest demonstrations, projects, and potentially inquiry-based learning may be associated with increased math self-efficacy in students. Drawing on research on effective mathematics instruction (Marine & White, 2023), educators can design

engaging lessons that promote understanding and boost student confidence in mathematics (Marine & White, 2023).

CONCLUSION

This study investigated the teaching strategies employed by senior high school mathematics teachers and their potential relationships with both mathematics anxiety and self-efficacy in Generation Z students. The findings offer valuable insights for educators seeking to create positive learning environments that foster student success in mathematics.

Contrary to initial expectations, the data did not reveal statistically significant relationships between any specific teaching strategies and mathematics anxiety levels. This suggests that factors beyond instructional methods may play a more prominent role in shaping math anxiety. Future research exploring student experiences, past academic performance, and emotional responses could provide a more holistic understanding of math anxiety in Gen Z students.

The analysis of self-efficacy revealed a more nuanced picture. Statistically significant positive correlations emerged between lecture/discussion, demonstration, and project-based learning with mathematics self-efficacy. These findings suggest that incorporating these strategies, alongside effective implementation practices, may be beneficial for fostering student confidence in their mathematical abilities. While the correlations for inquiry-based learning and audio-visual aids were not statistically significant, further investigation is warranted to explore their potential benefits.

The results highlight the importance of moving beyond a sole reliance on lecture-based instruction. While lectures can be informative, incorporating demonstrations, projects, and potentially inquiry-based learning can create more engaging and empowering learning experiences. Educators should strive to create supportive classroom environments that promote student effort and a growth mindset around mathematics. Drawing on research on effective mathematics instruction, teachers can design lessons that cater to diverse learning styles and cultivate a deeper understanding of mathematical concepts.

Further research is needed to explore the complex interplay between instructional practices, student self-efficacy, and mathematics anxiety in Gen Z students. Studies employing larger and more diverse samples, alongside robust measures of both teaching strategies and student emotions, are recommended. Investigating mediating variables, such as student engagement and classroom climate, could shed light on the mechanisms through which instructional practices influence student self-efficacy and potentially mitigate math anxiety. By continuing to explore these relationships, educators can be better equipped to create classrooms where all students can develop positive attitudes and strong foundational skills in mathematics.

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DECLARATION

Author Contribution

All authors contribute in the research process, such as collecting the data, analyzing the data, and writing the manuscript. All authors approved the final manuscript.

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Conflict of Interest

Both authors declare that they have no competing interests.

Ethics Declaration

We as authors acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that we have obtained the permission from the relevant institutes when collecting data. We support the International Journal on Emerging Mathematics Education (IJEME) in maintaining high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

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