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The Moderating Effect of Technology Attitude on the Relationship between Math Self-Efficacy and Attitudes towards Mathematics

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Abstract

The study examined whether math self-efficacy significantly affects attitudes towards mathematics. It also explored the moderating effect of technology attitude on the link between mathematics self-efficacy and attitudes towards mathematics. A total of 174 Science, Technology and Engineering (STE) students (79 males and 95 females) of Tagum City National High School participated in the study. Three (3) valid and reliable instruments were used to assess students' level of math self-efficacy, technology attitude, and attitudes towards mathematics. Results show that the level of math self-efficacy, and attitudes towards math of the STE students is moderate. Moreover, the level of technology attitude of the students is high. There is a significant relationship between math self-efficacy and attitudes towards math. However, there is no significant relationship between technology attitude and attitudes towards mathematics. The negative moderating effect of technology attitude on the relationship between math self-efficacy and attitudes towards math is established.

1. Introduction

Attitude is a central part of human identity. Everyday people love, hate, like, dislike, favor, oppose, agree, disagree, argue, persuade etc. All these are evaluative responses to an object. Hence, attitudes can be defined as "a summary evaluation of an object of thought" (Bohner & Wänke, 2002). Oppenheim (1966) defined attitude as a state of readiness, a tendency to act or react in a certain manner when confronted with certain stimuli. More specifically to learning, Wasiche (2006) defined attitude as a feeling towards something or somebody which is sometimes reflected in a person's behavior.

Attitudes formed by students when learning mathematics tend to remain for a long time and these attitudes may help him/her to learn mathematics better (Evans, 1965). Hence, mathematics need not be learned by students in secondary for the sake of career choice or advancement but students should be able to learn mathematics with understanding and therefore be able to apply mathematical ideas later in life (Stanic, 1995). In addition, mathematics plays a key role in shaping how individuals deal with the various spheres of private, social, and civil life (Anthony & Walshaw, 2009). This gives importance, then, to the feelings of students towards the subject. Callahan (1981) stated that students are very important and that their feelings have a strong effect upon the amount of work, the effort put therein and the learning that is finally acquired. Students' experience of negative feelings towards learning of mathematics may lead to unfavorable attitudes to the subject. Such negative feelings could be as a result of excess work load or poor teachers teaching method and the teacher's failure to attend to individual difference. Sewell (1981) remarked that at least half of the population, including many with high mathematical qualifications, had negative attitudes to mathematics, ranging from lack of confidence to anxiety and even fear. Furthermore, Ma and Kishor (1997) noted that a number of studies revealed that many children begin schooling with

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positive attitudes towards mathematics. However, their attitudes become less positive as children grow up, and frequently become negative at the high school.

In addition to attitudes towards mathematics, self-efficacy plays a crucial role in one's success. Bandura (1977) defined self-efficacy as "individuals' belief in their ability to successfully perform the task or tasks necessary to reach a given outcome. Mathematics self-efficacy is regarded as students' conviction of their capability to solve mathematics problems or to be successful in mathematics tests (OECD, 2012). Ozgen and Bindak (2011) examined the math self-efficacy of 712 high school students and reported their findings on a number of variables. Males were reported with higher levels of self-efficacy than females. Moreover, student self-efficacy levels decreased as students progressed from ninth grade to 12th grade. Students whose parents had higher levels of education and higher socioeconomic status were reported with higher levels of math self-efficacy. Lastly, students who believed that math class was important had higher levels of math self-efficacy.

The explosion of knowledge has led to proliferation of technology. Wright and Lauda (1993) described technology as "a body of knowledge and actions used by people to apply resources in designing, producing, and using products, structures, and systems to extend the human potential for controlling and modifying the natural and human-made environment." Integrating technology early in education may allow the learners to become more aware of not only how to use the technology, but also may give them more confidence in the subject, especially mathematics. In another study, it was noted that students felt more comfortable using technology since it allowed them to be more accurate in mathematics. Although not all students felt comfortable using technology, most students in one study accounted technology use as something that alleviated some of their anxiety with mathematics and the anxiety associated with taking tests (Meagher, 2012).

Nicolaidu and Philippou (2003) explored the relationships between students' attitudes towards mathematics, self-efficacy beliefs in problem-solving and achievement. Attitude and efficacy scales were completed by 238 fifth-grade students. Results showed that attitudes and efficacy were correlated. Kundu and Ghose (2016), in another study, studied the relationship between attitude and self-efficacy in mathematics among higher secondary students using 784 students of Class XI selected from 25 schools from southern districts of West Bengal. The correlational study revealed that the association between higher secondary students' attitude towards mathematics and self-efficacy in mathematics is high.

A study conducted by Watson (1998), in Tennessee USA, in the Internet enabled environment, has found that learners think that use of ICT tools has made them to gain self-confidence and are in control of how to use the tools for their school work. In a meta-analysis of research on the impact of technology on learning, it was found that students who used technology in their classroom performed 12 percentage points higher than those who did not (Tamim, Bernard, Borokhovski, Abrami, & Schmidt, 2011). Different examples of technology in mathematics include online assessment tools, online collaboration tools, computer algebra systems, apps, calculators, computer applications, and interactive whiteboards (Tamim, et al, 2011). However, Clark (1999) came up with an argument that media will never influence learning. He believed that the use of adequate instructional learning will influence learning. That is, if there are more than one media or media attributes that give the expected goals, they do not influence the learning. The instructional methods are the ones that have an influence on learning. Hence, the ICT tools alone will never influence learning.

The association of math self-efficacy and attitudes towards mathematics has been proven in many studies. However, with the inclusion of technology attitude in the framework, the researcher believed that this might impact the degree of association. According to Teo, et al (2015), technology attitude or attitude towards technology explains individual's intention for technology use. Hence, this study aimed at determining the moderating effect of technology attitude on the relationship between math self-efficacy and attitudes towards mathematics. This research attempted to determine the (a) level of math self-efficacy of the STE students; (b) level of attitudes towards mathematics of the STE students; level of technology attitude of the STE students; (c) significance of the relationship between math self-efficacy and attitudes towards mathematics; (d) significance of the relationship between technology attitude and attitudes towards mathematics; and (e) significance of the moderation effect of technology attitude on the relationship between math self-efficacy and attitudes towards mathematics.

2. Methods

2.1 Participants

Participants included 174 Science, Technology and Engineering (STE) students of Tagum City National High School (TCNHS). Of the 174, 79 (45.4%) were males, and 95 (54.6%) were females. In terms of age, 11 (6.3%) were 12 years old, 34 (19.5%) were 13 years old, 43 (24.7%) were 14 years old, 42 (24.1%) were 15 years old, 35 (20.1%) were 16 years old, seven (4.0%) were 17 years old, one (.6%) was 18 years old, an one (.6%) had unknown age. The mean age of the students was 14.47 years old. The 174 students were chosen through stratified random sampling from among nine (9) STE classes of TCNHS for School Year 2017 – 2018.

2.2 Procedure

Approval to conduct the study was first sought by the researcher from the school principal, Dr. Judith P. Magsipoc. Following the receipt of the approval, the researcher coordinated with the school planning officer and E-BEIS in-charge to get the number of STE students per class. The sample size was determined using the Slovin's formula. Based on the computation, it was determined that a sample of 174 students was needed in the study. Furthermore, stratified random sampling was employed to get the number of respondents per class.

The researcher adopted three (3) valid and reliable inventories to be used in the study, using some of the sub-scales that were applicable in the current research. He then formed the final questionnaire for the participants to answer. The questionnaire was administered to the students included in the sample. After answering the questionnaire for thirty (30) minutes, these were collected for data analysis. Results were analyzed using SPSS Version 24.

2.3 Measures

Three (3) sources of data were used for the investigation, all were collected during the School Year 2017 – 2018. These questionnaires were the general math self-efficacy sub-scale of the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ), confidence with technology and attitude to learning mathematics with technology sub-scales of the Mathematics and Technology Attitude Scale (MTAS), and the Attitudes towards Mathematics Inventory (ATMI).

Mathematics Self-Efficacy. Mathematics self-efficacy was assessed using an eight-item self-report measure of General Mathematics Self-Efficacy adopted from one of the sub-scales of the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) by May (2009). The general mathematics self-efficacy included items about the students' beliefs regarding their abilities in mathematics in general. Participants were asked to state what they think and feel about their mathematics courses on a five-point scale from (1) = "Never" to (5) = "Usually". The scale included eight (8) items pertaining to mathematics self-efficacy (e.g. "I believe I am the kind of person who is good in mathematics."). The reliability coefficient of the sub-scale was .90.

Technology Attitude. Technology attitude was measured using two (2) technology attitude indicators, namely: confidence with technology, and attitude to learning mathematics with technology. These indicators were taken from the Mathematics and Technology Attitudes Scale (MTAS) of Pierce, Stacey and Barkatsas (2005). Confidence with technology was about technology confidence as evidenced by students who "feel self-assured in operating computers, believe they can master computer procedures required of them, are more sure of their answers when supported by a computer, and in cases of mistakes in computer work are confident of resolving the problem themselves" (Gailbraith & Haines, 1998). This was also adopted by the Pierce, et al. In terms of attitude to learning mathematics with technology, the developers adopted the construct of Vale and Leder (2004), who defined "attitude to computer-based mathematics" as "the degree to which students perceive that the use of computers in mathematics provides relevance for mathematics, aids their learning of mathematics and contributes to their achievement in mathematics". The developers focused broadly on interest and assistance to learning without expecting the more sophisticated and specific reflections. Participants were asked to state what they think and feel about their technology attitude on a five-point scale from (1) = "Hardly Ever" to (5) = "Nearly Always". The sub-scale for confidence with technology had four (4) items (e.g. "I am good at using computers."). The sub-scale for attitude to learning mathematics with technology had also four (4) items (e.g. "I like using calculators for mathematics.”). The reliability coefficients for the confidence with technology and attitude to learning mathematics with technology scales were .79 and .89, respectively.

Attitudes towards Mathematics. The attitudes towards mathematics was measured using the following four (4) indicators: self-confidence, value, enjoyment, and motivation. The Attitudes towards Mathematics Inventory (ATMI) by Tapia (1996). Of the original forty (40) statements, only thirty-two (32) statements were used in the study. Self-confidence had 12 items (e.g. “Mathematics does not scare me at all.”). Value had seven (7) items (e.g. “Mathematics is important in everyday life.”). Enjoyment, on the other hand, had nine (9) items (e.g. “I like to solve new problems in mathematics.”). Lastly, motivation had four (4) items (e.g. “I am confident that I could learn advanced mathematics.”). . Participants were asked to state what they think and feel about their attitudes towards mathematics on a five-point scale from (1) = “Strongly Disagree” to (5) = “Strongly Agree”. Very high reliability coefficients were obtained for the overall scale (.963) and all the subscales: self-confidence (.928), value (.909), enjoyment (.911), and motivation (.784) as assessed by Majeed, Darmawan & Lynch (2013) as they did a confirmatory factor analysis of the ATMI.

To aid in the interpretation of data for math self-efficacy, technology attitude and attitude towards mathematics, the following parameter limit was used:

Table 1. Value Range Allocation, Verbal Interpretation and Description for the Interpretation of Math Self-Efficacy and Technology Attitude.

Value Range Allocation	Verbal Interpretation	Description
4.20 – 5.00	Very High	This means that the behavior described was demonstrated **at all times** when the situation occurs.
3.40 – 4.19	High	This means that the behavior described was demonstrated **most of the times** when the situation occurs.
2.60 – 3.39	Moderate	This means that the behavior described was demonstrated **sometimes** when the situation occurs.
1.80 – 2.59	Low	This means that the behavior described was demonstrated **rarely** when the situation occurs.
1.00 – 1.79	Very Low	This means that the behavior described was **very rarely** demonstrated when the situation occurs.

As to the overall attitude towards mathematics, the following parameter limit was employed:

Table 2. Value Range Allocation, Verbal Interpretation and Description for the Interpretation of Overall Attitude towards Mathematics.

Value Range Allocation	Verbal Interpretation	Description
16.20 – 20.00	Very High	This means that the behavior described was demonstrated **at all times** when the situation occurs.
12.40 – 16.19	High	This means that the behavior described was demonstrated **most of the times** when the situation occurs.
8.60 – 12.39	Moderate	This means that the behavior described was demonstrated **sometimes** when the situation occurs.
4.80 – 8.59	Low	This means that the behavior described was demonstrated **rarely** when the situation occurs.
1.00 – 4.79	Very Low	This means that the behavior described was **very rarely** demonstrated when the situation occurs.

3 Results & Discussions

The data were analyzed using mean, correlation and hierarchical regression analysis. The mean was applied to determine the level of math self-efficacy, technology attitude, and attitudes towards mathematics. The correlation analysis was used to determine the significance of the relationship between math self-efficacy and attitudes towards mathematics, and technology attitude and attitudes towards mathematics. The hierarchical regression analysis was employed to test the moderating effect of technology attitude on the relationship between math self-efficacy and attitudes towards mathematics.

3.1 Level of Math Self-Efficacy of STE Students

The STE students' level of math self-efficacy revealed these mean results under each of the statements in the sub-scale: I believe I am the kind of person who is good in mathematics. (3.08); I believe I can understand the content in a mathematics course. (3.53); I believe I can get an "A" when I am in a mathematics course. (2.97); I believe I can learn well in a mathematics course. (3.50); I believe I am the type of person who can do mathematics. (3.57); I feel I will be able to do well in future mathematics courses. (3.05); I believe I can do the mathematics in a mathematics course. (3.26); and I believe I can think like a mathematician. (2.26). Having a grand mean of 3.15, the verbal description for the sub-scale was **moderate** (Table 3). This means that math self-efficacy of the STE students is demonstrated sometimes. This implies that they have an average math self-efficacy.

This is supported by the study of Chiu and Klassen (2010) which revealed that high-achieving East Asian students may have underestimated their self-efficacy; whereas the low-achieving students may have overestimated their self-efficacy.

Table 3. Level of Math Self-Efficacy of Science, Technology and Engineering Students.

Items	Mean	Description
I believe I am the kind of person who is good in mathematics.	3.08	Moderate
I believe I can understand the content in a mathematics course.	3.53	High
I believe I can get an "A" when I am in a mathematics course.	2.97	Moderate
I believe I can learn well in a mathematics course.	3.50	High
I believe I am the type of person who can do mathematics.	3.57	High
I feel I will be able to do well in future mathematics courses.	3.05	Moderate
I believe I can do the mathematics in a mathematics course.	3.26	Moderate
I believe I can think like a mathematician.	2.26	Low
Grand Mean	**3.15**	**Moderate**

3.2 Level of Technology Attitude of STE Students in Terms of Confidence with Technology

The STE students' level of technology attitude in terms of confidence with technology revealed these mean results under each of the statements in the sub-scale: I am good at using computers. (3.79); I am good at using things like VCRs, DVDs, MP3s and mobile phones. (3.83); I can fix a lot of computer problems. (2.68); and I can master any computer program needed for school. (3.02). Having a grand mean of 3.33, the verbal description for the sub-scale was **moderate** (Table 4). This means that the technology attitude in terms of confidence with technology of STE students is demonstrated sometimes. This implies that they have average confidence with the use of technology.

Table 4. Level of Technology Attitude of Science, Technology and Engineering Students in Terms of Confidence with Technology

Items	Mean	Description
I am good at using computers.	3.79	High
I am good at using things like VCRs, DVDs, MP3s and mobile phones.	3.83	High
I can fix a lot of computer problems.	2.68	Moderate
I can master any computer program needed for school.	3.02	Moderate
Grand Mean	**3.33**	**Moderate**

This is supported by the study of Watson (1998), in Tennessee USA, in the Internet enabled environment, who found that learners think that use of ICT tools has made them to gain self-confidence and are in control of how to use the tools for their school work. Integrating technology throughout the curriculum in all subjects allows students to be more engaged in the classrooms, and have more confidence in the technology, which may lead toward a greater confidence in the subject (Allsopp, McHatton, & Farmer, 2010).

3.3 Level of Technology Attitude of STE Students in Terms of Attitude to Learning Mathematics with Technology

The STE students' level of technology attitude in terms of attitude to learning mathematics with technology revealed these mean results under each of the statements in the sub-scale: I like using calculators for mathematics. (4.05); Using calculators in mathematics is worth the extra effort. (3.74); Mathematics is more interesting when using calculators. (3.53); and Calculators help me learn mathematics better. (3.55). Having a grand mean of 3.72, the verbal description for the sub-scale was **high** (Table 5). This means that technology attitude in terms of attitude to learning mathematics with technology is demonstrated most of the time. This implies that they have positive attitude towards learning mathematics with technology.

This is supported by Ontario Ministry of Education (2005), who posited that Ontario Mathematics Curriculum for students in Grades 1-8 supported the use of calculators and explicitly stated "the computer and the calculator should be seen as important problem-solving tools to be used for many purposes."

Table 5. Level of Technology Attitude of Science, Technology and Engineering Students in Terms of Attitude to Learning Mathematics with Technology.

Items	Mean	Description
I like using calculators for mathematics.	4.05	High
Using calculators in mathematics is worth the extra effort.	3.74	High
Mathematics is more interesting when using calculators.	3.53	High
Calculators help me learn mathematics better.	3.55	High
Grand Mean	**3.72**	**High**

3.4 Summary on Level of Technology Attitude of STE Students

The STE students' level of technology attitude is presented in Table 6. Results revealed these grand means under each sub-scale: confidence with technology (3.33); and attitude to learning mathematics with technology (3.72). The overall mean technology attitude was 3.53 with a description of **high**. This means that technology attitude of STE students is demonstrated most of the time. This implies that they have a positive technology attitude.

Table 6. Summary on Level of Technology Attitude of Science, Technology and Engineering Students.

Indicators	Mean	Description
1. Confidence with Technology	3.33	Moderate
2. Attitude to Learning Mathematics with Technology	3.72	High
Overall	**3.53**	**High**

3.5 Level of Attitudes towards Mathematics of STE Students in Terms of Self-Confidence

The STE students' level of attitudes towards math in terms of self-confidence revealed these mean results under each of the statements in the sub-scale: Mathematics is one of my dreaded subjects. (3.05); My mind goes blank and I am unable to think clearly. (3.25); Studying mathematics makes me feel nervous. (3.35); Mathematics makes me feel uncomfortable. (3.60); When I hear the word mathematics, I have a feeling of dislike. (3.72); Mathematics does not scare me at all. (3.07); I have a lot of self-confidence when it comes to mathematics. (2.76); I am able to solve mathematics problems without too much difficulty. (2.80); I expect to do fairly well in any mathematics class I take. (3.23); I am always confused in my mathematics class. (3.44); I learn mathematics easily. (3.10); and I believe I am good at solving mathematics problems. (3.01). Having a grand mean of 3.20, the verbal description for the sub-scale was **moderate** (Table 7). This means that the attitude towards mathematics in terms of self-confidence of the STE students is demonstrated sometimes. This means that they have average self-confidence.

This is supported by Sewell (1981), who remarked that at least half of the population, including many with high mathematical qualifications, had negative attitudes to mathematics, ranging from lack of confidence to anxiety and even fear. In addition, Colgan (2014) noted that many students have negative attitudes towards mathematics and feel that they are not good at math.

Table 7. Level of Attitudes towards Mathematics of Science, Technology and Engineering Students in Terms of Self-Confidence.

Items	Mean	Description
*Mathematics is one of my dreaded subjects.	3.05	Moderate
*My mind goes blank and I am unable to think clearly.	3.25	Moderate
*Studying mathematics makes me feel nervous.	3.35	Moderate
*Mathematics makes me feel uncomfortable.	3.60	High
*When I hear the word mathematics, I have a feeling of dislike.	3.72	High
Mathematics does not scare me at all.	3.07	Moderate
I have a lot of self-confidence when it comes to mathematics.	2.76	Moderate
I am able to solve mathematics problems without too much difficulty.	2.80	Moderate
I expect to do fairly well in any mathematics class I take.	3.23	Moderate
*I am always confused in my mathematics class.	3.44	High
I learn mathematics easily.	3.10	Moderate
I believe I am good at solving mathematics problems.	3.01	Moderate
Grand Mean	**3.20**	**Moderate**

*****-reversed scoring

3.6 Level of Attitudes towards Mathematics of STE Students in Terms of Value

The STE students' level of attitudes towards math in terms of value revealed these mean results under each of the statements in the sub-scale: Mathematics is a very worthwhile and necessary subject. (4.20); I want to develop my mathematical skills. (4.52); Mathematics helps develop the mind and teaches a person to think. (4.44); Mathematics is important in everyday life. (4.33); Mathematics is one of the most important subjects to study. (4.36); High school mathematics courses would be very helpful no matter what I decide to study. (3.98); and I can think of many ways that I use mathematics outside of school. (3.80). Having a grand mean of 4.23, the verbal description for the sub-scale was **very high** (Table 8). This means that the attitude towards mathematics in terms of value of STE students is demonstrated always. This implies that they have very positive perception of the value of mathematics.

This is negated by the study of Gallagher and De Lisi (1994), who found that students view mathematics as not having much relevance to their lives. This may be because students under the Science, Technology, and Engineering (STE) program have high aptitudes in science and mathematics. The students learn to value mathematics and sciences since additional science and math-related subjects are offered to the students as enrichment to the basic K to 12 curriculum to prepare them to higher education in the areas of science, technology and engineering.

Table 8. Level of Attitudes towards Mathematics of Science, Technology and Engineering Students in Terms of Value.

Items	Mean	Description
Mathematics is a very worthwhile and necessary subject.	4.20	Very High
I want to develop my mathematical skills.	4.52	Very High
Mathematics helps develop the mind and teaches a person to think.	4.44	Very High
Mathematics is important in everyday life.	4.33	Very High
Mathematics is one of the most important subjects to study.	4.36	Very High
High school mathematics courses would be very helpful no matter what I decide to study.	3.98	High
I can think of many ways that I use mathematics outside of school.	3.80	High
Grand Mean	**4.23**	**Very High**

3.7 Level of Attitudes towards Mathematics of STE Students in Terms of Enjoyment

The STE students' level of attitudes towards math in terms of enjoyment revealed these mean results under each of the statements in the sub-scale: I have usually enjoyed studying mathematics in school. (3.47); Mathematics is dull and boring. (3.87); I like to solve new problems in mathematics. (3.26); I would prefer to do an assignment in mathematics than to write an essay. (3.21); I really like mathematics. (3.36); I am happier in a mathematics class than in any other class. (2.93); Mathematics is a very interesting subject. (3.82); I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in mathematics. (3.14); and I am comfortable answering questions in mathematics class. (3.09). Having a grand mean of 3.35, the verbal description for the sub-scale was **moderate** (Table 9). This means that the attitude towards mathematics in terms of enjoyment of STE students is demonstrated sometimes. This implies that they have average enjoyment in mathematics.

This is supported by Colgan (2014), who stressed that a large majority of students find mathematics "boring, mostly irrelevant and unrewarding."

Table 9. Level of Attitudes towards Mathematics of Science, Technology and Engineering Students in Terms of Enjoyment.

Items	Mean	Description
I have usually enjoyed studying mathematics in school.	3.47	High
*Mathematics is dull and boring.	3.87	High
I like to solve new problems in mathematics.	3.26	Moderate
I would prefer to do an assignment in mathematics than to write an essay.	3.21	Moderate
I really like mathematics.	3.36	Moderate
I am happier in a mathematics class than in any other class.	2.93	Moderate
Mathematics is a very interesting subject.	3.82	High
I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in mathematics.	3.14	Moderate
I am comfortable answering questions in mathematics class.	3.09	Moderate
Grand Mean	**3.35**	**Moderate**

*****-reversed scoring

3.8 Level of Attitudes towards Mathematics of STE Students in Terms of Motivation

The STE students' level of attitudes towards math in terms of motivation revealed these mean results under each of the statements in the sub-scale: I am confident that I could learn advanced mathematics. (3.22); I would like to avoid using mathematics in tertiary study. (3.33); I am willing to take more than the required amount of mathematics. (3.16); and I plan to take as much mathematics as I can during my education. (3.17). Having a grand mean of 3.22, the verbal description for the sub-scale was **moderate** (Table 10). This means that the attitude towards mathematics in terms of motivation of the STE students is demonstrated sometimes. This implies that they have average motivation in mathematics.

This is negated by Syyeda (2016), who said that many of the high ability students show a high level of motivation. This may be because STE students take ten (10) subjects in a grade level, with two (2) subjects as add-on subjects. They are, therefore, bombarded with school works and they need to balance and give relatively equal attention to all the subjects in order to pass.

Table 10. Level of Attitudes towards Mathematics of Science, Technology and Engineering Students in Terms of Motivation.

Items	Mean	Description
I am confident that I could learn advanced mathematics.	3.22	Moderate
*I would like to avoid using mathematics in tertiary study.	3.33	Moderate
I am willing to take more than the required amount of mathematics.	3.16	Moderate
I plan to take as much mathematics as I can during my education.	3.17	Moderate
Grand Mean	**3.22**	**Moderate**

*****-reversed scoring

Table 11. Summary on Level of Attitudes towards Mathematics of Science, Technology and Engineering Students.

Indicators	Mean	Description
1. Self-Confidence	3.20	Moderate
2. Value	4.23	Very High
3. Enjoyment	3.35	Moderate
4. Motivation	3.22	Moderate
Overall	**14.00**	**High***

*****16.20 – 20.00 - Very High
12.40 – 16.19 - High
8.60 – 12.39 - Moderate
4.80 – 8.59 - Low
1.00 – 4.79 - Very Low

3.9 Summary on Level of Attitudes towards Mathematics of STE Students

The STE students' level of attitudes towards mathematics is presented in Table 11. Results revealed these grand means under each sub-scale: self-confidence (3.20); value (4.23); enjoyment (3.35); and motivation (3.22). The overall rating for attitudes towards mathematics was 14.00 with a description of **moderate**. This means that the attitudes towards mathematics of the STE students is demonstrated sometimes. This implies that they have above average attitudes towards mathematics.

3.10 Relationship between Math Self-Efficacy and Attitudes towards Mathematics

The relationship between math self-efficacy and attitudes towards mathematics is presented in Table 12. Pearson's bivariate correlation coefficient showed a high positive correlation between the two (2) variables (r = .712) that was significantly different from zero (*p = .000*). The coefficient of determination was .5069. Math self-efficacy explained 50.69% of the variance in the attitudes towards mathematics. This is supported by Nicolaidu and Philippou (2003), who remarked that attitudes towards mathematics and self-efficacy were correlated. Furthermore, Kundu and Ghose (2016), in another study, studied the relationship between attitude and self-efficacy in mathematics among higher secondary students using 784 students of Class XI selected from 25 schools from southern districts of West Bengal. The correlational study revealed that the association between higher secondary students' attitude towards mathematics and self-efficacy in mathematics is high.

Table 12. Relationship between Math Self-Efficacy and Attitudes towards Mathematics.

Variables	r-value	Interpretation	p-value	Decision α = 0.05	Conclusion
Math Self-Efficacy Attitudes towards Mathematics	.712	High Positive Correlation	.000	Rejected	Significant
r^2		Coefficient of Determination			.5069

3.11 Relationship between Technology Attitude and Attitudes towards Mathematics

The relationship between technology attitude and attitudes towards mathematics is presented in Table 13. Pearson's bivariate correlation coefficient showed a negligible negative correlation between the two (2) variables (r = -.121) that was not significantly different from zero (*p = .112*). The coefficient of determination was .0146. Technology attitude explained 1.46% of the variance in the attitudes towards mathematics. This is negated by Ozel, Yetkiner and Capraro (2008), who examined the use of different technologies in mathematics in the K-12 level and reported improvement in student attitudes toward learning, higher achievement and conceptual understanding, and improved engagement with mathematics among the positive effects of technology integration.

Table 13. Relationship between Technology Attitude and Attitudes towards Mathematics.

Variables	r-value	Interpretation	p-value	Decision α = 0.05	Conclusion
Technology Attitude Attitudes towards Mathematics	-.121	Negligible Negative Correlation	.112	Not Rejected	Not Significant
r^2		Coefficient of Determination			.0146

3.12 Moderating Effect of Technology Attitude on the Relationship between Math Self-Efficacy and Attitudes towards Mathematics

Step 1: Math Self-Efficacy

Analysis of the results showed that math self-efficacy (β = .712, *p* = .000) was found to be significantly positively associated with attitudes towards mathematics. The r-value at this step was .712, with the r^2 being .507. The change r^2 (.507) was significant $F(1, 172) = 177.047$, *p* = .000. This is supported by Opara, Magnus-Arewa and Nwaukwu (2017), who investigated the predictors of students' attitude towards mathematics and found out that mathematics self-concept, mathematics self-efficacy and teachers' competency significantly predicted students' attitude towards mathematics.

Step 2: Technology Attitude

Analysis of the results showed that technology attitude (β = -.121, *p* = .112) was found to be not significantly negatively associated with attitudes towards mathematics. The r-value at this step was -.121, with the r^2

being .015. The change r^2 (.015) was not significant $F(1, 172) = 2.549$, $p = .112$. This is supported by Pierce & Stacey (2004), who indicated that what students do with technology does not necessarily concur with their normal repertoire for learning and doing mathematics.

Step 3: Technology Attitude as a Moderator

Prior to creating the interaction term, the independent variable (math self-efficacy) and the moderator variable (technology attitude) were centered by subtracting the mean of the variable from each participant's score on that variable. This was done to reduce the risk of multicollinearity and to make it easier to interpret the interaction term coefficient. The interaction term was computed as the product of the centered variables. The interaction term was entered into the final step of the regression analysis. The technology attitude by math self-efficacy interaction effect was significant ($\beta = -.178$, $p = .019$). The r-value at this step was -.178, with the r^2 being .032. The change r^2 (.032) was significant $F(1, 172) = 5.644$, $p = .019$. Technology attitude, therefore, had a negative moderating effect on the relationship between math self-efficacy and attitudes towards mathematics. This means that as technology attitude increases, the effect of math self-efficacy on attitudes towards mathematics decreases.

Table 14. Hierarchical Regression Analysis Results.

Variable	Unstandardized Coefficient Beta	Standard Error	Standardized Coefficient β	p-value	Decision α = .05
Step 1: Independent Variable					
Math Self-Efficacy	2.016	.152	.712	.000	Rejected
Step 2: Moderator Variable					
Technology Attitude	-.354	.222	-.121	.112	Not Rejected
Step 3: Interaction Term					
Technology Attitude x Math Self-Efficacy	-.614	.258	-.178	.019	Rejected

Dependent Variable: Attitudes towards Mathematics

In order to determine the direction of the significant moderation effect, a scatterplot of the slope (effect of centered math self-efficacy on attitudes towards math) and moderator variable was drawn. The graph shows that technology attitude has a negative moderator effect.

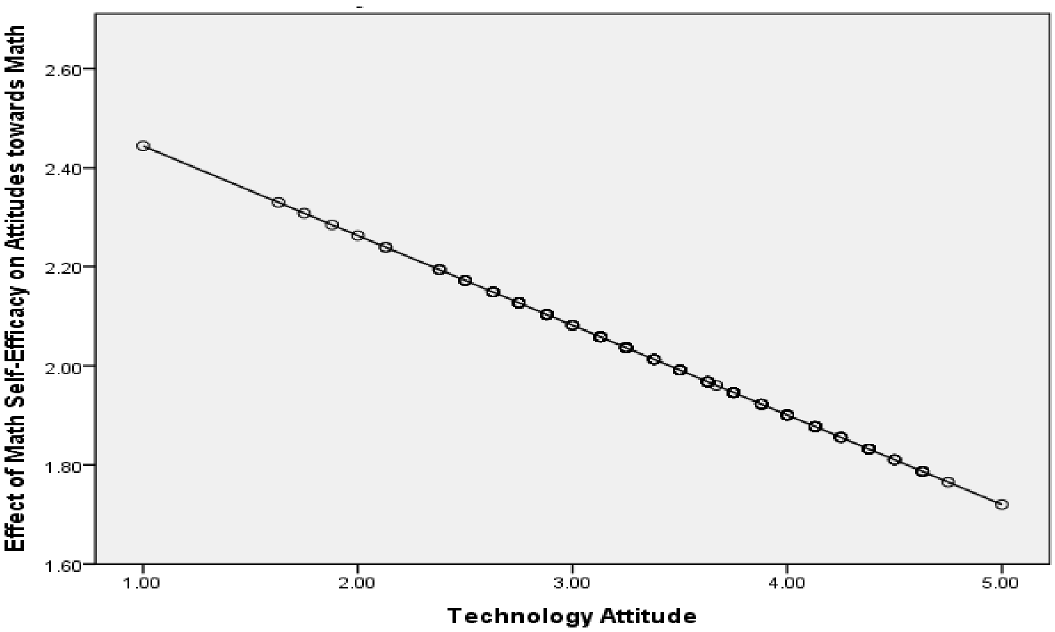

Figure 1. Moderating Effect of Technology Attitude on the Relationship Between Math Self-Efficacy and Attitudes towards Mathematics.

4 Conclusion

The study disclosed that the math self-efficacy and attitudes towards mathematics of the STE students are moderate. The technology attitude of the students is high. The research also showed that math self-efficacy is significantly related to attitudes towards mathematics. Moreover, it was also found out that technology attitude is not significantly related to attitudes towards mathematics. Lastly, the study revealed that technology attitude has a negative moderating effect on the relationship between math self-efficacy and attitudes towards mathematics. It is recommended that professional development initiatives may be done to expose teachers to self-efficacy theory, as well as teaching the rationale for, and the benefits of, these self-efficacy strategies. Teachers may promote learning environment where growth and progress are recognized. They may institute efforts to promote math self-efficacy by helping students to set learning goals, providing timely and explicit feedback, encouraging students to study harder, and using high achieving students as models. Since a negative moderating effect is established in the study, teachers may let students realize that they should not be too dependent on technology. This technology should be used strategically to help with reasoning and problem-solving. In addition, the use of pen and paper may also be of help to provide more opportunities for students to analyze, synthesize, and evaluate the why of progressing on the problems being solved. Further study may be conducted to validate the findings of this study.

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