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Mathematics Anxiety: Causes and Cases for Sound Intervention

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Abstract: **This study investigated the causes and cases for sound interventions of mathematics anxiety, a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in ordinary life and academic situations. College students were interviewed using an interview-guide and thematic analysis was employed in analyzing the data gathered. Results revealed that most of the participants' math anxiety is attributed to their elementary and high school experiences. Students felt anxious about mathematics when they had to communicate their knowledge in mathematics. Teaching mathematics and/or being evaluated in mathematics were particularly noted as stressful and mathematics topics like multiplication, division and different formula in the elementary level, basic calculus and problem solving in high school were specifically identified to cause math anxiety. Significantly, the mathematics teacher is one of the causes of mathematics anxiety among the students. The study recommends that students avoid their negative beliefs and towards mathematics to lessen their anxiety.**

Keywords: **Education, Mathematics, Anxiety, Negative Perception.**

1. INTRODUCTION

Academic frameworks, action researches, surveys and other studies carried out by academics, have shown that students' lack of interest and their dropping out of school are complex and multifaceted problems (Angrist & Victor, 2002). The psychological factors and their effects on academic situations are one of the top concerns of educational researchers. The clamor of the mathematics instructors on students' low performance is recently attributed to mathematics anxiety among the students (Tobias, 2013).

Mathematics anxiety has been defined as feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations. Math anxiety can cause one to forget and lose one's self-confidence (Tobias, 2013). Recent research on Math anxiety has recognized not only to be more complex than general anxiety but also common than earlier suggested (Olson & Gillingham, 1980; Ingleton & O' Regan, 1998). Math anxiety is not a discrete condition but rather it is a "construct with multiple causes and effects interacting in a tangle that defies simple diagnosis and simplistic remedies" (Martinez & Martinez, 1996, Bessant, 1995). A definition by Smith and Smith (1998) takes into consideration the intricacy of the phenomenon by encompassing both the affective and the cognitive domain of learning. They stated that Math anxiety is a feeling of intense frustration or helplessness about one's ability to do mathematics, and can be described as a learned emotional response to participating in a math class, listening to a lecture, working through problems, and discussing mathematics (Hembree, 1990; Le Moyre College, 1999).

Literature provides a number of conceptualizations of mathematics anxiety. Richardson and Suinn (1972) defined mathematics anxiety in terms of its (debilitating) effect on mathematical performance. They observed that the feeling of tension and anxiety interfere with manipulation and solving the mathematical problems in a wide variety of ordinary life and academic situations. It also involves feelings of tension and anxiety that interfere with the manipulation of numbers and solving the mathematical problems in a wide variety of ordinary life and academic situations (Suinn, 1988). Many students who suffer from mathematics anxiety have little confidence in their ability to do mathematics and tend to take the minimum numbers of required mathematics courses, which has greatly limited their career choice options (Garry, 2005).

This occurrence is supported by the findings of Diane and Tina (1986) who underscored that mathematics anxiety is the outcome of low self-esteem and the fear of failure, students tend to avoid mathematics whenever or whenever possible

Students today need practical math in their everyday lives. To learn mathematics, students must be engaged in exploring, conjecturing, and thinking rather than, engaged only in rote learning of rules and procedures (Abadi, 2014) since students' learning preferences change through times underpinning the theory of multiple differences (Spikell, 2003). Students' prior negative experiences in math class and at home when learning math are often transferred which causes lack of understanding of mathematics. Millions of adults are blocked from professional and personal opportunities because they fear or perform poorly in mathematics and these negative experiences remain throughout their adult lives (Tobias, 2013).

Helping learners overcome their negative beliefs and anxiety about mathematics requires interventions that facilitate fundamental shifts in learner's system of beliefs and conceptions about the nature and discourse of mathematics (Levine, 1996). This requires direct, conscious action on the part of the math-anxious person. It also requires a clear definition of and reflection on the person's part about what particular kinds of mathematics causes negative feeling and anxiety (Martinez & Martinez, 1996). The study was performed with the aim to identify the causes and cases of Mathematics anxiety among college students, which would help the institution design interventions for the suffering students.

2. THEORETICAL FRAMEWORK

The study was anchored on the theories conceptualized by Carey, Hill, Devine and Szucs (2016) on the relationship of mathematics anxiety and mathematics performance. The first theory, *The Deficit Theory*, suggests that people who start out with poorer mathematics performance are more likely to develop anxiety about mathematics. The second theory, *The Debilitating Anxiety Model*, suggests that the link between mathematics anxiety and mathematics performance is driven by anxiety's devastating consequences on learning and recalling mathematics skills. The mixture of evidence for each of the two theories suggests that in fact they might both play a part in the relationship between mathematics anxiety and performance. That is, mathematics anxiety might cause decreased performance and poorer performance might elicit mathematics anxiety, *The Reciprocal Theory*, as summarized below.

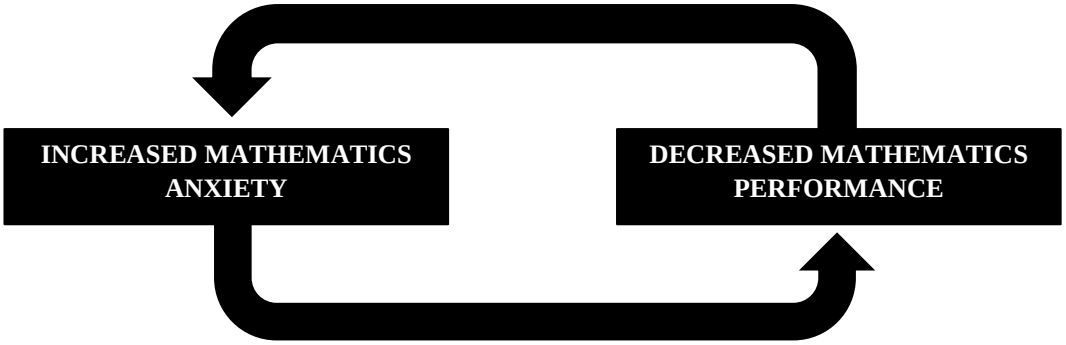

Figure 1: The Reciprocal Theory on Mathematics Anxiety and Mathematics Performance

The researchers (Carey et al., 2016) believe that the *Reciprocal Model* is best able to account for the mixture of data, which suggests that the relationship between mathematics anxiety and mathematics performance operates in both directions.

Philosophical Stance

A philosophical stance talks about reality, what knowledge is, and ways to gain knowledge. It is the guiding perspective about the nature of change and human behavior and thus, it is the foundation of research. This study is a qualitative study discussed in the context of ontology, epistemology, axiology, methodology and rhetoric.

From the point of view of ontology (which deals with what is reality) the nature of students at school requires them to determine their own knowledge and skills in their institution. Every student has a natural desire to learn, excel and to be somebody in the future. The source of reality was the experiences they have in their mathematics class as they related these to the researcher.

Epistemology addresses the question about the nature and origin of knowledge. In epistemological view, man has no fixed nature and he shapes his beings as he lives. Reality is a world of things, truth is subjectivity chosen, and goodness is a matter of freedom. From this point of view, the kind of knowledge acquired by the students depends on the kind of experience they have in school. The knowledge they gained in formal education equipped them with good values and skills that ultimately help them succeed in life and become productive member of society.

From the point of view of axiology (study of nature of values and value judgment), the value of the students at school were developed based on the kind of parents, teachers and community in which they live. Their sets of values were first acquired at home through their parents. As they enter school their sets of values and behavior are modified by how they are affected by their teachers, classmates and the school environment. Their own set of values and behavior toward mathematics was investigated in the study.

From the point view of methodology (deals with general principles of formation of knowledge), some knowledge of students were acquired through observations of their surroundings and their and their peer whom they frequently associate with. They may have realized that not all knowledge that they have gained in schools are applicable to the kind of community where they live, that success is not only measured as to what kind of degree a person has attained but also important in considering ones character in the attainment of one's goal in life. However, the researcher could validate the veracity of the information shared by the participants by establishing trust and confidence with them to give their most honest answers.

From the point view of rhetoric, the study of the elements as structure or style used in communication, students exhibit different structures and styles in communicating. Communication can be non-verbal. It is done through actions, facial expressions and tone of voice. Considering these, the researcher were able to establish rapport with the participants and their gestures were also considered in transcribing the information as in the interpretation of the results.

Objectives of the Study

The study aimed to investigate the cases and causes of mathematics anxiety of students for sound interventions. Specifically, the study aimed to:

1. identify the causes and cases of Mathematics anxiety; and

2. determine the implications of these causes and cases for the design of an intervention program for the suffering students.

3. METHODOLOGY

Research methodology is composed of the research design, participants, data gathering tool, data gathering procedure, data analysis procedure, ethical considerations and procedures to establish trustworthiness and objectivity.

Design

This study used a qualitative research design, a multi-case study. A case study is an in-depth investigation of a single person, group, event or community. Data are gathered from a variety of sources and by using several different methods (e.g. observations and interviews (McLeod, 2008). The case study method often involves observation of what happens to, or reconstruction of 'the history' of a single participant or group of individuals (such as a school, class or specific group), i.e. idiographic approach. The researcher opted for a multi-case study design employing five participants to really capture the experiences and insights of the students in mathematics.

Participant

The five participants in this multi-case study were the BSIT students. These students were pre-identified to have confessed of having difficulty and fear in mathematics. From a number of students, these five were identifies and eventually agreed to participate in the study. Ethical considerations, trustworthiness and objectivity were observed in the duration of the study.

Data Gathering Tool

The instrument used in the study was the self-made interview guide. This was to gather data from the participants identified. The interview guide contained open-ended questions to give the participants freedom to express their answers. The researcher's self-made interview-guide was composed of five parts: (1) demographic profile of the participants; (2)

Causes of math anxiety; (3) History of math anxiety; (4) Experiences on causes of Math anxiety; and (5) Mathematical concepts/ ideas that cause Math anxiety. Information about the origins of students' anxieties towards Mathematics, and situations and types of Mathematics causing anxiety are needed for the planning of intervention programs aimed at helping both the administration and the students address anxieties about Mathematics. The design of these questions was based on the research literature on Math anxiety (Martinez and Martinez, 1996; Smith and Smith 1998), the formation of beliefs and attitudes toward Mathematics (Cornell, 1999; Emenaker, 1996), and means of overcoming Math anxiety (Carroll, 1999; Raymond, 1997).

Data Gathering Procedure

Prior to the conduct of interview with the five participants of the study, the researcher obtained permission from the campus administrator. Likewise, a permission to conduct the interview with the student-participants were sought in order to encourage them to support the researcher all throughout the study. The participants were also assured that the information they give would be used for research purposes only and would be treated with utmost confidentiality and anonymity.

Furthermore, the participant's choice of whether or not to participate did not influence their relationship with the investigation in school, with the researcher and their grades. When everything was set, the scheduled interview pushed through. All interviews with the participants were conducted by the researcher.

It took more than a month for the researcher to finish the interview with the participants. One interview with the participant actually took more than a day. The researcher jotted down the important details that the interviewee gave. For some information which were not cleared, the researcher set another time for the participant to be interviewed again.

Data Analysis Procedure

Data from the interview were transcribed into word processing files. Once transcribed into word files, data analysis began by generating a list of themes and codes to provide evidence reflective of broader perspectives. Confidentiality on the information given by the participants was achieved by using pseudonym codes.

Prior to the analysis of the result, the researcher transcribed the interview records by noting only relevant information. The analysis of the relevant data gathered mainly employed thematic analysis procedure. After which, individual answers of the participants were analyzed and reflected in specific parts of this paper. Part of the analysis was the establishment of the themes for the answers of the participants. The themes then were used as bases for the discussion and analysis of the results.

Trustworthiness

Establishing both credibility and reliability is crucial when conducting quality research that employs qualitative method. Establishing credibility demonstrates internal validity with correspondence between participants' perspectives and how the researcher portrays their viewpoints (Mertens, 2005). In efforts to establish credibility, the researcher used prolonged and substantial engagement, progressive subjectivity, member checks, and triangulation (Mertens, 2005).

Trust is important in every research that concerns interviewing participants. Prior to the administration of the interview-schedule or the interview proper, the researcher genuinely talked to each participant and disclosed the true nature of the study to get the participant's trust. This would likewise establish rapport with the interviewee so that the veracity of the information given by the interviewee is established.

On the other hand, in the conduct of the study, the researcher took into considerations the ethical issues knowing that the study made use of students as participants. To protect the participants of the study, the researcher developed trust and confidence with them in order to promote the integrity of the research, guard against misconduct and any impropriety that can be reflected in their institutions, and cope with new challenging (Creswell, 2009). The researcher respected their rights, needs, values and desires. Furthermore, the researcher was very careful in asking sensitive questions for they may appear offensive to the participants.

Establishing Objectivity

The fact that the study's results are dependent upon the participant's answers, which are in turn, in a way, may be affected by the researcher's interpretation, biases may set in. In order to avoid personal biases in the interpretation of results, the researcher avoided personal interpretation of the participants' answers. The researcher tried to clarify the participants' answers by asking follow up questions. Triangulation of the data and information were likewise done through observing the participants' non-verbal cues during the interview.

Presentation of the Five Cases

Case A

Case A is a Bachelor of Science in Information Technology student from Barotac Nuevo, Iloilo. She is 18 years old. Her hobbies are eating while watching television, playing her mobile phones and watching Korean drama series. Her mother is a housewife and her father is a tricycle driver. The causes of her Math anxiety started when she was in her senior high school years. "*Math anxiety started during my senior high school years when I have my Basic Calculus subject. I really can't understand what my teacher was talking about in our class and maybe my teacher scares me for no reason*", Case A said. She added that every time she cannot catch up with the lesson and the moment her teacher call her name, she felt nervous.

Case B

Case B is from Ilaya 1st, Dumangas, Iloilo. He is 19 years old and is taking Bachelor of Science in Information Technology. His hobbies includes playing basketball, volleyball and computer games. His mother is a plain housewife and his father is a minister in the church. Case B said that he has Math anxiety when he cannot memorize the table of multiplication and cannot do the division method. He added that his math anxiety continued when he was in first year college and when he enrolled his first Math subject, "Mathematics in the Modern World." According to him, his Mathematics teacher does not explain clearly her subject matter. He found it difficult because he had no mathematics subject during his senior high school years for he took the TVL (Technical Vocational Livelihood) track. *"Obra lng ni mam pangakig kon indi ikaw makabalo kag wala sya naga explain sang maayo para kami makabalo"* he added. (Case B said that his teacher is always scolding them when they cannot understand what she is talking about the subject matter and she is not explaining it in a step by step method that is why according to him, he has anxiety with regards to numbers.

Case C

Case C is 19 years old and is taking Bachelor of Science in Information Technology. He hails from Capaliz, Dumangas, Iloilo. Her mother is a plain housewife and the father deceased already. She said that her sister is supporting her studies. She loves dancing and in the afternoon after the class she attends karate class. According to Case C, the cause of her math anxiety is her Math teacher. She added that her math anxiety started last first semester in her first math subject. Case C highlighted that Math anxiety can be present to anyone and also it depends to the teacher who teaches Math subject. "*I have phobia in Math subject because I cannot catch up with the lesson that we have. Every session, we have 3 to 4 Math topics being discussed the reason why I'm already confused especially about the numbers*," she finally said.

Case D

Case D is a 24-year old Bachelor of Science in Information Technology student. He is living with his aunt in Tamboilan, Dumangas, Iloilo. His hobbies are watching television, reading books, dancing and listening to music. Problem-solving and interpreting graphs are the causes of his math anxiety. "*The worst nightmare that I have was during my high school days in my Math subject*," he said. Case D added, *"Pinapapunta ako ng aking guro sa pisara at pinapasagot ako ng isang Math problem at doon ko naramdaman ang takot at kaba na baka magkamali ako ng aking sagot pagagalitan ako ng aking guro"*. (My teacher asked me to go to the board to write my answer to one of the Math problems given that time, I felt nervous and afraid that I might give the wrong answer and also my teachers might scold me.)

Case E

Case E is 19 years of age, a Bachelor of Science in Information Technology student and live in Tabucan, Barotac Nuevo, Iloilo. His father is a school maintenance worker in a private elementary school and his mother is a plain housewife. His hobbies are writing poems, spoken poetry and playing online games. The causes of Math Anxiety of Case E is the formula in Mathematics that he cannot understand. According to him every time there is formula, he felt dizzy. *"Galingin ulo ko basta my formula".* Aside from the formula in Mathematics, he also considered the Math teacher as one of the causes of his Math anxiety.

According to Case E, Math anxiety started during his elementary days. "*Sang elementary pa lang ako, pirmi lang ako ga-recite sa Math subject namon pero nakadlawan ako sang akon mga classmates biskan sakto akon sabat",* Case E said. Since then, he became hesitant to answer anymore. He added that if his math teacher knew how to present the lesson, he would also be motivated to participate in class recitation in spite of the numbers or formula that he hated most.

Causes of the Mathematics Anxiety among the Students

The analysis of data revealed that five participants perceived their negative perception and anxiety towards mathematics started mostly in their elementary or high school years. Student A for example, remembers "exactly" that it was in his senior high school that he learnt to dislike mathematics. Case A said, "*my Math anxiety started during my senior high school years when I have my Basic Calculus subject. I really can't understand what my teacher was talking about in our class and maybe my teacher scares me for no reason*".

Many researchers attempt to trace the evolution of mathematics anxiety among college students back to their elementary and high school classroom experiences. When early school experiences get the blame for mathematics anxiety, the elementary teacher is usually labeled as the responsible party. Mathematically, anxious teachers are said to pass on their anxieties to their students (Buhlman & Young, 2012 as cited by Trujillo and Hadfield, 2016). They are also often doubted as to their effectiveness as teachers of mathematics (Trujillo & Hadfield, 2016). According to Brush (2011), mathematically anxious teachers tend to use more traditional teaching methods, such as lecture, and concentrate on teaching basic skills rather than concepts.

On the other hand, when the five participants traced back their negative perceptions of math that led to Math anxiety during their elementary and high school years, they identified specific mathematics content, such as learning the basic calculus, reciting table of multiplication, solving division method, cannot catch up the topic discussed in math, problem solving, interpreting graphs, different formula in mathematics as the causes of their math anxiety. Student E for example, remembered the time in his elementary and said, "*Sang elementary pa lang ako, pirmi lang ako ga- recite sa Math subject namon pero nakadlawan ako sang akon mga classmates especially kon sala akon sabat". (He said that he was hesitant to answer anymore and did not participate after that incident).* He added that if her math teacher knows how to present the lesson particularly on the content he would have been motivated to participate in class recitation.

The participants' response that topics in math are really difficult is supported by related studies. Literatures affirmed that mathematics has been viewed as an inherently difficult subject. Many students are unable to see its practicality and teachers seldom attempt to make the connections. Foong (2007) explained that due to its cumulative and sequential nature, when students missed out something along the way, it is likely that they may never fully comprehend it. On the other hand, Mathematics is considered a difficult subject by most of the students due to aversive teaching style, difficulty in following the instruction, difficulty in understanding the subject, and difficulty in remembering its equations and ways to solve problem (Hembree, 2010). The same reason is given by students for disliking mathematics and there is a strong association between their belief regarding the difficulty of subject and dislike towards math.

The analysis also revealed that 5 participants identified their mathematics teachers as the major contributing factor why they disliked mathematics. Student B for example, commented about one of her college school mathematics teachers, *"Obra lng ni mam pangakig kon indi ikaw makabalo kag wala sya naga explain sang maayo para kami makabalo".* (Case B said that his teacher is always scolding them when they cannot understand what she is talking about her subject matter and she is not explaining the content step-by-step, that's the reason according to him he has anxiety with regards to numbers.) Another testimony expressed by Case C, "*Math anxiety can be present to anyone and also it depends to the teacher who teaches Math subject. I have phobia in Math subject because I cannot catch up the lesson that we have. Every session, we have 3 to 4 Math topics being discussed that's why I can't catch up the lesson that we have especially about numbers".*

Literatures agreed that most frequently cited cause of Math anxiety is the teacher, identified by Foong (2007) as the main source of students' tension. Highly-tensed students dread presenting solutions in front of their classmates, viewing such situations as threatening (Ashcraft, 2012). Teachers who complained of insufficient instructional time might resort to preparing their students for assessment rather than for understanding. This creates more tension when students encounter unconventional problems or when mathematics becomes more advanced. Researchers also claimed that anxious teachers spend lesser time teaching mathematics and are more likely to pass their phobia to their students (Hembree, 2010).

Situation Causing Mathematics Anxiety to Students

The participants felt most anxious about mathematics when they had to communicate their mathematical knowledge in some way, for example, in test situations or verbal explanations of word problem on the board. Also causing a lot of anxiety was the teaching of mathematics in practical situations due to insecure feelings of making mistakes or not being to solve it correctly. For example, Case E, felt Math anxiety during his elementary days, *"Sang elementary pa lang ako,*

permi lang ako ga- recite sa Math subject namon pero nakadlawan ako sang akon mga classmates biskan sakto akon sabat". (He said that he was hesitant to answer anymore and did not participate after that incident. He added that if her math teacher knows how to present the lesson he was also motivated to participate in class recitation in spite of the numbers or formula that he hated most.) For Case D, "*the worst nightmare that I have was during my high school days in my Math subject. Pinapapunta ako ng aking guro sa pisara at pinapasagot ako ng isang Math problem at doon ko naramdaman ang takot at kaba na baka magkamali ako ng sagot pagagalitan ako ng aking guro".* (According to Case D, he experienced one time that his teacher told him to go to the board and for the first time he felt nervous. He felt that if his answer was wrong and he might be scolded by the teacher.)

Literatures underscore that perception of Math as a difficult subject is associated strongly to lower self-efficacy than disliking of the subject. This finding supports very much the findings of Zan and Martino (2008) that students like mathematics as they can do it and dislike it as they cannot do it. Furthermore, some students have repeatedly performed poorly, leading to loss of self- confidence and increased tension. There are others who believe that mathematics is a measure of their intelligence (Trujillo and Hadfield, 2016) and are embarrassed by their inadequate performance. Lastly, student cohesiveness within a class has been found to have a significant positive correlation with mathematics anxiety level (Foong, 2007). The literature review has underlined the multi-faceted and varied nature of the origins of mathematics anxiety, thus supporting the research aim to diagnose our students' anxieties.

Types of Mathematics Concepts Causing Math Anxiety to Students

Formula in mathematics, number operations especially multiplication and long division was a concern since most of the students answered that they had hard time to cope with and learn this number operation. Student B, response to question about the mathematics concepts causing his Math Anxiety.

"I had a hard time in doing multiplication and division! I can't ever do it, the multiplication and division. I do not learn in times table. I still can't do it because it used the fingers in counting the numbers and I never had a good memory so I could never learn it. I still use pencil and paper to do the lines on my paper to count up things."

According to research, a student with Math anxiety has added difficulty working a problem such as long-division that requires one to continually keep track of the different calculations being performed. This happens because he is unable to focus solely on performing the calculations, and also has to deal with negative thoughts and feelings towards mathematics. If a student has math anxiety, it is also more likely that he has test and social anxiety as well (Zan & Martino, 2008). Again, students who are anxious about mathematics are less likely to continue working on problems if they fail to understand it the first time. This occurs over and over again if not treated.

Students who experience mathematics anxiety are more likely to delay completion or not do tasks assigned to them at all (Hellum, 2010). Described as a fear towards mathematical operations in mathematics classes, mathematics anxiety is found to hinder learners' positive thinking about mathematics learning and feeling calm. This fear causes low self-esteem, disappointment and academic failure (Khatoon & Mahmood, 2010; Jansen et al., 2013).

4. SUMMARY AND CONCLUSION

Data from this study suggests that negative experiences of the participants in the study most commonly originated in their elementary and high school years. The perceived reasons for these negative experiences are attributed to the teacher, the perception that Mathematics is a difficult subject and the lack of self-confidence. However, the last two factors can also be attributed to teachers rather than to specific mathematical content or to social factors.

Situations which caused most anxiety for the participants included communication in one's mathematical knowledge/ideas, whether in a test situation or in the teaching of mathematics.

Math anxiety is a learned response, and, as such, it can be unlearned by exploring and understanding the causes that trigger it. Anxiety is also a physical reaction to stressful situations, and its signs can be identified and controlled by proper cognitive and/or relaxation exercises, like accepting your fears and acknowledging your feelings or practicing a relaxation exercise involving breathing techniques; and also, by having determination, by turning negative-self-talk into positive self-talk, and by creating good study habits.

The findings have clear implications for the intervention program to follow after this study. The findings that many of the participants' Math anxiety was teacher-factor indicates the need for the facilitator in the ensuing workshops to warm, non-intimidating and supportive in nature. Much of the anxiety happens in the classroom due to the lack of diversity in

learning styles of students. Mathematics must be looked upon with a positive attitude to reduce math anxiety. Therefore, teachers must re-examine traditional teaching methods which often do not match students' learning styles and skills needed in a technologically advanced society. Lessons must be presented in a variety of ways which accommodates students' different learning styles. However, some amount of anxiety is helpful to keep students motivated and energized although anxiety levels need to be closely monitored so that it does not interfere with their ability to do well in class.

The findings also imply that the participants need to be provided with learning environments where they able to explore and communicate mathematics in a supportive environment, explore and relearn basic mathematical concepts and ideas, applying this relearnt knowledge in real life situation.

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