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About the Journal

Founded in 2013, the Journal of Teacher Action Research (ISSN: 2332-2233) is a peer-reviewed online journal indexed with EBSCO that seeks practical research that can be implemented in Pre-Kindergarten through Post-Secondary classrooms. The primary function of this journal is to provide classroom teachers and researchers a means for sharing classroom practices.

The journal accepts articles for peer-review that describe classroom practice which positively impacts student learning. We define teacher action research as teachers (at all levels) studying their practice and/or their students' learning in a methodical way in order to inform classroom practice. Articles submitted to the journal should demonstrate an action research focus with intent to improve the author's practice.

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USING BIBLIOTHERAPY AND PERSONAL REFLECTION AS TOOLS FOR REDUCING MATH ANXIETY

Christine M. Higgins

Cardinal Newman High School

Joseph M. Furner

Florida Atlantic University

Tina Gerencser

Cardinal Newman High School

Abstract This study shares an action research project in a high school located in South Florida addressing mathematics anxiety reduction with 9th grade students starting high school in an Intensive Math and Reading class with a Special Education teacher using a Math Anxiety Reduction protocol based on sound research. The paper shares the need, the research, the protocol, an analysis, and suggestions for teachers and schools so to address math anxiety so to build confidence.

Keywords: teacher action research, mathematics anxiety, high school, bibliotherapy, mathematics anxiety reduction

Introduction

Children don't hate math. What they hate is being confused, intimidated, and embarrassed by math. With understanding comes passion, and with passion comes growth – a treasure is unlocked.

-Larry Martinek, Founder of Mathnasium

Honest self-reflection opens your mind to reprogramming, change, success and freedom.

-Unknown

The student's essay was quite clear regarding their feelings about mathematics, "I am in Algebra I and I do not like it. It is the second semester and I have a better grade, but still hate math." Unfortunately, this is all too common in school classrooms today, especially for those students who have struggled with mathematics throughout their elementary and middle school years. Students who face this deficit may be limiting their opportunities for college and career choices. There is a need for students entering high school to have support that focuses on building mathematics skills and addressing mathematics anxiety. We are in a world that is increasingly being driven by technology and communication where employers are now listing flexible, empowered, strategic, curious, and innovative as preferred skills. Globally, the international tests indicate that American students still fall short when compared to student performance in other countries. The Organization for Economic Cooperation and Development (OECD) released the latest Programme for International Students Assessment (PISA) results from 2015. In mathematics, the United States' mean score was 470, which is 20 points below the OECD mean score of 490 (Kang, 2016; OECD, 2018).

The purpose of this action research project was to better understand why students continue to struggle with high school level mathematics, particularly algebra, to understand the role that mathematics anxiety may play in their quantitative development, and to make recommendations to inform teachers' instruction. An action research project was used to obtain information in an effort to change classroom practices to better aid students in learning math. Higgins (2013) found that mathematics teachers working together, sharing a common purpose and working towards a goal will have a bigger impact on student learning and success. Fraenkel, Wallen, and Hyun (2015) write that "practical action research is intended to address a specific problem within a classroom, school or other 'community...Its primary purpose is to improve practice in the short term as well as inform larger issues" (p. 588). The guiding question used throughout the project was, "How can the use of bibliotherapy, writing, and personal reflection activities help students reduce math anxiety?"

This project envisioned by the Professional Development Professor, Principal, and ESE Teacher is in line with work by Venables (2014) on how teachers can turn data and results into action research to assist them in understanding student success rates at the school, "In all cases, our ultimate purpose in reviewing and responding to data is to improve some aspect of our students' learning" (p. 19). The NCTM (1989) as part of their mathematics *Standards* recommend teachers checking for negative dispositions of their students many decades ago. NCTM then published strategies for addressing math anxiety in 1995 (NCTM) and the Common Core State Standards (CCSS) (National Governors Association, 2010) for Mathematics also concerned with preparing young people for STEM and building math confidence also addressed this concern about math attitudes. Peterson, Barrows, and Gift (2016) also cited the rigor of the new Common Core Math Standards and how important it is for teachers to also address and support the math anxiety when teaching the new standards. Reys, Lindquist, Lambdin, and Smith (2014) have been mathematics educators for decades and recommend that teachers train their students to persist in asking the

teacher to make all mathematics they are teaching clear so that students never feel any anxiety when learning. This is key and really needs to be put into practice in all classrooms.

Literature Review

Math Anxiety is Real. What is math anxiety? Simply put, it is anxiety when confronted with doing math, especially about one's own performance in solving math problems. It can range from slight nervousness to all-out panic. This anxiety makes it more difficult for students to focus in class, learn math, solve math problems, and take tests. Repeatedly students would rather give up than have to face their fear of the subject. This means that they never get better at math and can therefore never overcome their anxiety. Richardson and Suinn (1972) originally defined math anxiety as, "a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). Mathematics anxiety is the, "irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" (Buckley and Ribordy, 1982, p. 1). If this anxiety is not overcome, the student may suffer from this anxiety for their entire life, even beyond their time in school. Math anxiety is a well-documented phenomenon that has affected many cultures for over forty years or more, and not enough is being done to address it in our classrooms or in the way we teach math (Andrews & Brown, 2015; Beilock & Willingham, 2014; Chernoff & Stone, 2014; Dowker, Sarkar, & Looi, 2016; Finlayson, 2014; Furner, 2017a; Furner, 2017b; Furner and Kenney, 2011; Furner, 2004; Furner, 1996; Geist, 2010; Hembree, 1990; Metje, Frank, & Croft, 2007; Rubinsten, Eidlin, Wohl, & Akibli, 2015).

Undesirable attitudes toward mathematics and math anxiety are serious roadblocks for students in all levels of education (Geist, 2010). Beilock and Willingham (2014) state that "Because math anxiety is widespread and tied to poor math skills, we must understand what we can do to alleviate it" (p. 29). If math anxiety is such a problem, one has to wonder why more is not being done about it in our schools today with such an emphasis on STEM. Today, teachers and administrators are discussing project-based learning that will incorporate strategies across the STEM disciplines, and mathematical understanding is crucial to producing a work force that is strong in STEM areas and who can compete globally. (Furner, 2017a). Strong math skills help students with critical decision-making and are essential to successfully completing higher level math and science courses. The importance of this research is to add to the body of literature on math anxiety and to propose strategies and activities that may help students reduce their math anxiety.

Methodology

Qualitative research relies on a "holistic description" of a particular situation, phenomenon, or activity (Fraenkel et al., 2015, p. 426). A defining attribute of qualitative data uses words and rich description, rather than numbers. "Words, especially organized into incidents or stories, have a concrete, vivid, meaningful flavor, that often proves more convincing to a reader...than pages of summarized numbers" (Miles & Huberman, 1994, p. 1). To achieve this level of understanding, qualitative research employs several unique procedures that set

it apart from quantitative research. Some of these characteristics include: the research is done in the natural setting; data collection methods vary, but usually include in-depth interviewing, observations, and document analysis; the research is “emergent” rather than hypothesized; the research is interpretive, seen through the researchers’ personal lens; the process of data analysis focuses on reoccurring themes using “inductive and deductive processes” (Creswell, 2003, p. 183). Qualitative data sources for the action research included recorded class discussions, student assignments, *Mathitudes Survey* (Furner, 2007), and journal entries. Quantitative data was obtained through the use of pre- and post-tests.

The students began the semester by reading the book, “The Math Curse” by Jon Scieszka and Lane Smith (1995). The ESE teacher read and discussed the book, as well as solved the math problems that occurred throughout the story. This led to a discussion about individual student’s feelings toward math. The group discussion allowed the students to share without being judged. Through discussion, many of the students believed that it was their middle school teachers that shaped their feelings toward math. While some said their middle-school teachers created a safe and positive math learning environment, others blamed the teaching style of their teachers as the reason behind their continued math struggles and anxiety.

The discussions were one way to gauge the student’s personal views of themselves as learners of math. The students also shared their views of the benefits and significance of math in society. Many students stated that they did not understand the importance of learning math and did not know what the point was since they would never use higher math in the future. The group brainstormed all of the different ways that math could be used on a daily basis, including possible career paths and the usefulness and importance of math in their daily lives.

The students also were asked to write a “Math Autobiography.” The purpose of the assignment was for each student to reflect on their early experiences with mathematics and to describe how they felt about mathematics. Students were encouraged to describe their attitude toward math. Students could include some of their early experiences with math classes, both positive and negative. Students could explain why they like math or didn’t like math. They were expected to write a five-paragraph essay. While writing, there was open dialogue between the ESE teacher and the students regarding their feelings toward math.

The essay writing assignment took approximately two weeks to complete. During this time, students took a “*Mathitudes Survey*” (See Appendix A, Furner, 2007) and a “Math Anxiety Test.” The *Mathitudes Survey* portions created as part of research, Furner, 1996 and 2007 was created to collect qualitative data on students’ feelings toward mathematics. This survey and test were given to the students for them to gain an understanding of their feelings toward math and for the teacher to be able to identify those who may have math anxiety. Following the essay assignment, several discussions took place with the students. One topic centered on the importance of learning math and ways to help overcome negative feelings toward math. Many students continued to blame their low math ability and their disdain toward math on what they felt was previous teachers’ inadequate teaching. Teaching students to now advocate for themselves when not understanding a

topic was encouraged. The school has built in time within each day of the week for quiet study and tutoring. It was important to teach these students to use this time for getting extra help.

Another discussion was on the topic, “What is Math Anxiety?” The physical and psychological symptoms of math anxiety were discussed. The physical symptoms discussed included: sweating, heart palpitations, nausea, shaking and trembling. Some of the students said they recognized physical symptoms such as shaking, sweating, heart palpitations and nervous feelings in the stomach. The psychological symptoms discussed included: panic and feelings of helplessness, feelings of inadequacy, avoidance and lack of confidence. The students shared their feelings of inadequacy which led to their low confidence.

“Math Myths” gave the students an opportunity to hear some misleading facts about math: 1. You have to be born with a mathematical brain; 2. You can’t be creative and be good at math; 3. Women are not as good at math as men. The ESE teacher shared ways to reduce math anxiety: get plenty of rest, proper nutrition and adequate exercise before a math test, stay positive, keep a journal, seek help when needed, use the internet to research math topics not understood, use resources such as flashcards and playing games that work on core cognitive skills.

The class discussed “The Math Anxiety Bill of Rights.” Some of the “rights” discussed included: I have the right to learn at my own pace and not feel put down or stupid if I’m slower than someone else. I have the right to ask whatever questions I have. I have the right to need extra help. I have the right to ask a teacher or a tutor for help. I have the right to say I don’t understand. I have the right not to understand. I have the right to feel good about myself regardless of my abilities in math (*The Math Anxiety Bill of Rights by Sandra Davis at: <http://www.mathpower.com/>*)

A second book, “Math Rashes and Other Classroom Tales” by Douglas Evans (2002), was read during the class time. Bibliotherapy was used in hopes of connecting students to others with similar math fears and anxieties. Class discussions continued using the characters in the book, relating their own feelings towards math.

A third, and final, book “A Gebra Named Al” by Wendy Isdell (2017) also used bibliotherapy to help reduce the students’ negative feelings toward math and any math anxiety they may have. Focus on the math calculations and math content in the book was left to the Intensive Math teacher.

Math Anxiety Reduction using Bibliotherapy and Reflection Protocol. Participants for the action research project included 6-15 students in a combined Intensive Math and Intensive Reading classroom; the number of students was dependent on the daily rotation between the ESE and math teacher. Students were placed in the intensive classes due to low admission test scores, low standardized tests scores and low math grades from middle school. A few of the students were identified with a math learning disability, some other learning disabilities and Other Health Impairment (OHI) to include Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD). The group of students rotated between an Intensive Math class and an Intensive Reading class, thus, at times there would

be 6 – 8 students in each class. The time spent with students on the research project was 2-3 days per week depending on the rotating schedule. The project took place in the first semester of the 2017/2018 school year, from August until December. Several follow-up activities also occurred in the second semester of the 2017/2018 school year.

Students were first introduced to the topics of math anxiety and bibliotherapy during the Intensive Reading group. While working with the Intensive Math teacher and through discussion with the general education math teacher, the ESE teacher wanted to see if the students' disengagement with math, frustration, avoidance, and low-test scores were perhaps the result of unrecognized math anxieties. The students in the Intensive Math/Reading groups avoid doing homework and when they do, they often do it incorrectly. The students also verbalized their dislike for math by making statements, "I am not good at math", "I hate math", or "What is the point of math?" Other comments included, "No one likes doing something they struggle with; that is why I do not like math."

Strategies Used During Reading and Math. Pre-reading strategies that focused on vocabulary were used for each book. Students used a website, vocabulary.com, to understand some of the words found within the texts and they created illustrations that defined the words. Sometimes, the students would read independently and sometimes the books were read together as a group. If students wished, they could also read in a small group with the teacher or continue reading independently. Students were held accountable for their reading through formative assessments using vocabulary and comprehensive questions based upon their reading.

Journaling was another strategy used throughout the semester. Discussions focused on the characters' feelings towards math; students were encouraged to journal as it related to their own personal feelings towards math. Comments from the journals included, "We could relate to the character because she struggles with math like we do..." and, "She fell asleep on her book and dreamt and, sometimes I daydream during class because I am bored from taking too many notes and then I miss the notes." Also, "This makes me get further behind."

At the conclusion of reading the books and after winter break, the students were asked to complete a second "*Mathitudes Survey*" and take a second "Math Anxiety Test." They were also assigned to write another "Math Autobiography" so that they could reflect again on their attitudes toward math. The goal of the project was to observe any changes in attitudes towards math while using bibliotherapy and self-reflection.

The final strategy also took place at the beginning of the second semester and this focused on the student's perception of their own study skills. Given a choice of writing a poem, drawing a picture, or writing an essay, students were asked to show what they had learned about their own study skills and what improvements they would make for the new semester in math. Student work reflected skills such as: using friends to study with; staying on task; using websites and other study resources; creating a study schedule; taking better notes; and, making flash cards.

Results and Discussion

According to the ESE teacher, the students enjoyed “The Math Curse” and “Math Rashes.” Students were entertained by the stories. The students did not seem to mind writing their math autobiographies as they were able to express their feelings, as well as their frustrations. They also seemed to enjoy completing the *Mathitudes Survey* and Math Anxiety Tests. By sharing their thoughts and feelings through the autobiography and surveys, the students were able to relate to the other students in the class that had some of the same negative feelings as their own and it allowed the students to see that they were not alone in their struggles with feeling inadequate in math. It also gave the students the opportunity to discuss their feelings about their perceptions of what they believed to be “bad math teachers” in elementary school in a judgmental environment.

One difficulty was the disruption to learning due to the rotation of the classes between the Intensive Reading and Intensive Math teachers. Instructional time was lost in having to remind students of previous material covered. Another challenge was the fact that students were required to receive a grade. This was especially true with the part of the project that required reading the book, “A Gebra Named Al.” The students earned grades for their Intensive Reading class based on this lesson and it was important that reading skills were incorporated into the project. The grade seemed to take away from what the teacher had hoped to gain through the project in terms of focusing on reduction of math anxiety. Because students’ grades were dependent upon reading the novel, answering questions and learning vocabulary, it seemed to add more stress in terms of the students having to complete the required reading and lessons. It would be more beneficial to use it solely as bibliotherapy without required lessons and grades attached.

Qualitative data was gathered using a *Mathitudes Survey* and Math Autobiography. Students were asked to complete both, once in August 2017 and once in February/March, 2018. The data analysis process for qualitative research involves identifying key themes or patterns that emerge from the interactions and socialization within the culture. Fraenkel et al. (2015) feel that the data analysis process actually begins “from the first moment a researcher selects a problem to study,” and ends when the “final report is written” (p. 516).

The *Mathitudes Survey* (Furner, 2007) and Autobiographies revealed three common themes: (a) students did not feel prepared for the concepts in Algebra I; (b) the length and complexity of the math problems increased at this level causing students to give up, and (c) students did not see the need for learning Algebra I. One student said:

Coming into high school, I was not prepared for Algebra...my teacher never moved me up to the regular math class I was supposed to be in. I never had good math teachers in middle school, especially my 8th grade year. The person who taught me math was a social studies teacher who had no idea what she was teaching.

Another student expressed that she has negative feelings towards math because she did not feel prepared after elementary and middle school, “My middle school teacher never taught

me any math. She expected me to learn through an iPad screen and know everything. Since then, math has always been a subject I've struggled in a lot and it made me anxious."

The complexity of math topics in high school increases so the need for a strong foundation in basic skills is essential. For example, students will begin the year with solving one-step equations but will progress to solving multi-step equations, which often include fractions and decimals. One student expressed his frustration with math as the topics became more complicated, "Long problem solving makes this even more confusing. Too many numbers can make me think things differently. Also, long problem solving can make me tired...or maybe aggravating. And when I'm aggravated, I be mad with everyone around me." Another student wrote, "Math has been difficult for me because it is a lot of work. Sometime, doing long operations can get me off track, or it can make me lose focus."

Understanding the need for math and how it relates to everyday life was another area of concern, "The reason why I think I feel this way about math is because it's always been a pain to do...and I don't see the use of algebra. You might need to know algebra for a few jobs but I don't see a situation in life where I'm going to need to know how to do this in the future." Another student wrote, "Math is just the one subject in my mind you will never need in life."

The *Mathitudes Survey* revealed that many students' favorite things in math were the simple operations of adding, subtracting, multiplying, and dividing, and that their least favorite thing in math was "dealing with letters" and that the math "gets harder every lesson." These comments reinforce the themes present in the Math Autobiographies when students felt that the math was too complex. Six out of six students who took the survey said that math stresses them out because they're not good at it. In turn, when they were asked what is one thing they would ask for, several students wrote that they want to improve their math ability, "If I could ask for one thing in math, it would be to learn fractions better." Another student said, "If I could ask for one thing in math, it would be to be better at it."

When students returned for the second semester in January, they also wrote an essay about their progress in math during first semester and what they might do to improve their math grade for second semester. The ESE teacher asked the students to develop a study plan after reflecting on how they prepared or did not prepare for math tests during the first semester. Students study plans now included skills such as note-taking, staying on task, using study websites and games, such as *Kahoots*, and studying with friends to help them be more successful.

The *Mathitudes Survey* was given a second time in February 2018. When asked again if math were a color, what color would it be, students continued to have a more negative outlook answering with dark colors, such as black, and colors that they personally did not like. Additionally, when asked if math were an animal, what animal would it be, the responses, again, represented a somewhat gloomy outlook. For example, responses included a "snake,"

“bull,” and “lion.” However, while math continues to be a challenge for these students, there was a better outlook for some. One student admitted that she has a passing grade in her math class now and is no longer stressed out by it, “math used to stress me out because I didn’t understand it.” Another student said that math is not stressful because, “it is my favorite class.”

Quantitative data was gathered using a pre and post Math Anxiety: A Self Test (Freedman, 2017). Students were given the pre-test in August 2017 and the post-test in February 2018. Students were also asked 10 questions that focused on negative feelings toward math and their math class (See Appendix A). Students rated their answers on the self-test using a Likert scale, 1-5, 1 = Disagree and 5 = Agree. The scores were totaled and the following scale was associated with the level of math anxiety, see Table 1.

Table 1: Mathematics Anxiety Score Levels

Math Anxiety Score Range	Feelings about Math Levels
45-50 points	Sure thing, you have math anxiety.
30-39 points	No doubt! The thought of doing math still makes you uneasy.
20-29 points	Perhaps!
10-19 points	Wow! Possibly a math major in the making.

The average score in August 2017 was 35.25. Low score = 27; High score = 42. The average score in February 2018 was 30.25. Low score was 24; High score was 36. Overall there was a drop of 5 points in the average scores from August 2017 to February 2018, with 7 points being the biggest difference in scores.

The decrease in negative feelings towards math during the second semester may be attributed to the students’ increased awareness of what math anxiety is through the classroom discussions and the use of bibliotherapy, connecting with characters’ similar feelings of math and anxiety. Learning ways to reduce math anxiety was also helpful for students to realize that they had control over their feelings. Things like getting plenty of rest, eating a proper diet, getting enough exercise, and having positive thoughts were all things the students could control. Often, students, and some teachers, are unaware that math anxiety is real. At the start of the second semester, the students were required to reflect and put onto paper changes they would make in study skills. This reflection helped students formulate a plan for success for the second semester. Again, another opportunity for the students to take control of their learning. This action research helped teachers to realize that there are different pedagogical approaches that can help students succeed in the math classroom.

Implications

Four recommendations and instructional changes resulted from the action research:

1. Communication with elementary and middle school teachers regarding math anxiety and their own personal math experience became a priority. The research indicated that students felt their success in math was directly related to their experience with learning math in elementary and middle school and their teacher's ability. The principal will recommend to the District Office that professional learning opportunities take place that include dialogue between grade levels, a seminar on what math anxiety is and how to help students who struggle with it, and resources for teachers who want to improve their own math knowledge and instruction.
2. Better connection made between how mathematics is used in the real world and how it is being used in more and more careers which involve technology, design, and communication. Students repeatedly said that they did not understand why they needed to learn Algebra. The school should look at partnerships with local businesses who especially use some aspect of mathematics or science that will help students make these connections. Students need to see the value in learning something that is difficult but also valuable for their future.
3. One instructional change that resulted from the action-research was the discussion about math anxiety and the real feelings produced by it. This change went beyond the Intensive Math and Reading students, impacting Algebra I and II students as well. As other teachers became aware of the action-research on math anxiety, class discussions took place. The principal recommended that each school year, the math instructors begin with the *Mathitudes Survey* and a discussion on math anxiety.
4. A second instructional change was the continued use of bibliotherapy in the Intensive Math Class. The bibliotherapy will focus on discussion and not require additional assignments for students in order to alleviate any added stress. Students need to understand that they are not alone when it comes to their feelings and anxieties about math.

Conclusion

Using Bibliotherapy and Personal Reflection as tools for reducing math anxiety can be an effective method for an Intensive Math & Reading Course where students need extra support with both reading and mathematics confidence. This paper described an action research project in a high school located in the Southeast, U.S. addressing math anxiety reduction with 9th grade students starting high school in an Intensive Math and Reading class with a Special Education (ESE) teacher using Math Anxiety Reduction protocol. The paper shared the need from the perspective of the principal of the school and how she felt students could benefit from reading about people who have math anxiety in order to build confidence. The research protocol is not new and has been advocated in previous research. The findings from this research recommend that teachers first consider students attitudes toward math as they begin the school year, and second, talk about past experiences in math

classes, even if these experiences are negative. The research is very clear when it comes to addressing math anxiety, in order to overcome or reduce it, one needs to talk about it. They need to discuss what caused it, how they feel, and how they can cope with it and develop more confidence to overcome such anxiety. Teachers can also help students when they are better prepared to teach study skills, note taking, how to approach homework and how to prepare for quizzes and tests.

Most research on math anxiety points out the distinction between reduction and prevention. The best approach for preventing math anxiety is using what is considered “best practices” for teaching mathematics. In turn, reduction is much different and requires more counseling and desensitization techniques, discussion, counseling, reflection and even bibliotherapy. Today, as students enter middle or high school, they should be evaluated and checked for their dispositions toward mathematics. Teachers need to take on the role of counselor or team up with other specialists to address any student who has negative feelings towards mathematics, which can hold them back or prevent them from having success during the next few years. The principal, ESE teacher, and professor worked as a team in developing protocol to help 9th graders address math anxiety and other fears of quantitative reasoning. According to Venables (2014), teachers can no longer work in isolation. It is essential that teams “collectively and collaboratively” work together for the success of students (pg.103). This project has helped some of the students understand their anxiety and it has given these students the tools for studying and learning math, building their confidence. It is critical that when students graduate from high school they can say: “I like math and I can choose any career I want and I will never let math hold me back from my dreams.” When math teachers allow students to discuss their feelings and self-reflect on their learning in math class, when they start to understand and can then develop a passion for math, then teachers can unlock a treasure and love of math that can help their students for their future.

About the Authors

Christine M. Higgins, Ph.D. is the principal of Cardinal Newman High School in West Palm Beach, Florida. She received her Bachelor's Degree in Mathematics from Florida Atlantic University and her Master's in Educational Leadership and Ph.D. in Curriculum and Instruction from Florida Atlantic University. Research interests include teacher leadership and professional learning. In addition to teaching mathematics at the secondary and college levels, Dr. Higgins has taught in the Department of Education Research at Florida Atlantic University. Dr. Higgins currently lives in Port Saint Lucie, Florida with her family and enjoys reading, writing, and working with children. Email: chiggin5@fau.edu

Joseph M. Furner, Ph.D. is a Professor of Mathematics Education in the Department of Teaching and Learning at Florida Atlantic University in Jupiter, Florida. He received his Bachelor's degree in Education from the State University of New York at Oneonta and his Masters and Ph.D. in Curriculum and Instruction and Mathematics Education from the University of Alabama. His scholarly research relates to math anxiety, the implementation of the national and state standards, English language issues as they relate to math instruction, the use of technology in mathematics instruction, math manipulatives, family math, and children's literature in the teaching of mathematics. Dr. Furner is the founding editor of Mathitudes Online at: <http://www.coe.fau.edu/centersandprograms/mathitudes/> He is the author of more than 80+ peer-reviewed papers. Dr. Furner has worked as an educator in New York, Florida, Mexico, and Colombia. He is concerned with peace on earth and humans doing more to unite, live in Spirit, and to care for our Mother Earth and each other. He is the author of *Living Well: Caring Enough to Do What's Right*. Dr. Furner currently lives with his family in Palm Beach, Florida. He enjoys his job, family, civic and church involvement and the beach. Email: jfurner@fau.edu

Tina Gerencser is a teacher of special education in Palm Beach County, Florida. She received her Bachelor of Education in the areas of Elementary Education 1-8, and Special Education K-12 from Capital University in Columbus, Ohio. In addition to teaching, Ms. Gerencser is an Academic Life Coach, tutoring and instructing students in study skills and test-taking strategies. Ms. Gerencser currently lives in Delray Beach, Florida. She enjoys nature, riding her bike, and visiting friends and family. Email: tackgere123@gmail.com

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Appendix A: *Mathitudes Survey*

Name_____

Grade_____

Math Class_____

Age_____

Career or Career Interest_____

Mathitudes Survey

1. When I hear the word math I.....
2. My favorite thing in math is.....
3. My least favorite thing in math is.....
4. If I could ask for one thing in math it would be.....
5. My favorite teacher for math is_____ because_____
6. If math were a color it would be.....
7. If math were an animal it would be.....
8. My favorite subject is_____ because_____
9. Math stresses me out: True or False Explain if you can.
10. I am a good math problem-solver: True or False Explain if you can.

