I DON'T KNOW WHAT TO DO: MATHEMATICS ANXIETY AS PERCEIVED BY STUDENTS AND THEIR PARENTS

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A problem influencing mathematics performance and student's perceptions of their ability to learn mathematics is mathematics anxiety. This mixed method study examined the perceptions, correlations, and mathematical conversations of Hispanic fourth and fifth grade low-performing students and their parents. A psychological approach provided the framework necessary to understand the theories behind mathematics self-concept. Instrumentation included the Mathematics Anxiety Rating Scale for Elementary students (MARS-E), the Mathematics Anxiety Rating Scale for adults (MARS-SV), and interviews. Various mathematical situations and mathematical conversations were found to affect mathematics self-concept. The psychological implications disclosed specific characteristics to further understand how to create conditions to support mathematical learning.

Keywords: Affect, Emotion, Beliefs, and Attitudes

The problem of concern relates to the number of under-represented elementary students continually performing low academically and specifically in mathematics. The National Association of Education Progress (NAEP) reported only 36% of fourth graders were considered proficient in mathematics according to their mathematics assessment (NAEP, 2022). Hispanic students scored 21 points below white students and the achievement gap continues to widen according to NAEP. This becomes problematic as the mastery of mathematics is critical for STEM (science, technology, engineering, and mathematics) professions which are predicted to increase (Lacey & Wright, 2009), mathematics skills are an essential life skill (Vijayan & Joshith, 2018), and mathematics is a gateway in providing access to higher education and better employment opportunities (Bryk & Treisman, 2010). More importantly, research has shown several problems connected to low mathematics achievement including mathematics anxiety (Ashcraft & Krause, 2007; Luttenberger, Wimmer, & Paechter, 2018; Ma & Xu, 2004; Papuosek, Ruggeri, & Macher, 2012; Ramierez, Gunderson, Levine, & Beilock, 2013; Wigfield & Meece, 1988), parent mathematics anxiety (Berkowitz, Schaeffer, Maloney, Peterson, Gregor, Levine, & Beilock, 2015; Elizondo, Bruun, & Pletcher, 2021a; Schaffer, Rozek, Berkowitz, Levine, & Beilock, 2018), and issues related to self-beliefs such as low self-concept (McCleod, 1992; Shavelson, Hubner, Stanton, 1976; Shavelson & Bolus, 1981). Studies have shown a parent's mathematic anxiety correlates to their child's mathematics anxiety and affects mathematics performance in positive and negative ways (Berkowitz, Schaeffer, Maloney, Peterson, Gregor, Levine, & Beilock, 2015; Schaffer, Rozek, Berkowitz, Levine, & Beilock, 2018; Elizondo, Valadez, Lynch-Davis, & Bruun, 2021b; Soni & Kumari, 2017).

The problem of low performance in mathematics persists nationally (Fleischmann, Hopstock, Pelscar, Shelley, 2010) and further research is needed to fully comprehend the psychology of mathematics related to performance and motivation. There is little empirical evidence that studies the examination of Hispanic fourth and fifth grade under-represented students considered low performing in mathematics, what contributes to their mathematics self-concept (MSC), and if Hispanic parents contribute to MSC. The following four research questions guided a larger research study:

3. What are the perceptions of mathematics anxiety of fourth and fifth grade students considered low performing in mathematics?
4. What are the perceptions of parents' mathematics anxiety?
5. Is there a relationship between a parents' mathematics anxiety and a student's mathematics anxiety?
6. How do parents and their students talk about mathematics?

This research report will predominantly focus on results related to mathematics self-concept and the fourth research question concerning mathematics talk.

Theoretical Framework and Literature Review

Self-concept provides one perspective to help us understand an individual's behavior and it is a central concept relevant in psychology (Epstein, 1973). Researchers broadly defined self-concept as a person's perception of him or herself and these perceptions are created by one's experience and by their environment (Shavelson, Hubner, & Stanton, 1976; Shavelson & Bolus, 1981). Shavelson and his associates (1976) identified perceptions to be influenced by reinforcements, evaluations of significant others, and how one acknowledges their own behavior. They provided a definition of self-concept, created a theoretical framework for self-concept research, established a hierarchically model of self-concept, and further identified the construct of self-concept to be defined by seven critical features. The features more prominent for this study included: (1) self-concept was formed by participants categorizing information about themselves and then disclosing that information, (2) self-concept was hierarchical with perceptions of behavior at the core and moving to judgements about the self in subareas such as how participants felt about their self-concept related to mathematics, (3) general self-concept was more positive, however, in situation-specific experiences such as participants experienced mathematics anxiety within certain contexts, it became problematic, and (4) self-concept was descriptive and evaluative, individuals described themselves as "I enjoy mathematics" or evaluated themselves as "I do well in mathematics".

Mathematics Self-Concept

A student's mathematical self-concept (MSC) refers to their perceptions or belief in their ability to do well in mathematics or their confidence in learning mathematics (Elizondo et al., 2021b; Reyes, 1984;) and educators have realized the importance of fostering a student's self-concept as a critical component of mathematics education (McLeod, 1992; NTCM, 2000). A study by Wilkins (2004) conducted an international study consisting of 39 countries and found a correlation between MSC and mathematics performance to be positive and significant. Students with positive MSC had greater achievement and students with negative MSC had lower achievement. Other research discovered a reciprocal relationship may exist between MSC and mathematics anxiety (Ahmed, Minnaert, Kuyper, & Van Der Werf, 2012) and mathematics anxiety can foster negative self-concepts regarding mathematics abilities (Ashcraft & Kirk, 2001; Wu, Barth, Marsh, Craven, & Yeung, 2014). In addition, research investigated high school Latino students and results revealed MSC can help minimize a decrease in mathematics interest and low levels in mathematics interest placed a student at risk due to their decline in MSC (Denner, Valdes, Dickson, & Laursen, 2019).

Mathematics Anxiety

Mathematics anxiety can be defined as feelings of tension and nervousness (Richardson & Suinn, 1972), when individuals manipulate numbers and solve mathematical problems in academic situations (Carey, Hill, Devine, & Szucs, 2017; Hopko, Mahadevan, Bare, & Hunt, 2003; Paechter, Macher, Martskvishvili, Wimmer, Papousek, 2017; Richardson et. al, 1972), or have fear of making mistakes in mathematics (Chipman, Krantz, & Silver, 1992; Dutton, 1951). Studies have found students' mathematics anxiety to negatively impact one's ability to master mathematics content (Ashcraft & Krause, 2007; Hembree, 1990; Ma & Xu, 2004; Meece, Wigfield, & Eccles, 1990), mathematics anxiety affects working memory which is critical to the arithmetic and mathematics performance (Ashcraft & Krause, 2007; Luttenberger, et. al, 2018), mathematics anxiety affects mathematics motivation (Ashcraft & Krause, 2007; Hembree, 1990; Ma & Xu, 2004; Meece, Wigfield, & Eccles, 1990),), and effort put into mathematics learning (Paechter et. al, 2017; Wigfield & Meece, 1998).

Impact of Parents Mathematics Anxiety

Parent's mathematics anxiety is associated with lower student mathematics achievement (Maloney, Ramierez, Gunderson, Levine, & Beilock, 2015; Berowitz, Schaeffer, Maloney, Peterson, Gregor, Levine, & Beilock, 2015). First grade students of higher anxious parents learned less mathematics (Berkowitz et. al, 2015), and children learn less mathematics when their parents dislike or feel inadequate in mathematics (Maloney, et. al, 2015). Negative attitudes concerning mathematics are harmful and can result in low mathematics motivation, low mathematics self-efficacy (Hembree, 1990), and eliminating negative associations regarding parents' mathematics anxiety resulted in improved mathematics achievement (Schaffer, Rozek, Berkowitz, Levine, Beilock, 2018). Gunderson and associates (2012) discussed how parents' ideologies based on mathematics anxiety, mathematics self-concepts, and other mathematical beliefs affect their interactions with their child concerning mathematics and can influence their child's mathematics anxiety, attitudes, and achievement.

Parent Involvement and Mathematics Achievement

Not all types of parent involvement are beneficial for students' academic outcomes and what is more important is the way parents help (Moroni, Dumont, Trautwein, Niggli, & Baeriswyl, 2015). Studies have shown when parents exert control in mathematical homework situations such as doing it their way, this diminishes a child's sense of competence, mathematics self-concept, task persistence (Silinskas & Kikas, 2019), and lowered mathematics performance (Dumont, Trautwein, Ludtke, Neumann, Niggli, & Schnyder, 2012; Hill & Tyson, 2009; Nunez, 2015; Silinskas & Kikas, 2019). When children perceived their parent's help as interference, intrusive, or felt negativity during parent controlling homework assistance, this had a negative effect (Pomerantz & Eaton, 2001) and decreased mathematics self-concept, performance, and task persistence (Silinkskas & Kikas, 2019).

Funds of Knowledge and Mathematics Talk

Everyday mathematical concepts learned at home provide the building blocks to develop mathematical concepts learned in school (Gonzalez, Andrade, Civil, & Moll, 2001) and families offer unique types of knowledge that can and do promote learning for their children (Moll, Amanti, Neff, & Gonzalez, 1992). Families contribute to a student's mathematical learning (Civil, 2007), parents helped their children make real-world connections during mathematical homework time, held discussions related to mathematics homework, taught financial literacy (Wiliams, Tunks, Gonzalez-Carriedo, Faulkenberry, & Middlemiss, 2020), and families encouraged their children to learn mathematics in a positive way (Williams et. al, 2020). Discussions regarding mathematics in the home (Williams et al., 2020) and children being exposed to "math talk" before starting school was positively related to early mathematical abilities a year later (Susperreguy & Davis-Keen, 2016). Research also found that the number of times parents engaged their children in number related activities at home predicted their numerical knowledge and development (Ramani, Rowe, Eason, & Leech, 2015).

Methodology

The basis for this study resulted from mixed method research (Elizondo et al., 2021a) conducted in the summer of 2018 and showed mathematics anxiety (MA) to be an issue for both parents and students. The current study took place at three elementary schools (Title I) in south Texas. Eligibility included students who did not pass the State of Texas Assessment of Academic Readiness (STAAR) mathematics and scored low on mathematics benchmarks. Students (n=38) identified with the following demographics 36 Hispanic, 2 African American, 22 males, and 16 females. In addition, one parent from each child participated in the study (n=38) for a total of 76 participants. Parents associations included 36 Hispanic, One African American, 11 males, and 27 females. Purposeful sampling (Patton, 2002) was used to select information-rich cases based on the MARS-E (Suinn, Taylor, & Edwards, 1988) and MARS-SV (Suinn & Winston, 2002).

Data Collection

The quantitative part of the study utilized the MARS- E (26 items) and measured the degree of anxiety experienced by students in a variety of mathematics-related situations. Students were asked to indicate the degree of anxiety or nervousness that they felt in each situation, using a five-point Likert scale from 1 (not at all nervous) to 5 (very, very nervous). Total scores were calculated by taking the sum of all 26-items, the lowest possible total score of 26 signified low anxiety and the highest score of 130 indicated extreme anxiety (Suinn et al., 1988). Parent's MA was measured using the MARS-SV. The scale had 30-items designed to measure the anxiety experienced when completing mathematics-related activities. The MARS-SV is a five-point Likert scale that parents used to rate their anxiety using descriptors of (1) not at all, (2) a little, (3) a fair amount, (4) much, or (5) very much. The 30-items were calculated, and total scores ranged from 30 to 150 with higher scores indicating higher levels of MA.

The qualitative portion of the study was a descriptive analysis of students and parents' perceptions of MA and the discussions between parent and students regarding mathematics. Five families were purposively selected and consented to be interviewed using semi-structured interview questions. Parents were selected according to five profiles established by the MARS. (Table 1).

Table 1: Five Profiles Selected for Interviews

Parent	Student (child of parent)	Family
High Anxiety	High Anxiety	La Fuente Family
Moderate Anxiety	Moderate Anxiety	Vidal Family
Low Anxiety	Low Anxiety	Hernandez Family
High Anxiety	Low Anxiety	Lucido-Schwartz Family
High Anxiety	Moderate Anxiety	Jones-Mendez Family

Data Analysis

Descriptive statistics was used to portray the participants' mathematics anxiety in a collection of data, to depict patterns in the data, and to summarize the details of the data (Vogt, Gardner, Haeffele, & Vogt, 2014). The Pearson *r* correlation measured the association between students and parents' mathematics anxiety (Vogt et al., 2014). Analysis of the MARS results were broken down by specific constructs related to performance anxiety and test anxiety. Each question was analyzed according to their constructs finding the mean and standard deviation. This allowed a closer examination of the type of anxiety experienced by participants in certain mathematical situations. (Table 2)

Data was also gathered from the semi-structured interviews and the data was transcribed. MARS scale results informed the types of interview questions. For instance, participants showed more mathematics anxiety when learning new difficult mathematics material and interview questions were designed to provide a more in-depth rich description of that particular mathematics anxiety as perceived by parents and students. The researcher used descriptive coding or topic/theme coding (Wolcott, 1988) to allow any additional themes to naturally emerge from the transcriptions. Four themes emerged from data that included performance anxiety, test anxiety, positive mathematics self-concept and mathematics talk. In addition, three sub-themes materialized from data and included school, real-world, and assessment mathematics talk. The second cycle coding utilized was axial coding (Boeije, 2010; Glaser, 1978; Glaser & Strauss, 1967; Strauss, 1987; Strauss & Corbin, 1998). This linked the themes found in the first cycle with interview transcriptions (Charmaz, 2014). After the data had been arranged and the main themes were verified, themes were placed onto a concept map in a diagramming process to show connections and sequential progression recommended for axial coding (Strauss, 1987).

Results

This mixed-method research study examined 38 students and parents' perceptions of mathematics anxiety (MA) as measured by the MARS-E and the MARS-SV. The Pearson product-moment correlation coefficient determined there was a moderate relationship between parents and students MA in all five profiles ($r=.39$, $n=38$, $p>0.05$). The findings for this study were consistent with other mathematics anxiety (MA) research that showed a moderate relationship between parents and students with MA (Berkowitz, Schaeffer, Maloney, Peterson, Gregor, Levine, & Beilock, 2015; Gunderson, Ramirez, Levine, Beilock, 2012; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Schaffer, Rozek, Berkowitz, Levine, & Beilock, 2018). More importantly, data found both parents and students within the five profiles had positive mathematics self-concept (PMSC) despite exhibiting character MA. The quantitative findings from the MARS scale results produced five profiles (Table 1) and qualitative results further explained the various mathematical situations that contributed to a PMSC.

The current study found both parents and students within the five profiles had positive MSC despite experiencing MA. For example, both parent and child in the La Fuente family had high MA. However, Jacob (the child) talked about his mathematics self-concept and stated, "I don't think people will think that I am stupid in math, math is easy to learn, and it is my favorite subject." Marisol the mother explained her MSC, "My math anxiety has nothing to do with how people look at me, my everyday math skills are an eight (scale of 1-10). and math was my favorite subject in school." The Vidal family experienced moderate mathematics anxiety (MMA) and Alejandro (the child) expressed his own perceptions regarding his MSC, "I know I am doing good, and I feel fine learning math. I think others think I am good at math. Math makes me better and whenever I don't understand the teacher, or my mom helps, and I get it." Marcus his father disclosed his beliefs about his mathematical skills and said, "I use math at work all the time and people depend on me to be good at it. It comes natural for me, and I am good at it (math)." Parents and students believed their mathematical learning and skills were good, and their perceptions of how others viewed their mathematical skills was positive. Therefore, they exhibited a PMSC.

Positive MSC was further demonstrated as students continued to discuss their perceptions of their mathematical skills and their belief that they could learn mathematics. Jacob with the La Fuente family (HMA) provided additional insight by stating "Math is easy to learn, but division is difficult. I could be better, I need to practice more. I am excited to learn math and what I don't understand my mom can help me. My parents think I can do math and I am not nervous doing math in front of them." Other students like Marcus (MMA) and Arris (MMA) talked about their mathematical skills, Marcus explained, "My math skills are like a 7 (scale 1-10). I feel fine about learning math, and I know that I am doing good in math. My parents think I am good at math, and I feel good doing math with my mom and dad." Arris (MMA) also stated,Ω "My parents rate me at 8.5 (regarding his mathematics skills) and I can learn math, and I like it." This data further validates the theory behind MSC, and this study demonstrates that other's perceptions about mathematical skills may have contributed to students having a positive MSC.

Positive MSC was further validated as all profiles demonstrated parent support instead of parent control as previous research (Silinkskas & Kikas, 2019) found parent control contributed to a negative MSC. Parent support for this study consisted of parents assisting their child with homework only when asked, parents understood their child's learning needs, parents were actively involved, and learned new mathematical concepts for their children when needed. For example, Jacob (La Fuente Family) described mathematics homework time at home "I go to my mom first, she does not make me feel nervous and she helps me understand." Marisol his mother further explained by saying "We go over each problem, step by step, I try to keep him from getting nervous. I do old school use items in the house to explain the math. I learn how to better help him with his math homework from my husband." Other parent support was shown with the Jones-Mendez family, Azalea the mother had high MA and her son Arris had moderate MA. Arris explained that he asks his mom to help him when he needs it "I understand when she helps me and after all it is just math, I like math." Azalea described the mathematical discussions that occur and stated "I don't feel nervous helping him, I can listen to all his math lessons right now because of CO-VID and what he does not get, I help him with that. I don't project my lack of math confidence on my son, and can I learn what is needed to help him."

Students in this study felt their parents' support and involvement contributed to their success in mathematics, they were happy for the homework assistance, and the interactions between parents and students were very positive and could have contributed to their positive MSC. As illustrated when Jacob stated "It makes me feel a little happy when my mom helps me with my math homework. She gets close to me, and we look over the answers at the dinner table and she makes sure it is correct. She helps me a lot." Alejandro (Vidal Family) also commented about how he feels about his mathematics homework interactions with his mom and stated "Doing my math homework in front of my mom makes me feel kind of good because I am getting help. I am happy when my mom helps me, and I ask my mom when I don't get it (math).

The three types of mathematics talk occurring within the profiles included schoolwork, real-world, and assessment mathematics talk. Mathematics talk may have contributed to the PMSC experienced. Parents with high mathematics anxiety (MA) showed increased occurrences of mathematics talk when compared to other profiles with the exception of the parent with high MA and the student with low MA (the Lucido-Schwartz family). Examples of mathematics talk that occurred in the La Fuente family, Marisol (HMA) explained "I try to help him as much as possible, we study for his math tests together, and he asks me for help on his homework. We talk about his math grades, and I encourage him to do better when he needs to do better. We talk about his STARR math results, and when he does not do well, I tell him he will do better next time." Other profiles displayed similar mathematics talk such as Marcus (Vidal family MMA) "We talk about why he got a bad grade in math and what can we do to get a better grade. We talk about his STAAR math results and why he did not do well or if I need to talk to his teacher like does he need a tutor." Parents may contribute to a PMSC through mathematical talk occurring in the home especially if discussions are supportive and positive in nature.

Williams et al., (2020) found parents supported mathematics learning and that they intentionally promoted mathematics in their household like financial literacy. This was also the case in the current study, parents intentionally taught their children financial literacy. For example, Marisol (HMA) explained "I teach him the value of money like when we buy clothes, we talk about spending $40 on one shirt or spending $40 on one shirt, one pair of pants, and have money left over for ice cream." Jacob also discussed how his mom teaches him how to budget his money "She teaches me how to budget, and how to spend my money wisely." Two parents in the study discussed how they explained their household budgets to their kids. Marcus (MMA) stated "We talk about money when we go shopping like if he wants to buy something, I will explain that funds are kind of tight and explain why. He needs to learn how to budget and stay within a budget." Another parent Asia (HMA) said "We talk about saving money and how to budget money. I teach him the value of money and I have to pay the bills and what that means.

The following table provides a few examples of the mathematical situations that caused high MA and participants interview comments showed their positive MSC despite experiencing HMA.

Table 2: Mathematical Situations and Positive MSC

Profile	Mathematical Situation	Positive MSC
La Fuente Family (HMA)	Learning Math (HMA)	"My everyday math skills are an eight and I can learn math." (student and parent)
	Homework beyond basic functions (HMA)	"I know adding, subtracting, multiplying and dividing, (student and parent) I do not know the new math. Eventually, I will learn it." (parent)
	Getting the answer wrong when helping with homework (HMA)	"I listen and learn from my husband. Once I learn it, I can help him." (parent)

Jones-Mendez Family (PHMA/SMMA)	Getting the right answer (HMA)	"I do it over and over until I get it. If I don't get it, then I ask my mom. It is just a subject and I can learn math." (student) "I learn from his teacher (online classes) and I teach him what he does not understand. Like I said, if I don't know it, I will google it and I end up getting the answers right." (parent)
Vidal Family (MMA)	Learning New Difficult Math (HMA)	"I am fine learning new stuff. You just have to learn it." (student) "I get anxious with new stuff because people depend on me, but I can do it and I am good at math." (parent)

Conclusion

Data provided evidence to further understand the psychology of Hispanic fourth and fifth graders low performing in mathematics and their parents. What can be learned from this study is that parent support through mathematical discussions can create conditions to support positive mathematics self-concept despite experiencing mathematics anxiety. It will be critical to create conditions in the classroom that support a positive mathematics self-concept (PMSC), train pre-service and in-service teachers to create curriculum and conditions that support learning through PMSC, and build partnerships with parents to teach them about fostering the concept of parent support instead of parent control during mathematics homework. Mathematics learning should be enjoyed instead of students feeling anxious or unmotivated. Designing learning environments that support PMSC, reduce mathematics anxiety, and support the psychological development of students is needed. It will be necessary to continue research to further understand the implications of PMSC, what curriculum cultivates a PMSC, what teacher and parent interactions and discussions with students increase PMSC, what reduces mathematics anxiety, and how can we engage all learners through this process. Researchers could learn from students like Jacob who experienced high mathematics anxiety but had a PMSC, "Math is my favorite because it is kind of easy to learn. I am excited to be learning math and I don't feel nervous when my mom helps me with my math. I could be better in math, I just need to practice."

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