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Making Connections to Address Mathematics Anxiety: A Case Study of the Instructional Triangle and Remedial College Instructors

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Making Connections to Address Mathematics Anxiety: A Case Study of the Instructional Triangle and Remedial College Instructors

Abstract

Mathematics anxiety is a reality for many students as a number of community college and four-year university students feel disconnected from math and struggle to pass mathematics courses. Using a case study and grounded theory approach, six remedial mathematics instructors were interviewed and observed to examine their instructional strategies and practices. During the interviews, participants expounded upon the changes in strategies and practices implemented when aiding students struggling with anxiety. *The Instructional Triangle* was applied across participants to compare and contrast their experiences. The analysis focused on environmental factors that could increase or exacerbate mathematics anxiety. In particular, a theme of creating connections emerged from how teachers assess for and adjust their strategies and practices to support remedial mathematics students struggling with anxiety. Based on the findings, interventions for assisting educators and students in mediating anxiety promoting perspective-taking and empathy are recommended. Such intervention could inform future strategy and practice development, implementation, and evaluation.

Keywords

Mathematics Anxiety, Instructional Triangle, Interventions, Strategies, Practices, Qualitative Research

Introduction

Mathematics developmental study programs provide a bridge for students who have not mastered the necessary skills and knowledge to navigate their college education. In Georgia, remedial math instruction is of great concern. According to the University System of Georgia (USG), the number of remedial mathematics students who fail to complete their two-year or four-year degrees within the state of Georgia is greater than the national average (USG, 2018). The USG reported that 37% of students enrolled in learning support/remediation at two-year institutions, only seven percent graduate within three years (USG, 2018). Thus, 93% of two-year students enrolled in learning support/remediation fail to graduate (USG, 2018). Additionally, of the 52% of students enrolled in learning support/remediation at four-year institutions, only 25% graduate within six years (USG, 2018). Consequently, 75% of the students enrolled in learning support at four-year institutions fail to graduate (USG, 2018).

As remedial courses serve as the gateway for students to access core and degree-earning courses, remediation is pivotal in a college career. Unfortunately, students who do not complete remedial math courses are more likely to drop out of college during their first two years (Chen, 2016, p. 72). Additionally, less than a third of community college remedial mathematics students will enroll in college-level mathematics courses (p. 6). To further understand how to mitigate the role of math anxiety in college student math performance, this study focuses on remedial math instruction. The purpose of this study was to determine the strategies and practices used by educators to mitigate math anxiety within remedial mathematics courses at identified postsecondary institutions in South Georgia. Based on the literature, students in remedial mathematics are likely to experience moderate to high math anxiety and are unlikely to graduate. Furthermore, the researcher sought to understand educators' experiences teaching remedial mathematics courses regarding various topics, such as how their knowledge and experience impact their teaching philosophy, and how they interact with students with moderate to high math anxiety. Given these statistics, further examination of remedial mathematics in higher education is warranted.

Math Anxiety

One factor attributing to these poor outcomes is the invisible battle that students face, math anxiety. In fact, many students feel that failing math is like a "sudden death" (Tobias, 1995, p. 50). Hart and Ganley (2019) stated that moderate anxiety is not relegated to students at school but impacts the general population across the life course. Whether the failure occurs in a K-12 or college course, this experience can be "instant and frightening" which prevents students from engaging in mathematical tasks, pursing related degrees and/or occupations (Tobias, 1995, p. 50). Even though the phenomenon of mathematics anxiety impacts students as early as elementary education and as late as advanced collegiate education (Jackson & Leffingwell, 1999), mathematics anxiety has not been specifically studied within the context of *remedial* mathematics. This study focuses on strategies and practices implemented in remedial mathematics to mediate the negative effects of math anxiety.

Braham and Libertus (2018) defined math anxiety as "a negative emotional reaction to situations involving numbers or math" (p. 15). Math anxiety is detected as early as kindergarten but is distinct in fourth and fifth grades (Boaler, 2016; Jackson & Leffingwell, 1999). Even when identified early on, math anxiety continues to plague students' motivation toward mathematical concepts well into adulthood (Driscoll, 2005).

Math anxiety can pose a barrier to successful completion of mathematics courses necessary to graduate from college. Approximately 80% of community college students, compared to 25% of four-year college students, taking mathematics courses struggle with moderate to high math anxiety (Beilock & Willingham, 2014). Additionally, 67% of two-year and 44% of four-year students are remedial non-completers who have leave the institution without a degree (Chen, 2016). Given the prevalence of math anxiety within this population, and that math anxiety is a barrier to math performance, remedial math instruction should be examined for mitigating factors. Because math is a required course for all pathways, avoidance of math can adversely impact a student's choice of major, the likelihood of college completion, and subsequent career choices (Chen, 2016; Tobias, 1995).

The environment can also play a role in exacerbating math anxiety or potentially mitigating its effects. For example, instructional practices can exacerbate or increase students' math anxiety (Jackson & Leffingwell, 1999). Specifically, if teachers demonstrate that they enjoy mathematics and provide a safe learning environment, students are less likely to report feeling math anxiety. Conversely, teachers who show anger or reject students who ask for help create a poor environment for learning which fosters anxiety. Educators' behaviors that negatively impact "students' attitudes and achievement" include exhibiting anger, as well as educators who set unrealistic expectations, educators who embarrass students in front of peer groups, educators that exhibit gender bias, as well as educators who have the perception of being insensitive or uncaring (1999, p. 584).

Theoretical Framework: Instructional Triangle and Cognitive Consistency Theory

To examine remedial math instruction, as well as strategies and practices used by educators to mitigate math anxiety, the following theoretical lens was adopted. *The Instructional Triangle* (Ball & Forzani, 2009), originally represented as bidirectional connections between teacher, student, and content, served as a tool throughout data collection and analysis to discuss connection and disconnection as related to math anxiety (see Figure 1). This framework provided language to describe both the teacher and student perspective of remedial math instruction as interpreted from interviews, observations, and review of documents.

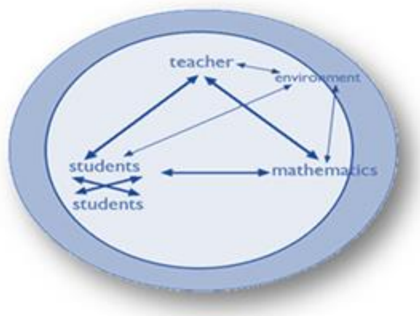

Figure 1 An Adaptation of Instruction and Interactions and The Instructional Triangle, (Ball & Forzani, 2009, p.499; Cohen et al., 2003, p. 124)

In understanding *The Instructional Triangle* and its relationships, it is essential to establish that each student will connect to their instructor, other students, and most importantly, the content (Ball & Forzani, 2009; Cohen et al., 2003). The development of depth in the relationships in these relationships (i.e., teacher-to-content, teacher-to-student, student-to-teacher, student-to-student, and student-to-content) speak to the degree of *connection* experienced. The lack of depth in the relationships characterize the degree of *disconnection* experienced.

The Instructional Triangle is underpinned by Dale Schunk's (2016) *Cognitive Contingency Theory*, which illustrated the various types of relationships between teacher, student, and content (Ball & Forzani, 2009; Schunk, 2016). Schunk (2016) referenced Fritz Heider's (1958) theory of Balance and combine with both the Balance Theory with the Cognitive Consistency theory and illustrated by way of the set of triangles The first author adapted Schunk's (2016) image of the triangles by illustrating T (teacher) and her student, S and the C, content (2016, p. 344). The triangle is very similar to *The Instructional Triangle* as depicted by

Ball and Forzani (2009) and Cohen et al. (2003); however, Schunk's (2016) triangle depicts the types of relationships that could occur (2016, p. 344).

Current Study

Teachers model for students how to interact with mathematics as a content area by demonstrating ways of thinking and problem solving, as well as reacting to themselves as students of math (Ball & Forzani, 2009, Cohen et al., 2003). Teachers' beliefs, their experiences as students, and their professional development will impact instructional design, instructional delivery, their ability to make themselves and the content accessible to students (Ball & Forzani, 2009; Cohen et al., 2003; Geist, 2015). Additionally, as demonstrated by the *Instructional Triangle* or more specifically *Cognitive Consistency/Balance Theory*, teachers can have a strong connection with, or understanding of, the content but a poor connection, or rapport, with students. This misalignment can impact the students' connection with the content, as in their understanding of, attitudes towards, and confidence regarding the content (Ball & Forzani, 2009; Cohen et al., 2003; Pajares, 1993; Schunk, 2016; p. 344). For this study, the teacher-to-content relationship was an illustration of each educator's strategies. Thus, it is important to understand that strategies are mindset, instructional preparations, educational background, beliefs about students' ability, beliefs about teaching ability, and teachers' connection to the content. Additionally, within this study design, the teacher-to-student relationship is illustrated by educator's practices. Practices are in class or direct interactions with students in which the strategies are carried out (Ball & Forzani, 2009). This research utilized the terms strategies and practices interchangeably; the researcher also clarifies distinctions between the two concepts related to this study's scope. A case study design was utilized to answer the research question that guided this study: *What strategies and practices do remedial mathematics instructors use to mitigate mathematics anxiety?*

Methods

Teachers were selected from two or four-year institutions with single or concurrent remedial mathematics course offerings in South Georgia. The purposeful sampling method was beneficial in targeting a specific sample with specific qualifications (fulltime or adjunct mathematics educators in higher education who teach remedial mathematics). The sample group received a survey that helped the researcher identify participants who met the study's more in-depth criteria.

Data Collection

Data were collected via survey, observations, interviews, and a review of documents. Demographic information was collected with the survey. The researcher conducted two in-depth interviews and two observations and collected the teachers' instructional materials (practice exams, workbooks, worksheets, and PowerPoints). Six participants with two to over 30 years of experience were interviewed (see Table 1). All but one participant identified as female and had at least a master's degree. In addition, each participant was observed twice using the Mathematics Classroom Observation Protocol for Practices: MCOPP (Gleason et al., 2017; see Appendix A).

Table 1:Demographic Characteristics of Participants

Pseudo Name	Ethnic Group	Gender	Type of Courses	Types of Environments	Years of Teaching Experience	Education
Brenda	CA	Female	Single	k-12, College	9	Masters
Harry	CA	Male	Single	Middle, High, College	2	Bachelors
Sarah	CA	Female	Concurrent/core	5, 7-12th grades, College	20+	Masters
LeAnn	CI	Female	Concurrent/core	High school, online, college	19	Masters
Penny	CA	Female	Concurrent/core	College	20	Masters
Joy	AA	Female	Concurrent/ remedial	k-12, online for-profit, College	30+	ABD

Note. AA=African American; CA =Caucasian, CI=Caucasian Immigrant

Data Analysis

A qualitative inquiry was used to analyze the cases in this study (Creswell & Gutterman, 2019). An iterative process of coding data yielded several findings and implications. Figure 2 below provides an example of open coding after several interactions of selected coding (including an external coder's findings). For additional coding, selected coding, and code breakdown (See Appendices).

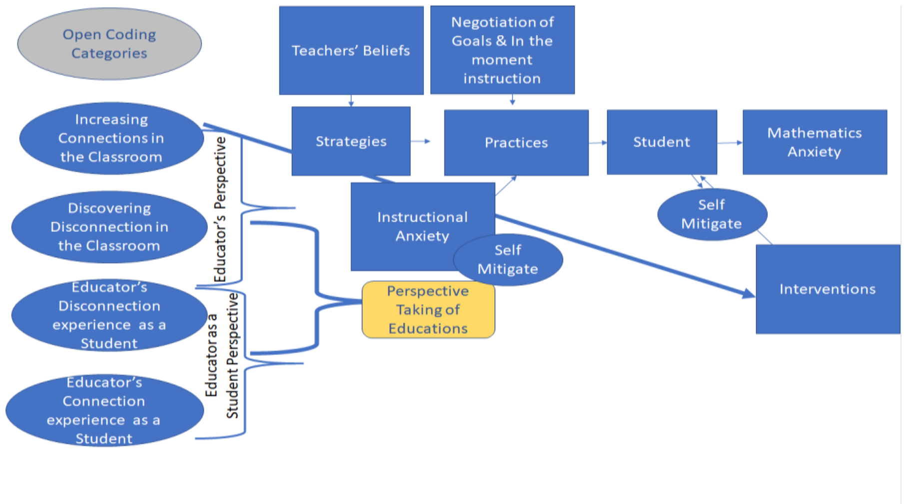

Figure 2. Axial Coding for Connection and Disconnection with Mathematic Environment (for a Possibly Anxious Educator or Anxious Student)

Findings

In response to the research question, *What strategies and practices do remedial mathematics instructors use to mitigate mathematics anxiety?* the following themes emerged from the iterative coding of the data across sources: Connections and Disconnections throughout The Instructional Triangle of the educators in the sample in their roles as students and educators (Ball & Forzani, 2009). Using quotes from their interviews, observations from their classrooms, and aspects of their course documents, we provide a rich description of each theme.

Connection (See Appendix C for Participants' Comparison Triangles)

As *The Instructional Triangle* indicates, relationships exist between the teacher and the content, the teacher and the student, the student, peers, the student, and the content (Ball & Forzani, 2009; Cohen et al., 2003). A major theme is that of connection, which creates and or enhances the teacher and the content, the teacher and the student, student and peers, and the student and the content. To better understand this, we examine the participant's connection to the content as students (see Table 2). All six of the participants made a strong connection with the content in elementary school. Brenda asserted that she was good at math and that this was confirmed by her teachers.

The participants indicated they started to identify themselves as both math-oriented and achievers during their connection experiences. Most participants were encouraged to take advanced level courses or dual-enrolled into college courses. Thus, participants developed a strong math self-concept and efficacy (Bandalos et al., 1995). For example, Harry described himself as a “star student” in college.

Table 2. *Connections: Educator as Student*

Sub-Theme	**Quote**
Connection to teacher	Harry: First time I guess was back in high school. When my history teacher, actually in history has never been my favorite subjects but. Right. I went to a very small school, so every teacher taught, like eight different subjects to cover more ground like every section so she taught history, she taught, economics, she taught the drama class. And I think she taught a geography class as well. She had several different jobs. But, yeah, my freshman year of high school I was very much, inside my own shell. Because it was a new high school, I didn't have any friends carried over from middle school. I didn't have any friends and I didn't know how to make any. And this teacher. She got me interested into the drama class. And she really helped me get out of my shell and actually talk to people. And yet when. By the time I graduated, I graduated a star student. So, I made her my star teacher, which she usually gets star teacher about every year. So, this is like her third year in a row. But, yeah, it was really special. For calculus 3. And a lot of it had to do with the professor to tell that he was in love with the subject material, and he was really good at teaching it, and he reminded me a lot of myself too. So that was the first time and then pretty much after that I had him for as many courses, as I possibly could. I had him, I think seven times throughout my math degree so. So, let's see calculus three history of math. Set Theory. Real analysis. Linear Algebra. See, senior seminar.
Connection to student	Sarah: Let's see. Jackie. Probably early elementary, maybe, 2nd or 3rd grade. The two friends of mine, Maddie and Jackie we actually ended up living on the same street, and we're the same grade, and just, you know, we're the best of friends growing up.
Connection to content	Harry: (Calculus I & II): the thing is, I went back and learned those content, basically, teaching myself. Okay. In

	preparation for calculus three. And, and especially during calculus three. I really learned to enjoy like differentially integration and stuff like that it was, it was actually a lot of fun. I enjoy calculus a lot I wish I could go back and retake the courses to replace my grade but apparently that's only offered to students. After you took the class after a certain time period before that so
Connection to self	Brenda: You can do this. Even though you're struggling with this topic. You might have to take a different approach than you've had to take in another class. So you might need to spend more time on it. You might need to go ask for help from even another student that's doing well or an instructor before after class, use other resources I didn't really have YouTube by then. There's so many resources now so that would be helpful.

Disconnection (See Appendices C for Participants' Comparison Triangles)

The participants reported developing a strong confidence in their ability until they experienced a disconnection within a math course. The disconnection experience for each participant was just as powerful and informative as their connection experiences. Thus, just as *The Instructional Triangle* is an indicator of the possible connection between the teacher to content, teacher to student, student to peers, and student to content relationships, it is also an indicator of the possible disconnections or disruptions of those relationships (Ball & Forzani, 2009; Cohen et al., 2003).

All participants indicated that they had their disconnection experience much later in their student experience, which contrasts with the literature on students developing or experiencing math anxiety during their formative years (Jackson & Leffingwell, 1999). In contrast, our participants had excelled during their formative periods. They did not, however, experience their disconnection experience until they engaged in much more complex mathematic tasks, as noted by the courses that they were enrolled in at the time of their disconnection experiences:

- Brenda – Geometry
- Harry – Calculus I
- Sarah – Integrative Math Course (Algebra, Trigonometry, Precalculus)
- LeAnn – Multivariable Calculus
- Penny – Linear Algebra

- Joy – Math Analysis

The first author can also relate to this experience as she had an educator who exhibited gender and racial bias; additionally, the educator was insensitive and seemed to be intentional about undermining students' ability to successfully pass College Algebra.

Several participants stated that their instructors made the environment unwelcoming or hostile as supported by some of the participant's experiences. For example, Joy highlighted that her teacher-to-student relationship was more strained as her teacher also served as her academic advisor. She stated that her teacher "was not a welcoming" educator and did not help her build her confidence. Jackson and Leffingwell (1999) spoke of similar experiences wherein the teacher creates an environment in which students develop a strong disconnection with the materials and exacerbate or increase students' anxiety (p. 583). These "insensitive and uncaring" educators typically do not respond to students' requests for help, allow unacceptable behaviors between peers, ignores documented medical issues (allergies to chalk), and show "anger or disgust" at students' request for help (p. 584).

Table 3. *Disconnections: Educator as a Student*

Sub-theme	Quote
Disconnection to teacher	Joy: it was. Math, Analysis. It was the class that a math major was actually supposed to take math analysis first. But I had been placed, I mean, my schools was good and everything, but I think I was placed in college algebra. So, I asked to get out of college algebra and put in math analysis which was an error/mistake. I should have started around in college algebra I was gone on analysis. Well analysis was in the end not the best thing for me. Not just because of me but you always want to blame a professor the professor was, there was someone to sneered at talk with his back to and his back was to the students that he's writing and mumbling and I thought that it may have been a cultural thing. I know every time I went to meet with him I was always very apprehensive. And they're running saying, very ironic thing was, he was my advisor, since I was not sure if I was gonna be a teacher in a few man, and I was trying to start a math analysis. He tried in his way and his way of helping. Not really. He was not a warm nature first and I know that this like judging him what is a warm natured

	person. He was not a welcoming for Yeah, I just feel welcome in his office, I didn't feel right yeah I'm still anxious and not feeling like he's trying to go through the motions of helping me, and I'm taking notes, and he's asking me did you do this, did you do that. But he's not doing another way of saying it was just, it was a weird confrontation I don't want to call it that, but it was, I just never felt good in the meetings, ended up taking that class over with another professor
Disconnection from self	Brenda: Embarrassed probably, I am sure that I didn't want to admit to yeah I didn't get it. I was a good student really. even though, you know, part of me is like, forget it, you're not gonna get it. I wasn't somebody that just said I'm not gonna do any homework I'm not gonna do I didn't do that. I took notes I mean, I tried, but it wasn't, I needed help. I didn't get help so out what I was trying was just not working because I did not have the skills. where I was going wrong. no, I was, I was like, I can't believe I can't believe you can't do this. Yeah, everybody else seems to doing fine they are getting it
Disconnection to content	Joy: Well the course content was very formidable, it was a lot of math analysis. But at the same time, when I compare my experience the second time I took it with the my first. It was the way it was delivered. (The second time was very empowering to me it was a professor that was very energetic, very motivational professor. Very in your face coming to your desk seeing if you understood hopping around just the funny person, entertainment, but the other person. Other professor was totally the opposite. The second professor had a reputation for being very forthcoming and very well. In this first professor. Throughout my time in college. He had a reputation that no one wanted to take him. So he knew the material but he wasn't he didn't And I know a lot of students say this on different evaluation material but he was good at) Right, yeah. When you have anxiety that content can become so nebulous so distorted. It's almost like you're not able to even touch it, because that anxiety is like a block blocking it from you.

In addition to disconnections experienced by the educators as students, the educators shared disconnections between themselves and their current students, as well as the content. When the participants recognized these connections, they were able to intervene on behalf of their students to help mitigate their math anxiety. For example, Brenda came to class armed with calculators as resources. Another participant, Joy, went a step further by giving tutorials on how to use calculators in different situations to reduce technology-related anxiety. Penny took a more direct approach by meeting with students in private. She explained that she would "reach out to that student… at another time and place" to discuss their math anxiety.

Table 4. *Disconnections: Educators*

Sub-theme	**Quote**
Students' peer disconnection	Sarah: They don't like it, you know they don't want to work in groups because of their PTSD. I've had a couple students that had PTSD and are very uncomfortable with a group situation. You know, and they they always want to sit in the back, and, you know, have their eye on the door but they're the facts and nobody can be behind them and you can't move, it's so sometimes those are challenging, but I understand it, you know like, I get it. Because I'm married to the military you know have been for years. So, but it makes it difficult to, you know, for them to help them
Educator's intervention to students' anxiety	Brenda: I do bring calculators to the class Yeah, in case. Students need to use calculator. Yeah. They're hard to pick up I have picked them up at garage sales and, and different stuff, you know, they're expensive. Trying to accumulate as much as I can and give them to students that don't have at least during the test, you know, quiz or whatever.
Practices for students with anxiety	Penny: I would probably reach out to that student at another time and place, and see if they could meet with me or see if something could happen so that they could relay to me about this strategy. What about what's happening in the class is blocking them. And then maybe that would allow me to think of ways I can adapt to that person,

Implications and Recommendations

Based on these findings we recommend that college math educators be trained to assess their classes for opportunities to increase connection and reduce areas where students have disconnections. Additionally, as McKibben (2017) stated, educators should be trained in learning the flags of anxiety to help students become more aware of how they feel. Assisting students in having self-awareness will allow educators to provide the student with some self-mitigating techniques. As the participants indicated, they are devising interventions for their students. Furthermore, mathematics education-related organizations could provide a free depository; wherein educators can become a part of professional learning communities to share successful interventions. Educators should consider the benefits of these types of accountability groups as an aid in which they have opportunities for mentorship relationships.

Interventions to Teach Fearlessness

Educators can create a culture by which they "teach fearlessness" in the classroom. The following are some of the techniques that educators can employ setting expectations, creating a safe environment, assessing and addressing disconnections, creating intentional opportunities for connection with (teacher, peers, and content), restructure the course grading as to reduce test anxiety, holistically addressing the whole student.

Class Structure and Fear Reducing Test Design and Techniques

Educators can utilize their class's grading structure to aid in lessening anxiety from the beginning of the course. Iossi (2007) and other researchers stated that testing or retesting is a practice or strategy for addressing math anxiety, specifically test anxiety. Educators should assign higher point values for homework than test scores. It provides students with a level of control (work ethic more than the ability to test becomes the motivating value). Educators will have to determine the balance of support with the needs of formal assessment. Boaler (2016) also advised educators to allow students to resubmit their work for the highest grade. Boaler (2016) stated that this sends a key message of growth mindset to students, which communicates that educators "care about learning, not just performance" (p. 167).

Thus, as educators, value decisions will have to be made on the side of the growth mindset/transformational or on the side of performance evaluation. Educators' choice is not a binary decision. An educator can still assess students' knowledge and performance while also promoting a growth mindset. Brock and Hundley (2016) stated that the performance-based educator typically ranks students by intelligence and achievement and focuses primarily on those students that are deemed "smart" (p. 140).

Thus, the performance model is the antithesis of growth as it is promoting perfectionism more than the power of learning through mistakes. Students who may be struggling with anxiety may not fare well in performance-based courses as they will not receive differentiated learning that accommodates their learning styles (Brock & Hundley, 2006, p. 140). McGuire and McGuire (2015) provided educators who are teaching underprepared students some tips:

- set high expectations and showcase the standard for success,
- assess while teaching, meet students where they are,
- provide students with critical thinking tips,
- clearly communicate students' responsibility,
- stay connected,
- and have faith "this stuff works" (pp. 158-9).

The tips allow educators to understand the need for differentiated learning and the importance of setting high but realistic expectations for students individually and corporately.

Assessing for Connection and Disconnection

Educators can assess or observe students for disconnection with the content; educators can ensure students sense a high level of patience and care. One method is to ensure that students do not feel rushed when asked questions or repeat demonstrations. Educators' responses will set the tone for how students' peers' respond and perceptions of students' ability (Jackson & Leffingwell, 1999). Thus, removing the anxiety related to peer's judgment or the need for students to have a fully developed knowledge of the content. Educators should avoid some harmful behaviors, such as creating a hostile environment (i.e., ignoring students' questions, demonstrating impatience, angry behaviors, and an insensitive or uncaring demeanor; 1999).

Limitations and Recommendations for Future Study

A major limitation was the exclusion of students' participants. Students are the direct and indirect recipients of educators' instructional design and implementation. Students become barometers of the educational climate created by educators; thus, educators have the power to create safe environments where students can fully engage in developing relationships with (teacher, peers, and content; Jackson & Leffingwell, 1999). Additionally, within a conducive learning environment, one can discover or gain depth in one of the two relationships that cannot be depicted by *The Instructional Triangle* (the intra teacher and students' relationships; Ball & Forzani, 2009; Cohen et al., 2003). This study provided a context for exploring the intra educators' relationships with teacher, peers, and content. As educators revisited the experiences of connection and disconnection, it provided educators an opportunity to gain a perspective of what issues may arise for students in terms of their instar student experience.

Future studies can provide content for each of the tenets or perspectives that a student can engage while self-mitigating anxiety and making stronger connections with teacher, peers, and content. Thus, future studies offer a resolution to the limitation of ways in which students are self-mitigating anxiety. Additionally, researchers may discover students' role in creating connections or disconnections. Thus, an exploration of how educators may utilize students' intra-understanding to speak to those mechanisms of the connection while also partnering with students to address the disconnection mechanism. Education is a partnership with a commitment of sorts to exchange, develop, improve upon, or address deficiencies in understanding.

Conclusions

Anxiety has served as an agent of disconnection in learning environments. Anxiety has impacted educators' connection to the content and students and students' connection to teachers, peers, and content. Educators utilize their methods to assess and address anxiety. There is a need for more advanced training for educators to assess and address anxiety more effectively. Educators' interventions and students' self-mitigating techniques can serve as ways to change the paradigms of education; education can become connection driven instead of teacher, peers, and content driven. Both educators and students can learn how perspective-taking can allow them to speak to their anxiety and maintain connection within the learning environment.

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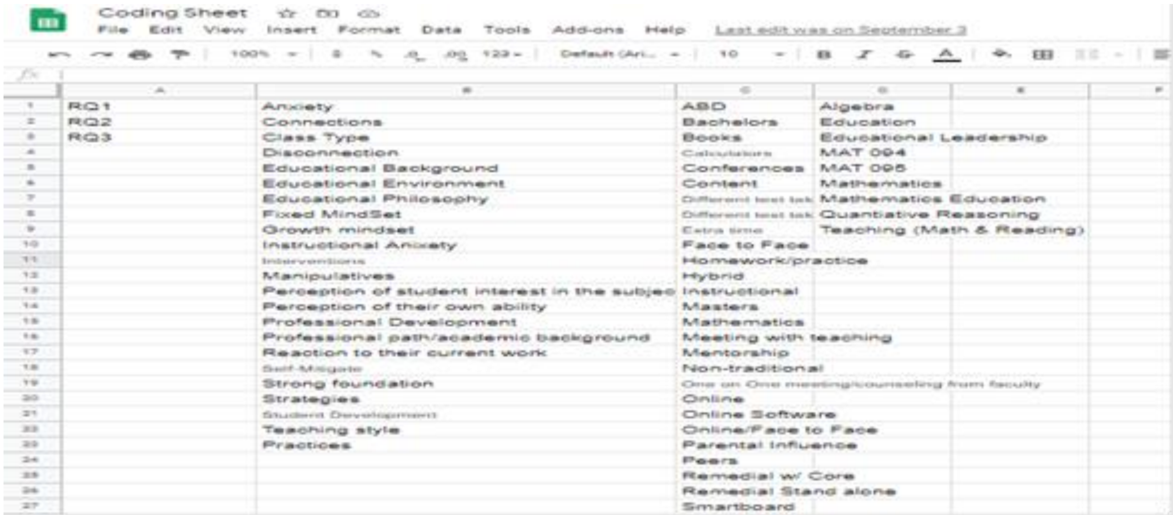
Appendices

- Mathematics Classroom Observation Protocol for Practices: MCOPP (Gleason et al., 2017). – Appendix A
- Excel Coding: Selected Coding and Code Breakdown – Appendix B
- Participant's Comparison Connection and Disconnection Instructional Triangle – Appendix C

Appendix A - Mathematics Classroom Observation Protocol for Practices: MCOPP (Gleason et al., 2017).
Facilitation Actions (*SE – Student Engagement, *TF- Teacher Facilitation)

Item #	Item	Student ID #	SE	TF	Problem or concept related to interaction
1	Students Engaged in Exploration/investigation/problem solving				
2	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent concepts.				
3	Students were engaged in mathematical activities				
4	Students critically assessed mathematical strategies.				
5	Students preserved in problem solving				
6	The lesson involved fundamental concepts of the subject to promote relational/conceptual understanding.				
7	The lesson promoted modeling with mathematics.				
8	The lesson provided opportunities to examine mathematical structure. (symbolic notation, patterns, generalizations, conjectures, etc.).				
9	The lesson included tasks that have multiple paths to a solution or multiple solutions.				
10	The lesson promoted precision of mathematical language.				
11	The teacher's talk encouraged student thinking.				
12	There were a high proportion of students talking related to mathematics.				
13	There was a climate of respect for what others had to say.				
14	In general, the teacher provided wait-time.				
15	Students were involved in the communication of their ideas to others (peer to peer).				
16	The teacher uses student questions/comments to enhance conceptual mathematical understanding.				

Appendix B - *Excel Coding: Selected Coding and Code Breakdown*



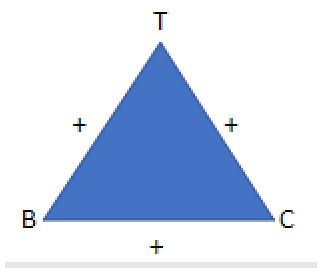
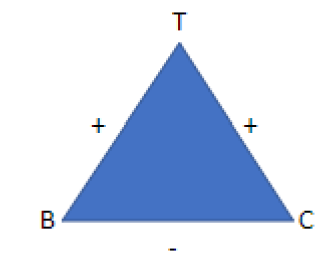
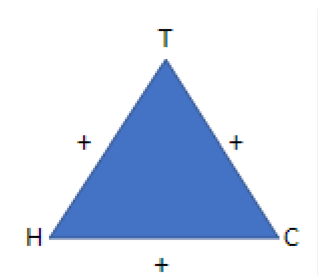
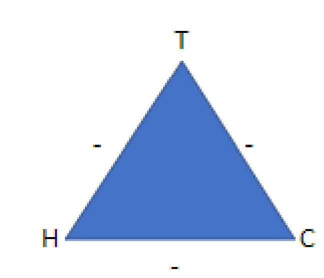
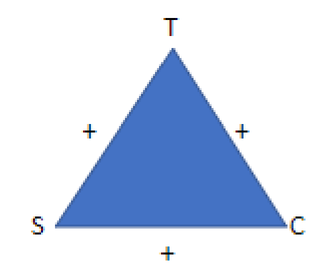
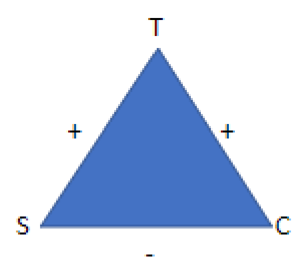
	A	B	C	D
1	RQ1	Anxiety	ABD	Algebra
2	RQ2	Connections	Bachelors	Education
3	RQ3	Class Type	Books	Educational Leadership
4		Disconnection	Calculators	MAT 094
5		Educational Background	Conferences	MAT 095
6		Educational Environment	Content	Mathematics
7		Educational Philosophy	Different test tak	Mathematics Education
8		Fixed MindSet	Different test tak	Quantiative Reasoning
9		Growth mindset	Extra time	Teaching (Math & Reading)
10		Instructional Anxiety	Face to Face	
11		Interventions	Homework/practice	
12		Manipulatives	Hybrid	
13		Perception of student interest in the subjec	Instructional	
14		Perception of their own ability	Masters	
15		Professional Development	Mathematics	
16		Professional path/academic background	Meeting with teaching	
17		Reaction to their current work	Mentorship	
18		Self-Mitigate	Non-traditional	
19		Strong foundation	One on One meeting/counseling from faculty	
20		Strategies	Online	
21		Student Development	Online Software	
22		Teaching style	Online/Face to Face	
23		Practices	Parental Influence	
24			Peers	
25			Remedial w/ Core	
26			Remedial Stand alone	
27			Smartboard	

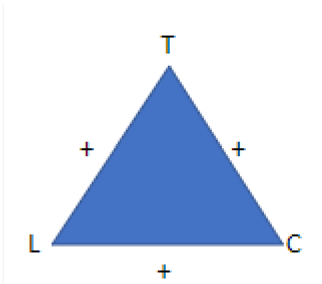
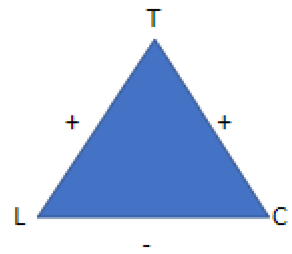
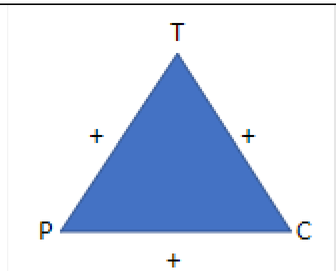
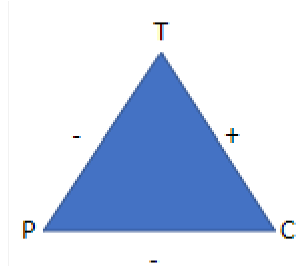
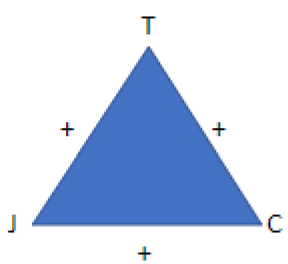
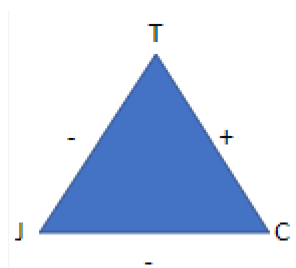
Excel Coding: Selected Coding

Participants Document	Coded Segments
Brenda's Interviews	141
Harry's Interviews	138
Sarah's Interviews	126
LeAnn's Interviews	120
Penny's Interviews	140
Joy's Interviews	136
Total Number of Coded Segments	**801**

Code Breakdown

Appendix C - *Comparisons of Participants' Connection and Disconnection The Instructional Triangles - Adaptions of The Instructional Triangle (Ball & Forzani, 2009).*

Participant	**Connection Instructional Triangle**	**Strongest Connection**	**Disconnection Instructional Triangle**	**Strong Disconnection**	**Perceptions of ability during and after course associated with the disconnection experience**	**Impact of Disconnection Experience on Teaching**
Brenda		The strongest connection between the student and the content.		The strongest disconnection between the student and the content	During the course, Brenda felt as if everyone except her understood the content. She passed the course; during the interview, she stated that she could do geometry as an adult.	Brenda stated that the experience made her sympathetic to what her anxious students experience.
Harry		Strongest connections between the teacher (byproduct a stronger connection with the content-reconnection to content) and the student and content.		The strongest disconnection between the teacher and content, teacher and the student, and student and the content	During the course, Harry thought the course experience was what he should expect as a college student. He later had his connection experience wherein he reconnected with the content and had a very impacted connection with a role model professor. Harry took this professor for several additional classes and chose math as a major due to his new relationship with the professor and the content. Harry stated that one of his outward signs of anxiety was that he cried during a test.	Harry stated that his experience informed him of "what not to do" as an educator.
Sarah		Strongest connections between the teacher and content, the teacher and the student, student and peers, and student and the content.		The strongest disconnection between the student and the content	During the course, Sarah's math self-concept was challenged in the course as she was so stressed that although she never contemplated suicide, she did not want to go on. Her professor was extremely helpful and made strong connections with her peers to overcome her challenges.	Sarah understands that "when students struggle, there is a reason for it." Thus, she is not dismissive about the issue and seeks to helps students within her capacity.

Participant	Connection Instructional Triangle	Strongest Connection	Disconnection Instructional Triangle	Strong Disconnection	Perceptions of ability during and after course associated with the disconnection experience	Impact of Disconnection Experience on Teaching
LeAnn		Strongest connections between the teacher and the student and the student and the content.		The strongest disconnection between the student and the content	During the course, LeAnn had a really good report with the professor and her peers. However, the content was very difficult, and LeAnn and her peers worked hard to succeed in the course.	LeAnn is very student-centered in developing both her strategies and practices.
Penny		Strongest connections between the teacher and the content, teacher and the student, student and peers, student, and content.		Strongest disconnections between the teacher and the student (byproduct a disconnection between the student and the content)	During the course, Penny felt as if her professor was unapproachable, so she relied heavily on her peers to understand the material.	Penny "reaches out" and makes inquiries if she thinks that students are struggling in her class.
Joy		Strongest connections between the teacher and the student and the student and the content.		Strongest disconnections with the Teacher and the content	During the course, Joy felt as if the professor was making the classroom a hostile environment. Additionally, the professor also served as Joy's advisor. Joy was very anxious when going to his office. Joy wanted to change her major to Mathematics Education, and her advisor/professor counseled her against it. Thus, she later had to retake the class and get a new advisor.	Joy asserted that students were struggling with anxiety, which then makes the content "nebulous" and "distorted." Thus, she is conscious of the various types of anxiety students may struggle with and make interventions accordingly.

The Connection and Disconnection Triangles are An Adaptation of The Instructional Triangle (Ball & Forzani, 2009, p. 499).