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Math anxiety and attitudes in pre-service elementary teachers

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MATH ANXIETY AND ATTITUDES IN PRE-SERVICE ELEMENTARY TEACHERS

by
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Dedication

This work is dedicated to my students past, present, and future.

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Abstract

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The purpose of this study was twofold. First, I identified the attitudes held by pre-service elementary teachers, investigated whether the attitudes could be improved and anxieties reduced, and determined if there was evidence that long-lasting changes in attitudes were achieved. Second, I evaluated my own leadership to see what styles I practiced both inside of, and outside of the classroom. Data was collected through an attitudes questionnaire, student journal data, student interviews, student surveys, and my own journal. Students did show negative attitudes and high anxiety that seemed mitigated by classroom activities. My leadership style in the classroom was primarily a situational style with an ethic of care. Outside of the classroom my style shifted somewhat to also include some transactional and political leadership techniques.

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Chapter One

Introduction

In 1993 Mattel Toys produced its first line of talking Barbie dolls since the 70's. One of the phrases that she uttered was, "Math is tough." The National Council of Teachers of Mathematics (NCTM) made an attempt to have the dolls removed from shelves (NCTM, 1993). The American Association of University Women (AAUW) joined them to voice their disapproval. Their argument was that having a doll make a statement such as the above reinforced a gender stereotype that girls are not good at or do not like mathematics. The NCTM and AAUW found this not only offensive but felt that it would be harmful to the girls exposed to the message. The debate escalated to a point where it made network newscasts and appeared on *Entertainment Tonight*. Ultimately the result of the protest was that any family that wanted a substitute Barbie (that said nothing) could request a replacement (1993).

Popular singer songwriter Jimmy Buffet has a song on his *Beach House on the Moon* CD called "Math Suks" (Buffet, 1999). The lyrics describe his view of mathematics, "Math suks, math suks. You don't even have to spell it all you have to do is yell it…math suks, math suks" (1999). Although it is admittedly a catchy tune, the message is disturbing. It is unimaginable that an artist would sing a song saying, "Reading Suks." It is just as unlikely that any toy company would produce a toy that said, "Reading is tough." It seems that it is more socially acceptable to hate or be inept at math than other subjects like reading and writing.

Students who struggle with math in my classes do so for many reasons. Three reasons stand out among the rest. In no particular order, poor academic preparation, lack of basic study skills, and a fear or hatred of the subject interfere with student success. Regardless of the course level, from Computation to Calculus, students demonstrate an almost paralyzing fear of mathematics. This fear can impact them in a serious way when it causes them to limit their program major selection by what the math requirement is. For example, students who would really like to get an Associate's Degree in Business will change their major because they do not want to try Calculus.

Theoretical Framework

The theoretical framework for this study comes from research in three areas: the definition and identification of math anxiety, the effect of math anxiety and poor attitudes on performance, including the existence of stereotype threat with regard to math for certain populations and the influence teachers have on students with regard to math attitudes. When these three well researched topics are considered in concert, there is no doubt that by influencing the attitudes of pre-service teachers, it is possible to, in turn, affect the children they teach and break the cycle of math avoidance and poor math attitudes that plague our culture.

Since the early 1950's researchers have been developing instruments to investigate mathematics attitudes and anxiety (Aiken & Dreger, 1961; Fennema & Sherman, 1976; Suinn, Edie, Nicoletti, & Spinelli, 1972; Tapia & Marsh 2004). Further research on the scales has been done in three major areas: research on the psychometric properties of the scales (Broadbooks, Elmore, Pederson, & Bleyer, 1981; Hopko, 2003; O'Neal, Ernest, McLean, & Templeton, 1988), attempts to revise the scales (Hopko, Mahadevan, Bare, & Hunt, 2003; Mulhern & Rae 1998; Plake & Parker, 1982), and the use of the scales in practical or applied settings to actually measure attitudes and make comparisons, such as gender or race-based differences (Bessant, 1995; Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Ramirez, Taube, & Taube, 1990).

Motivations toward mathematics are developed early, are highly stable over time, and are influenced greatly by teacher actions and attitudes (Middleton & Spanias, 1999). The effect of attitudes on achievement is significant at all grade levels peaking in upper elementary school and middle school (Ma & Kishor, 1997). National Assessment of Educational Progress (NAEP) data was used to show that attitudes and self-concepts are more negative for girls than boys and that a connection can be made between lower self-concept and negative attitudes and lower performance (McGraw, Lubienski, & Strutchens, 2006). In several studies, significant amounts of variance in performance on the Mathematics Achievement Test (MAT) and other mathematical tasks were explained by the anxiety score on the Math Anxiety Rating Scale-Adolescents (MARS-A) (Dew, Galassi, & Galassi, 1984; Plake & Parker, 1982). High math anxiety is also related to low course grades (Suinn & Edwards, 1982; Woodward, 2004). Low mathematical self-efficacy is linked to lack of motivation and poor performance on mathematical achievement tests (Middleton & Spanias, 1999; Randhawa & Gupta, 2000). In a meta-analysis of 113 studies of math attitudes and math achievement, a significant statistical relationship was found between the two (Ma & Kishor, 1997). Attitudes, including anxiety, do seem to impact performance.

Stereotype threat is being at risk of confirming, as a self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995). Women may be judged by the negative stereotype of being weak in math. This may disrupt their mathematics performance (Spencer, Steele, & Quinn, 1998). When women and men of similar ability took performance based tests in mathematics, those women who were told the test was harder for women did worse than women who were told there would be no gender differences on the test (Cadinu, Mass, Frigerio, Impaliazzo, & Latinotti, 2003; Cullen, & Waters, 2006; Ford, Ferguson, Brooks, & Hagadone, 2004; O'Brien & Crandall, 2003; Spencer et al., 1998). This group of studies support a theory of self-fulfilling prophesy. The women who expected to do poorly actually did worse.

One important predominantly female group to consider is elementary school teachers. They are critical because of their unique impact on future generations of students. If teachers hate math or have anxiety about math, it is reasonable to assume that their negative feelings could be contagious and spread to the children they teach. Research supports this theory (Austin Wadlington & Bitner, 1992; Harkness, D'Ambrosio, & Morrone, 2007; Middleton & Spanias, 1999; Peterson, Fennema, Carpenter, & Loef, 1989; Trujillo & Hatfield, 1999). Since pre-service and in service teachers have statistically similar beliefs about mathematics (Austin, et al., 1992), it is important to consider to what extent pre-service teachers exhibit anxiety or negative attitudes. If their attitudes are carried over to their classrooms, then any changes in attitudes while still in school would theoretically carry over to their classrooms as well.

Change Theory

This project ultimately involved an attempt to change the attitudes of pre-service elementary school teachers. An attempt was made to complete what Argyris (1990) would call the second loop in the change cycle. Too often we focus on putting out fires never taking the time to consider what is causing the fires in the first place. When it comes to math anxiety, plenty of references exist that give strategies to reduce anxiety or improve attitudes (Arem, 1993; Davidson & Levitov, 2000; Godbey, 1997; Kogelman & Warren, 1978; Mitchell & Collins, 1991; Ooten, 2003; Shodahl & Diers, 1984; Tobias, 1993). Rarely do the strategies in these books and courses reveal the underlying reasons for the problem. This project aimed to do just that. By understanding the reasons why the pre-service teachers had the attitudes they did, the attitudes could be improved and the cycle of math-hate could be broken. Hopefully, after the intervention, these future educators will not pass negative feelings about mathematics on to their future students. Since students often relate math anxiety to experiences with teachers, I posited that if I could change the attitudes of the future- teachers, I may help stop the spread of the problem. Senge, Kleiner, Roberts, Ross, Roth, and Smith (1999) also discussed analysis and change of underlying assumptions and culture. They noted that one of the key challenges to profound change is the need to change culture. If through my leadership in this study I was successful in changing the math attitudes of these future teachers, and it results later in changes in the way they teach children in the future, that would indeed be a profound change.

Significance

The significance of this study lies in the potential to influence future generations of students with regard to their math attitudes and the value that they attribute to mathematics. Since Sputnik, the United States has attempted to recruit students into the areas of math and science. It is hard to motivate students to be interested in, or dare I say love, math or science when their teachers have negative attitudes toward the subject. By working with pre-service teachers on their attitudes about mathematics, there is a chance that their future students may have better attitudes themselves. These kids may choose more rigorous math sequences or even math related majors later in life. Doors will not be closed to them professionally because they avoid math. A more numerate public may prepare differently for their retirement, ask different questions of politicians making policy decisions, or choose different career paths. Math knowledge can make us a more competitive country. The space race does not have to be over.

Research Questions

The research questions for the project were:

1. What attitudes and anxieties regarding mathematics do pre-service elementary school teachers hold in a large suburban community college?
2. To what extent can the activities in class influence pre-service teachers' attitudes about mathematics and reduce their anxiety?
3. To what extent can significant change in math attitudes occur based on classroom activities?
4. To what extent do I use a situational style of leadership and an ethic of care in my classroom when teaching courses to pre-service elementary teachers?
5. In what ways is my leadership outside the classroom similar to and different from inside the classroom?

In summary, it is well documented that math anxiety and negative attitudes are pervasive in our culture. These attitudes affect math performance. It is a particular problem for females as they seem to function differentially from men on these constructs. In a predominantly female career like elementary teaching, this issue is particularly problematic. These attitudes and anxieties could be in turn influencing young children's attitudes. This project attempted to break this cycle by changing math attitudes in pre-service teachers. In addition, I analyzed my own leadership as an instructor. In particular, I wanted to investigate whether my espoused leadership theory matched my actions. Argyris (1990) warns that when the espoused values do not match the actions, the leader is ineffective. Senge and colleagues (Senge et al., 1999) call it walking the talk. I say I am a situational leader who tries to use a care ethic. Is that actually what I do?

Chapter Two

Leadership Theory in Use

As a young child, my favorite fairy tale was Goldilocks and the Three Bears. Throughout my life I found the idea of finding the happy medium very appealing. Not too much, not too little, just right. I have never wanted to be the overachieving perfectionist who annoys the people around me nor the slacker who does not fulfill my responsibilities. As I got older and started taking philosophy classes in college, I could put a more academic spin on this life theory. I found out that I really believed strongly in the Aristotelian theory of the golden mean (Aristotle, 2004). He believed that for every virtue there is excess and deficiency, and one's goal is to find the balance between the two. For example, according to Aristotle, in feelings of fear and confidence, courage is the mean. Much of my leadership theory depends on this life theory of balance.

What is my definition of a leader? The most basic answer to this question is someone who has followers. Without followers, there is no leader. I know I am a leader because I have followers. I have students and peer faculty who look to me as a leader. I have been elected to chair our faculty governance body for thirteen straight years. Why do they vote for me? What is it that I do that influences them to follow me? I was appointed by the College President to co-chair our most recent Middle States Self-Study. Why did she select me for this position? My leadership theory comes from my vision of the relationship between leaders and followers, is supported by my values, and is made clear in my actions in implementing a personal mission statement.

Vision, Values, and Personal Mission Statement

Vision. In his book, *The Botany of Desire*, Michael Pollan (2001) describes man's interaction with nature. In particular, he considers the concept of co-evolution between man and some plant species. He sees man as no different than a bee, "In a co-evolutionary bargain like the one struck by the bee and the apple tree, the two parties act on each other to advance their individual interests but wind up trading favors: food for the bee, transportation for the apple genes." (p. xiv) My vision of the leader and follower matches this description. There should be a codependence, a co-evolution, between the leader and the follower. The relationship should be mutually beneficial. When two organisms live closely together with mutually beneficial outcomes, it is called symbiosis. The leader and follower should function together in such harmony.

This idea of relationship is a key to following an ethic of care. Feminist philosophers and educators propose a leadership style that prioritizes relationships (Gilligan, 1992; Noddings, 2003; Sernak, 1998). An ethic of care and responsibility develops from an individual's feeling of interconnectedness with others. It is contextual, arises from experience, is characterized by nurturance, and emphasizes responsibilities to others. This idea is very appealing to me. I value the idea of relationships and believe that context is a determining factor to behavior. Noddings added an element to her theory that is important. She posits that the care needs to be received in order to complete the cycle. One cannot really give care if it is not received. If I go into a class and give a lesson, but the students did not learn, I do not believe I can claim to have taught them. In the same way if I am trying to help a student to improve their math attitudes, but they reject my help, I have not really functioned with an ethic of care. There has been a breakdown.

Dewey (1916) speaks of individuals as, “Chiefly interested upon the whole, in entering into the activities of others and taking part in conjoint and cooperative doings. Otherwise, no such thing as a community would be possible” (p. 23). Even a century ago, the importance of relationships was recognized. If the goal for an individual is to make the whole stronger, it does not matter whether they are a leader or a follower. The ultimate goal is the same. For a county college, lack of community would be devastating. It is why we are referred to as community colleges.

More recently, Wheatley (2006) also discussed this type of relationship. “What is critical is the *relationship* created by two or more elements. Systems influence individuals, and individuals call forth systems. Which potential becomes real depends on the people, the events, and the situation” (p. 36). She goes on to discuss how the relationship between leader and follower is like that of paired particles. The action of one always influences the actions of the other. I find this idea very appealing. As a faculty member I change students, but they change me too. With every lesson I give, I learn more about how to communicate ideas to students. I have been teaching for 24 years now and still learn something new every day. The interaction is never one way. There is a daily give and take. Foster (1986) noted that “Followers interact dynamically with leaders; at times followers are leaders and leaders are followers” (p. 178). I believe this wholeheartedly.

In our community college environment, relationship building is recognized as a crucial component of attaining the college mission. “Community college faculty and staff make a difference in the lives of people who may not have other opportunities to pursue higher education…relationship building is an important part of a leader’s responsibilities”

(Boggs, 2003, p.18). In particular, students who come from families who have not had college experiences need mentoring and guidance. They often look to faculty to help them with a secondary curriculum, not just their course content, but how to be a good student, how to learn.

Palmer (1998) provides further insight. "Becoming a leader of that sort—one who opens, rather than occupies space—requires the same journey we have been exploring for teachers…As those inner qualities deepen, the leader becomes better able to open spaces in which people feel invited to create communities of mutual support" (p. 161). Again, Palmer indicates that the relationship is what matters. The leader tries to build a mutually beneficial situation with the followers. In the College faculty this type of open, mutual support is useful. Sometimes young faculty are reluctant to participate and older faculty get burned out. When the comfort level is high and the environment non-threatening, people are more likely to participate. They are compelled to pitch in and help when they can, because they see others pitching in too. They do not feel so isolated and overburdened.

Values. My vision of the leader-follower relationship is influenced by a system of values. That system has been shaped by a few very significant events in my life. My personal value system has four major pillars: work hard, be a good team member, remember and respect history, and share your gifts. For each, a personal recollection may help explain why the value is important to me and how it relates to my vision.

Work ethic. Most of my childhood memories involve "the farm." It has been in the family since the Civil War. Just about everyone in the family has worked on the farm at one time or another. I worked there every summer from the time I was 12 until I graduated from college. We packed peaches and apples and occasionally peppers. At one time it was a tomato farm, supplying Campbell Soup. When that business left Camden, we changed to orchards. For those 10 years that I worked in the packing house, I learned a lot about leadership, work ethic, male/female roles, minority relations, and team work. The experience shaped who I am today more than anything that happened in my 12 years of formal schooling before college.

My career as a farmer started during the summer between 7th and 8th grade. My grandmother's brother was the one operating the farm at the time. He was unmarried with no children. My grandmother and her two sisters would come to his place to get dinner for him, each taking a couple nights a week. When Grandmom went, I went with her. I loved being there. One day we arrived toward the end of the work day and I was hanging around at the packing area. There were several boxes of apples coming off the line, but no one loading the truck. I jumped up on the truck and started loading it. I was just trying to pitch in. I was quite a tomboy so lifting boxes was no big deal to me.

It was a big deal to my uncle, though. I never heard him scream so loud. The men who were supposed to be working on the truck got in big trouble and I got in even bigger trouble. Women did not load trucks! I negotiated with him a week later to be allowed to work in the packing house. If he saw me lift one box, I was fired. I was allowed to sort the apples (separate out damaged from good) or bag them. Three dollars an hour was great money for a kid of 12, so I accepted the terms. This was my first big lesson about gender roles: women cook dinner and men lift boxes. Within a year I was loading trucks and pretty much managing the packing house. If I was working, my uncle felt comfortable leaving to take care of other business. His first big lesson about gender roles: 13 year old girls can do just about anything men can do.

During the time when I worked on the farm, I also had a paper route. That was a 365 day a year job, rain or shine or snow. I would walk it or ride my bike. Similarly, on the farm, crops do not care that it is Sunday; they do not care that it is the 4^{th} of July. There is no such thing as a day off. If you do not pack the peaches the day they come off the tree, they are ruined. Working under these conditions gave me a life-long willingness to do what needs doing, when it needs doing. If it takes long hours then it takes long hours. If it needs to be done on a weekend, then it needs to be done on a weekend. My work on the farm and delivering papers really helped develop the work ethic I have today.

Teamwork. My family is very sports oriented. It does not matter who is on the outs with whom, we can talk Phillies. When my grandfather was in a room with one of his great grandchildren and had little in common with them, they could talk baseball. We play, we watch, we discuss. I played organized softball from age 5 to age 30. I was a team captain on every team I ever played on, from playground, to high school, to college, to post-college. These experiences obviously shaped my abilities as a leader and teammate.

The most important moment in my development in that area was in a conversation with my cousin Jay. He was six years older than I, and I idolized him. I had no brothers, so he was like a big brother to me. I was a young teen and I was bragging to him about my prowess at softball…best on the team, best in the league, etc. He stopped me in the middle and asked how my team was doing. “Last place.” He then said the words that will stick with me forever, “Kelly, it is better to be the worst player on the team that wins the championship than the best player on the team in last place.” And he walked away. I was stunned. It was a life changing interaction.

From that moment my approach to any team situation was different. It is about the success of the team, not my success. If I am successful too, that is great. The team comes first though. As an employee of the college that is my attitude, the college comes first. I serve on committees because the team needs me. I teach certain courses because the team needs me. Things that make the college stronger make my work environment more pleasant. Why would I not do my part to make that happen?

History. Like a lot of little girls, I played school when I was young. The difference was that most of my friends and family believed that that would be my destiny. My father resisted the whole way. He thought I was “too smart to be a teacher.” I think that when I became a college professor he was accepting of that because he thought it was a more intellectual pursuit. I am not sure that he was right. Instead of working with 10-year olds I teach fractions, decimals, and percentages to 18-60 year olds.

When I graduated from Rowan with a Master’s Degree in 1991, my grandfather came to the ceremony. I never really saw him cry before, but that day he was choked up over the fact that there was a college graduate in the family. Although my cousins’ children have gone onto college since, I was the first in the family to do it. I have always felt a special responsibility to my family. It is as if each accomplishment I made was their own as well. Now that I am a parent, I understand the feeling.

Using talents. The teaching moment that affected me the most came about 2 years into my career. Camden County College housed the Mid-Atlantic Post-Secondary

Center for the Deaf and Hard of Hearing. Since 1990, I have taught the math classes for these students. One semester, a non-deaf student who had failed my algebra class the term before, begged to get into my all deaf section. It was the only one that I taught that fit into his schedule. I talked with him about the disadvantages he would have in this section, but he insisted that he learned more math from me than any teacher in his life, etc. I eventually agreed. There was one problem. This student was blind. Now each day I had to create a lesson so visual that the deaf students would understand and succeed, but so auditory that a blind person could understand and succeed. It was a wonderful lesson for me to learn so early in my career. Since I am fluent in American Sign Language, I still teach any self-contained deaf math classes. Working with these students constantly keeps me fresh in my approach and makes me a more complete teacher.

Of the thousands of experiences that I have had that I know shaped me as a leader, the four that I chose above stand out as most significant. The cumulative effect of these experiences is who I am today. Overcoming my uncle's prejudices was an early introduction to tolerance and gender roles. My cousin's speech shaped my view about the role of an individual on a team. My grandfather's reaction to my graduation opened my eyes to my responsibility to my family and others that came before me. My classroom experiences with physically or cognitively challenged students have made me a better and more complete teacher. I am a farmer, a team member, a family member, a teacher. The associated values: work ethic, teamwork, respect of history, and use of gifts, support my vision for leadership. In order to develop the mutually beneficial relationship between myself as a leader and my students as followers, there must be a commitment to the team, to sharing, to holding up one's end of the work, and to the history of the organization, past, present, and future. What we do today will be reflected on as history tomorrow.

Mission statement. My personal mission as a leader is as follows: Use my gifts to help others achieve their potential by working with them on their terms at their level to achieve their goals. We work together, and based on the follower and the situation, we develop a plan of attack. To implement the mission, I must be able to recognize where people are, where they want to go, and how we can best get them there.

Leadership Theories

As I see it, interactions have three parts, the leader, the follower, and the situation. The action plan is completely dependent on all three. The question is always: How should this leader and this follower react in this situation?

Primary theory. There is no one-size-fits-all solution to how to help developmental students learn math. For every student there is a different set of baggage filled with bad experiences, anxieties, bad teaching, and general misunderstanding of the subject. It is impossible to approach teaching students with a single strategy. Different students and different situations call for different strategies. Suppose I noticed that a container in my garden did quite well after I poured a gallon of water on the plants. Would I then universally use one gallon of water on everything I grow? If I water a small potted plant with a gallon of water it is too much and if I water a tree, a gallon is insufficient. When it comes to watering plants the Goldilocks (Aristotelian) principle is needed: not too much water, not too little, just right. In the same way, if one method works with a particular student, there is no guarantee that it will work with others. I view teaching as a situational profession, therefore my primary theory on leadership is also situational.

Lifespan theory or Situational Leadership. If leadership is indeed dependent on the relationship between the leader and the led, then leadership needs to be adaptive. Individuals have different needs. In order to optimize their productivity, they need to be led in different ways. For almost forty years Blanchard, Hersey and others have introduced, modified, and perfected the theory of Situational Leadership (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982). The theory started off with the name Lifespan Theory, but evolved into Situational Leadership.

According to the theory, a leader can use one of four general styles depending on the extent to which they act in a directive way, and the extent to which they act in a supportive way (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982). By directive they mean the leader gives information about how to do the task. By supportive they mean that the leader engages in two-way communication with the follower. The four styles are identified as S1, S2, S3, and S4. The S1 style is highly directive but not highly supportive. It is referred to as the directing style. The S2 style is highly directive and highly supportive. It is referred to as the coaching style. The S3 style is highly supportive but not highly directive. It is referred to as the supporting style. Finally, S4 is low on both direction and support. This is referred to as the delegating style (see Figure 2.1).

Further, the theory identifies the follower in terms of their developmental level (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976;

Hersey & Blanchard, 1974, 1981, 1982). The individual functioning at D1 is an enthusiastic beginner, D2 a disillusioned learner, D3 a capable but cautious performer, and D4 a self-reliant achiever. The classifications are situational, not intrinsic. A new faculty member I recently mentored was clearly functioning at D4 in the classroom but was at D1 on college politics.

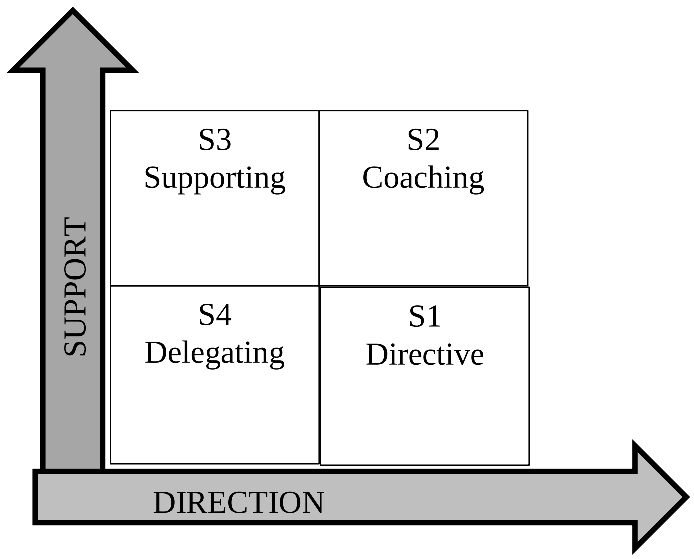

Figure 2.1. Situational Leadership Classifications

According to the theory, the style should match the developmental level, S1 (directive) for D1 (enthusiastic beginner), and so on (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982). Consider the example of a child learning to hit a ball. At first they are very enthusiastic but they do not know what to do. They need direction, how to hold their hands, where to put their feet, when to swing. As they proceed, they may become frustrated as they miss the ball or hit it poorly. They know a little bit about what to do, but they need coaching. As their skills improve and they get better, they may need to be motivated to practice. They may not need directions, but they need to be supported. They want to hear the cheers. Finally, when they master the art of hitting they can play ball without much interaction or direction.

A validity study for Situational Leadership (Walter, Caldwell, & Marshall, 1980) shows the danger of a leader misapplying their leadership style. For example, if a follower is at the D1 level, needing direction, but the leader adopts an S4 delegating style, the results can be catastrophic. I am reminded of the scene in *Kindergarten Cop* when the teacher walks out in the hall, leaving the five year olds to fend for themselves. He returns to find chaos. He expected them to self-regulate, but they clearly needed more structure and direction. According to the theory, each developmental level has a matching style that will optimize the productivity of the follower. A mismatch can lead to frustration, lack of productivity, or withdrawal from the activity. At the college I have witnessed inexperienced teachers working with developmental students and telling them, “You should know that.” The student is functioning at the D1 or D2 level and the teacher expects them to be at D3 or D4 (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982). This creates self-esteem issues in the students and frustration in the faculty member. They are not working together as a team for a common goal; they are functioning separately for very different goals.

Dewey (1916) also discussed the use of direction. He saw direction, control, or guidance as being forms of education. He also described direction as existing on a continuum from guiding assistance to regulation or ruling. This implies that direction itself is a strategy that can vary on a continuous scale; there must then be different leader/follower/situations that warrant different directional strategies. Even within one style, direction, there are situational applications.

The United States Army now recognizes the advantages of Situational Leadership, "FM 22-100 stresses that leaders must be able to adjust the leadership style to the situation as well as to the people being led. Leaders are not limited to one style in a given situation and…being able to adapt appropriate styles will influence soldier's success" (Yeakey, 2002, p. 72). This quote embodies my vision of the triad of interaction between leader/follower/situation. The leader must try to maximize the potential of the follower in the given situation.

Thoughts about change. Pre-Socratic philosopher Heraclitus noted that "we can never walk into the same river twice" (Barnes, 2001, p. 70). Just as there are constant changes in the flow of a river, we change as people and the people and organizations around us change constantly. Heraclitus also posited that the only thing that does not change is change itself. All else is in a constant state of flux (Guthrie, 1975). How does a situational leader handle this constant ebb and flow?

Situational leadership by nature looks at change as evolutionary rather than revolutionary (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982). The followers move through developmental stages. The whole theory depends on these rather predictable changes. Working with developmental students lends itself more to what Marzano and colleagues (Marzano, Waters, & McNulty, 2005) refer to as first order change. First order change is incremental. Second order change is a dramatic departure from the expected. Second order change is deep rather than incremental. When learning math, students tend to change incrementally. They learn and grow, learn a little more, grow a little more. When it comes to attitudes, changes do not need to be incremental. There can be revolutionary change. This change is not always positive. One bad experience can send a student down a path of math avoidance and even math hatred. Good experiences can also influence student attitudes. While I strive to incrementally improve a student's mathematical skills, I try to dramatically change their comfort level and attitudes about math.

There is a country song that says "If you want to hear God laugh, tell him your plans." I think that my realization about what I can control about students and what I cannot was one of my toughest lessons. Sometimes I backslide and still act like I do not know that I cannot control everything. I want my students to do well. I do not want life to get in their way. I do not want them to drop out of school because they do not have childcare or because they cannot afford to pay. I do not want them to make mistakes and cut class when they should not or not do homework that they should. But I cannot control that. I can help them, but I cannot do it for them. We can make an academic plan for success together, but sometimes it is hard to implement because of outside interference. Wheatly (2006) says, "I have given up trying to control anything. It has taken me a long while to learn this, but I finally understand that the universe refuses to cooperate with my desire to play God." (p. 46) I have not quite given up, but I do hear God laugh every once in a while.

There are a few non-academic theories that I have about change. First, "if it's not broke, don't break it." Sometimes in an effort to establish oneself as a leader, a person can try to change too much. It is important to recognize policies, procedures, and people that are effective. We do not necessarily want to dramatically change these things. Second, the proverbial butterfly flapping its wings (Bradbury, 1980) can be a very important model of change. Sometimes a small change or even a random uncontrollable event can lead to massive change. For example, just after I graduated with my BA, I was working as a tutor at Camden County College and taking a semester of additional math classes prior to enrolling in a PhD program in mathematics. A woman in the basic skills math department at CCC fell and broke her leg, one day before the semester started. In an act of desperation, the department chair called to see if I would like to teach the class. I had never taken an education class, had no aspirations to teach, but it was better money than tutoring and she was in a bind, so I said yes. I fell in love that day. Teaching was like a disease that took over my body; it consumed me. My life plan changed. I no longer wanted to research and develop theorems, I wanted to teach math to people who hated it. I would like to think that the thousands of students that I have affected over these past twenty plus years would say that one random event, a stranger they never met breaking her leg, changed their life too. Even a planner like me recognizes that when the butterfly starts flapping (Bradbury, 1980), anything can happen.

Supporting Leadership Theories. There are other leadership theories that support my vision of Situational Leadership and the vision I have for strong leader/follower relationships.

Transactional leadership. Many people have written about the theory of transactional leadership. Burns (1978) first identified it, in conjunction with transformational leadership. Bass (1985) later refined the theory. The biggest difference between the two men's theories is that Burns looked at transactional and transformational leadership as two ends of a single continuum and Bass looked at them as two different concepts. Bass argued that the best leaders are both transformational and transactional (1985).What determines when the leader should implement each strategy? The situation of course!

In layman's terms, transactional leadership involves trading one thing for another (Bass, 1985; Burns, 1978). This is sometimes referred to as *quid pro quo*. In this type of leadership, the trade is often services for money. One does his or her job, and he or she gets paid for it. It is a rewards system. The transactional leader gives the followers something they want in exchange for something the leader wants. In the classroom the transaction involves grades.

Bass (1985) further identified three forms of transactional leadership: contingent reward, management by exception-passive, and management by exception-active. Contingent reward is based on a leader clarifying expectations and establishing rewards for meeting those expectations. Management by exception involves the leader intervening when expectations are not met. The difference between active and passive has to do with when the intervention takes place. The passive leader waits for a mistake to be made and then intervenes. The active leader anticipates problems and intervenes before mistakes are made. During coursework at Rowan, I incorrectly inferred that Transactional Leadership is looked down upon; a meta-analysis by Judge and Piccolo (2004) found that transactional leadership techniques are valid and predictive of a leader's job performance.

How does transactional leadership (Bass, 1985; Burns 1978) support my vision? There are situations when the relationship between the leader and the follower is most productive through the use of transactions. In particular, when followers are functioning at the D1 level (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982), the technique is useful. For example, in a basic skills classroom I might use the passive management by exception strategy by giving a pop quiz if students do not seem to have their homework done. I previously laid out my expectation that homework should be done. When it is not, the intervention is made. How is this mutually beneficial? As a teacher I get information about my students' progress. Did missing the homework hurt them or do they understand the material anyway? The students benefit by exposure to the priority topics from the lesson, they know what they need to be studying, and they learn that if they want to avoid a quiz, they should do their homework! I might also use the active management by exception by announcing a quiz in advance. If I anticipate that students need to see what is important from a particular section, I can intervene in advance to guide them.

While I am in no way Machiavellian in my leadership style, Niccolo Machiavelli made a very keen observation about recognizing trouble among followers in *The Prince* (2006). He likened diagnosing trouble among the led to a doctor diagnosing a disease. In the beginning, it is hard to diagnose the disease, but easy to treat it. As the disease progresses, it becomes easy to diagnose, but very hard to cure. This is the challenge of the transactional leader using management by exception (Bass, 1985; Burns, 1978). Diagnosing that problems exist is sometimes difficult to do before it is too late. Transactional leadership is not the primary style that I employ in the classroom, but it is useful at times. Harkening back to the Goldilocks analogy, not too much, but use it when appropriate.

Transformational leadership. Burns (1978) and Bass (1985) also discussed a type of leadership called transformational. Transformational leaders focus on higher intrinsic needs rather than simple short term goals. The theory identifies four dimensions of transformational leadership: charisma or idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. Respectively, these represent how a leader behaves in admirable ways that cause the followers to identify with the leader or how the leader connects with followers on an emotional level, the extent to which the leader articulates a vision that is appealing or inspirational to followers, the extent to which the leader challenges assumptions and solicits the followers' ideas, and the extent to which the leader attends to the followers' needs, and acts as a mentor or coach.

How does this leadership theory support my vision? By its very nature this theory focuses on connections between leaders and followers. It speaks of the leadership styles like coaching and supporting (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). The theory is very much in line with a vision of the co-evolutionary, symbiotic relationship between the leader and the led. In my interactions with the College's Faculty Assembly, I must be an inspirational leader who behaves in admirable ways, leads by example, and challenges the intellectual potential of my peers. This governance group works hard to keep the college strong. I help clarify their role in the college fulfilling its mission. That vision keeps the group moving in a positive direction. In the classroom, I model good study behaviors, exude a positive attitude toward math, and create an environment in which students are encouraged to ask questions.

Leadership as stewardship. Another conceptualization of a leader is a leader as steward. “The leadership that counts, in the end, is the kind that touches people differently. It taps their emotions, appeals to their values, and responds to their connections with other people. It is a morally based leadership—a form of stewardship” (Sergiovanni, 1992, p. 76). This concept of leadership also considers the idea of relationships and co-evolution. “Stewardship represents primarily an act of trust, whereby people and institutions entrust a leader with certain obligations and duties to fulfill and perform on their behalf” (p. 91). Sergiovanni also discusses the concept of power over and power to. Power over emphasizes control, what people do, when they do it, how they do it. Power to has a different view. It is a source of energy for achieving shared goals and purposes. Power over is rule-bound, but power *to* is goal-bound. In both of the above, the leader is exerting some form of control. A third version, power with, truly places the leader and follower on equal footing, working together for a mutually agreed upon goal.

How does this leadership theory support my vision? The Faculty Assembly of Camden County College is the governing body. I am the chair of that body. Those who elected me have an expectation that I will use my position to advance the Assembly’s agenda. They depend on me to bring relevant issues about curriculum, academic policies, and assessment to the group for vote. I depend on them to bring relevant issues to my attention so they can make it to the agenda, and once there, I expect them to debate the issues rationally and thoroughly. They then count on me to bring the proposal to the administration and see it advance through the President's Cabinet so it can be implemented in a timely manner. I expect them to, then, implement the policy. There is a dependency between us. They expect me to speak and act on their behalf; I expect them to lend me support when needed. I am not a supervisor with power over this faculty (Sergiovanni, 1992). Rather, I have both power to help the group achieve its goals and a desire to share power with them in the fulfillment of the college mission. With respect to students, I think that, based on my student evaluations of me, my students feel comfortable entrusting me with the obligations and duties associated with preparing them for their next math class or related subjects (Sergiovanni).

Servant leadership. Another popular categorization for leaders is servant leaders. This concept was first discussed by Robert Greenleaf (1977). He posits that great leaders are servants first. If a leader is truly servant first, then other people's highest priority needs are being served. The accumulation of power or wealth by the leader is not important. I would like to think that I serve the college and its students not for prestige or money, but out of a true desire to make life better for our community. I do not just want to serve individual students, but the greater community as well. Suppose I teach a student and she later becomes a nurse, or a fireman, or a teacher; she, in turn, serves others. The whole community becomes better. If I meet my goals, I will be better, the students will be better, the college will be better and the community will be better. "Servant Leadership is more easily provided if the leader understands that serving others is important but that the most important thing is to serve the values and ideas that help shape the school as a covenantal community" (Sergiovanni, 1992, p. 91).

Follower Needs

The second element of the leader, follower, and situation triad is the follower. Situational leadership depends on assessing the followers and adopting an appropriate leadership style to match their level (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982). Blanchard identifies three skills needed to accomplish this: diagnosis, flexibility, and partnering for performance (Blanchard, 2007). To diagnose the developmental level, I must consider commitment and competence. I must then have the flexibility to change styles as the individual develops over time. Finally, I must be a good partner. "Leadership is not something you do to people, but something you do with people" (Blanchard, 2007, p. 101). There are two main groups that I lead on a regular basis, students and peer faculty. Clearly there are many differences between these groups. There are also, however, many differences within the groups. This section will look to identify the followers in my work environment and to consider how their levels might be viewed.

Maslow. No matter how else they might be characterized, followers are human beings first. As such, they are motivated by a hierarchy of needs. Maslow (1943) identified a 5-tiered categorization for human needs. The most basic needs are those involving survival. These are followed closely by the desire to feel safe and secure. Next is the need for love and belonging. Developing self-esteem follows. Finally there is the level of self-actualization. I consider this hierarchy as applied to the two major groups of followers I interact with, students and peer faculty.

Students. I teach students in three major categories, basic skills students, students majoring in non-math intensive majors, and students in math intensive majors. For basic skills students, academically speaking, the first two levels of the hierarchy are still not fully developed (Maslow, 1943). Their history of failure, bad experiences, or lack of exposure to mathematics typically leaves students feeling quite anxious. Some fear that if they cannot pass math, their dream of a degree is shattered. Others feel that they are stupid or not college material. Students at these levels are motivated by the simple need to pass, to have some success in a subject that has been problematic in the past.

Students who pass or test out of basic skills, but who are not in math intensive majors have typically moved beyond the survival level, they are still not always feeling safe (Maslow, 1943). They may still feel like they are in jeopardy of failing or feel overwhelmed by the math. They probably do have a sense of belonging, because their peers in class are similarly non-math oriented. They have a shared, "I don't really like math" attitude. This binds them together as a group of learners. As they have success, their self-esteem begins to develop. As they take the last math class or two of their careers they will finalize their impression of mathematics as something they value or not, a very important distinction.

Finally, there are the students who are math majors or are in math intensive programs. They typically have the first three levels well under way and are very intensely working on the fourth. They are working to develop a healthy knowledge base in math and a strong self-esteem about the topic (Maslow, 1943). A few may even reach their top potential and reach that final level. Of course some may hit the Calculus wall and backslide a bit. Depending on where a student falls on the hierarchy (Maslow), their needs will vary. The leadership style that will optimize their performance will also vary. Situational Leadership Theory (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) allows the leader to adapt their response based on these needs. This is why the theory is so appealing to me.

Faculty. Similar to students, faculty will vary in their needs. I consider faculty in four groups, adjunct faculty, non-tenured faculty, tenured faculty with low academic rank, and tenured faculty with full academic rank. Professionally speaking, adjunct faculty are lucky if they can get past the first two levels of the hierarchy. The nature of their employment conditions makes this so. They are never guaranteed classes. At best they get to pick from the scraps that the full time faculty leave behind. At the worst they are blindly assigned to courses that need instructors on an emergency basis. They get a day or two notice and often have very little control in what they teach. They are usually just happy to get a class or two and are rarely picky about what they are offered. They want to survive and feel safe. They want to do a good enough job to get hired again. Some move beyond this level, they feel confident that they are needed by the department. They may also know they belong and are valued, but they long for full time employment. They want the recognition for their work that shows full commitment to them as employees. Adjunct faculty, at best, get stuck between Maslow's (1943) third and fourth levels and at worst, never fully achieve the first.

At Camden County College faculty tenure is a five-year process. The fact that the college commits to the faculty member means that they have at least some confidence that levels one and two are well underway. They spend these first five years focusing mainly on level three (Maslow, 1943). They want the sense of belonging. They need their department to embrace them; they want the college to recognize their value to the team. The non-tenured faculty member always has it in the back of his or her mind that he or she may not be retained; there is a survival issue (Maslow). Their primary focus, however, is to make themselves so integral to functioning of the department of college that no one would think of letting them go. They can do this by being a great teacher, volunteering to work on department projects, serving on committees, and participating in professional development activities.

Once tenure is achieved, there is still work to be done. The fourth level of the hierarchy calls for the development of self-esteem (Maslow, 1943). At this level the faculty member branches out more to participate and maybe even lead committees. They look to move up the ranks academically, to get promoted. They spend more time getting professional development and doing academic activities that will make such recognition more likely. If they achieved departmental acceptance but not yet college wide, they may still be working on level three issues as well.

Finally, the full-rank tenured faculty member functions quite differently. They have no fear of being fired, they are being financially rewarded by their status, they can participate in activities (or not) based on how they feel if fulfills their potential. Faculty members at his level are only motivated by what makes them feel fulfilled. There are no more ladders to climb within the promotion structure.

Situational Leadership. Blanchard and Hersey (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) define four levels of development that they call maturity. The levels are based on the follower's motivation to do a task and their ability to get the task done. They refer to the levels using the notation D1, D2, D3, and D4 to represent developmental stages. As stated previously, at the D1 level the individual has low ability but is highly motivated. At level two the ability is still very low to moderate, but motivation has dwindled. The third level has moderate to high ability but low motivation. Finally, level four have both high ability and high motivation. Again as the individuals mature and his or her developmental level changes, so must the leadership style to optimize his or her performance. Like applying Maslow's hierarchy (1943), this system will look different for students and faculty both between and within the groups.

Students. Using the same classifications as before, I will start with basic skills students. It would be great if students with low skills started off as enthusiastic beginners, but they do not. The reality is that developmental students are most typically either students with both low skills and motivation, or students with moderate skills and low motivation. It is the rare student in basic skills that has high motivation to do math, regardless of skill. Basic skills students are primarily D2 or D3 (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). Students in non-math intensive programs are the most variable of the three groups. They can literally be anywhere along the continuum. Students of this type vary in math ability and in motivation. Still there are more students in the two low motivation categories. If they loved math, they would likely be in a more math intensive major.

Finally there are the math majors. Clearly they have the higher skill levels. Motivation can still be an issue. Sometimes community college students who are very talented still lack desire. These students would be primarily in the D3 or D4 levels.

Faculty. Oddly enough, most adjunct faculty are either D1 or D4 (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). They are either enthusiastic beginners or knowledgeable veterans. Either way they are highly motivated. No one would live the nomadic and unstable life of an adjunct, if they were not highly motivated. Low motivation and the adjunct lifestyle just do not mix. Now, what makes them motivated can certainly vary, the need for a paycheck, a desire to help humanity, a love of the subject matter, etc. What varies among adjuncts is the knowledge basis, both in content and in teaching methods. New non-tenured faculty tend to be enthusiastic beginners, D1. As they get tenure, they move through the D2 and D3 levels and by the time they get full rank they tend to be D3 or D4 in most situations (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982).

Connection to Action Research Project

I claim to be a situational leader (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) who follows an ethic of care (Gilligan, 1992; Noddings, 2003). If that is so, then I could use my leadership to change the way some students perceive mathematics. Treating each student as an individual, noting why they came to have the attitudes they do, working with them individually to overcome their fears and hatred, and motivating them to have a healthy respect for mathematics is a reasonable goal. These students have self-selected a major in education. They say that they want to teach elementary aged children. In making that choice, they have by default decided to be math teachers. As math teachers they will have the responsibility of influencing their students' attitudes about mathematics. Since research supports that teachers have an effect on students' views about mathematics (Austin et al., 1992; Harkness et al., 2007; Middleton & Spanias, 1999; Peterson, et al. , 1989; Trujillo & Hatfield, 1999), I can influence these students and they in turn can affect future students.

The use of a survey instrument, interviews and journaling as a mixed methods approach to this study is appropriate because it allows me to use multiple sources of evidence (Bowling, 2002) to find where students lie on the developmental scale that determines the situational leadership strategy used for that student (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) . When more information is available, there is a better chance that my evaluation of the developmental level is accurate. Since a mismatch of developmental level and situational style can be catastrophic (Argyris, 1990), an accurate evaluation is imperative.

How will I grow as a leader though? If Nodding's (2003) theories are correct, the relationship between myself and the students will fulfill my needs as well as theirs. I have a need to help people. I can only truly say that I have helped if the student accepts my contributions and a change ensues. If there is no change, then I have not been successful in my attempt to lead them. This research project should help me develop my skills at evaluating the developmental level of my students and interacting with them in a way that causes positive change. If successful, I will have demonstrated growth as a leader.

Summary

To summarize my views, I believe that there should be a strong relationship between myself as a leader and my students or peer faculty. I think we should not just co-exist but co-evolve, with mutually beneficial outcomes as a result. Situations will also dictate what strategies or styles of leadership will help us best achieve our goals. Students and faculty must be treated as individuals, being met at their level and moved in the direction of their goals. Planning is a good way to start the movement toward the goals, but flexibility is needed as well. If we work hard, work as a team, respect history, and use our talents to their optimum level, there is no reason why we cannot all meet our personal and group goals. In this project, my intention is to use my leadership to help students recognize what about their history has given them negative attitudes toward mathematics and try to help them remediate those attitudes. For each student there will be a different story and many different approaches may be needed in order to overcome their variety of experiences. This is the challenge of following an ethic of care (Gilligan, 1992; Noddings, 2003) and being a situational leader (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982).

Chapter Three

Review of Relevant Literature

Attitudes about mathematics and anxiety about mathematics have been studied and researched for over fifty years. The following literature review summarizes research work in the areas of math anxiety and attitudes. It begins with a discussion of instruments that have been developed and used to measure mathematics anxiety and attitudes. Next, issues regarding school situations are discussed. A look at the impact of math attitudes on performance follows. Finally, both gender and race or ethnicity issues are investigated.

Instruments

Before addressing the issue of how to change attitudes and reduce anxiety, the existence of these conditions should be formally discussed. There have been several instruments that have been created and refined to identify and measure math anxiety and attitudes. They have been studied for their psychometric properties, refined and improved over time, and adapted for other populations. Some of the most commonly used scales and their derivatives are discussed below. They are ordered chronologically by the original version of each scale.

Aiken-Dreger Mathematics Attitude Scale (AD-MAS). The Aiken-Dreger Mathematics Attitude Scale was developed in 1961 (Aiken & Dreger, 1961). The scale was a simple 24-item measure on a Likert scale. The total score on the test was the sum of the Likert ratings. The authors theorized that there would be four dimensions to the scale, enjoyment, motivation, importance (value), and anxiety. Only enjoyment and value were retained. Further research on the scale centered on its factor structure (Adwere-Boamah, Muller, & Kahn, 1986; Michaels & Forsyth, 1977; Taylor, 1997). Two factors were found in the original study as well as in the more recent research. The factors were denoted enjoyment and value.

One recent study focused on adult learners (Taylor, 1997). Over 400 students between the ages of 21 and 65 participated in the study. The research was conducted over a two-year period. The two-factor structure was confirmed for this group, with high internal consistency coefficients of .91 on the enjoyment factor and .83 on the value factor. When more than two factors were extracted, very little additional variance was explained and the factors were not interpretable.

Another study, which focused on the structure of the scale for urban minority youth, (Adwere-Boamah et al., 1986) showed the same factor structure, including individual item loadings. Since other studies used predominately White middle class students, this study further confirmed the two-factor structure for the scale for various populations.

Math Anxiety Rating Scale (MARS) and its derivatives. *MARS.* Former American Psychological Association (APA) President Richard Suinn was the first researcher to create a scale that focused solely on Math Anxiety (Suinn et al., 1972). The scale, called the Math Anxiety Rating Scale, is often referred to as simply Suinn's MARS. The 98-item measure uses a 5-point Likert Scale. Items came from practical situations such as computing sales tax, or completing a tax form, as well as classroom situations such as taking a math test or being called on in class. Each item measured anxiety on a scale from one to five, with one being "not at all" and five being "very much." Scores range from 98 to 490. Norms were created to show the level of anxiety on a percentile basis. For example, a score of 124 is at the tenth percentile, 146 at the twenty fifth percentile, 178 at the fiftieth percentile, and 262 at the ninetieth percentile. The mean for the scale was reported to be 187.3 with a standard deviation of 55.5. Reliability coefficients were in the .80 range.

Further investigations of the MARS involved testing it for factor structure (Brush, 1978; Capraro, Capraro, & Henson, 2001; Frary & Ling, 1983; Resnick, Viehe, & Segal, 1982), measurement error (Capraro et al.), as well as validity (Brush). A two-factor structure emerged in the original study (Suinn et al., 1972) and was confirmed by those above. The two factors were always interpreted as problem solving anxiety and evaluation anxiety. Other studies aimed to investigate reliability and consistency (Capraro et al.; Dew, Galassi, & Galassi, 1983). A meta-analysis of 67 articles which used the MARS as a measurement instrument found a mean test-retest reliability of .84 with a range from .72 to .95 and a mean coefficient alpha of .915 with a range from .75 to .998, for studies reporting such measures (Capraro, et al.). This indicated broad support for the MARS as a reliable instrument

Shortened versions. Since a 98-item scale is not very parsimonious, research on shortening the scale has been conducted (Hopko, et al., 2003; Plake & Parker, 1982; Rounds & Handel, 1980). At first, subscales were considered. A 30-item scale was derived from the original 98 items that focused on items in two areas, Math Test Anxiety (MTA) and Numerical Anxiety (NA) (Rounds & Handel). Fifteen items from the original scale were identified for each of the two subscales. The MTA scale purported to measure anxiety related to math tests and courses, and the NA scale measured everyday concrete situations requiring numerical manipulations. Internal consistency for the two subscales were measured at .96 and .91 respectively. The initial study involved only female participants. Later the subscales were validated for a sample with mixed gender (D'Ailly & Bergering, 1992).

A 24-item version of the MARS was developed that correlated .97 with the original scale and had a coefficient alpha of .98 (Plake & Parker, 1982). This version is denoted as MARS-Revised or MARS-R. A two factor structure was intentionally created by selecting items from the original scale with the highest factor loadings on the two extracted factors. Sixteen items were used to create a Learning Mathematics factor and eight for an Evaluation factor. Replication tests in this study showed the structure upheld. In another study, however, the two-factor structure did not fit as well (Hopko, 2003). Due to that lack of fit, Hopko attempted to revise the MARS-R.

The MARS-R was further refined to create a scale with only nine items (Hopko et al., 2003). This version is denoted as the Abbreviated Math Anxiety Scale (AMAS). Internal consistency was measured to be .90 with the Learning Math subscale measuring .85 and the Evaluation subscale measuring .88. This new even more parsimonious scale correlated at a rate of .85 with the MARS-R.

MARS-A. The MARS was also revised to accommodate testing of younger individuals (Suinn & Edwards, 1982; Suinn, Taylor, & Edwards, 1988). The MARS-A, a scale for adolescents, has items that have been edited or replaced to reflect the typical activities of this group. For example, rather than asking about tax forms, it asked about studying for a driver's test and memorizing the figures involved. The scale still contained 98 items and still used the same 5-point Likert scale. To show the validity of the scale, the authors correlated the results with grades in math classes. Significant negative correlations existed. That is, students with the highest grades had the lowest anxiety and those with lower grades showed more anxiety. In addition, a factor analysis was conducted to confirm the factor structure of the scale. It retained the same two-factor structure as the original scale. Internal consistency was measured at .96 and split-half reliability at .89. Like the adult test, norms were created to allow for comparisons of anxiety levels. Further investigation of the MARS-A (translated into Lebanese) with respect to concurrent validity revealed that the MARS-A correlated significantly with physics, chemistry and mathematics grades along with overall GPA (Saigh & Khouri, 1983).

MARS-E. A shorter 26-item test was created for elementary-aged children, The Suinn Mathematics Anxiety Rating Scale, Elementary Form (MARS-E) (Suinn et al., 1988). Fourth, fifth and sixth grade students were the target audience. Again items were written to be appropriate for the age group. For example, deciding what time it will be in 25 minutes, correcting a problem on the blackboard, etc. The word nervous was used rather than anxious in the scale. So a score of one on an item meant “not nervous at all” and a score of five meant “very, very, nervous.” Validity was established through correlation with the Stanford Achievement test. A significant negative correlation was found, as expected. Also, the anticipated two-factor structure (test and performance) emerged. The authors conducted a separate study of this scale for use with Hispanic elementary school students (Suinn, Taylor, & Edwards, 1989). Nearly identical results emerged as for non-Hispanic students. When the test was translated into Japanese and used on Japanese students however, four factors emerged (Satake & Amato, 1995). They were labeled Calculation/Problem Solving Anxiety, Test Anxiety, Classroom Performance Anxiety, and Application Anxiety.

Fennema-Sherman Math Attitudes Scale (FS-MAS). Fennema and Sherman (1976) developed a set of nine scales intended to measure mathematics attitudes. These scales were found to measure domains different from, but not independent from, the anxiety measured by the MARS scales (Kazelskis, 1998). The scales include: Attitude toward success in mathematics; mathematics as a male domain; mother; father; teacher; confidence in learning mathematics; mathematics anxiety; effectance motivation in mathematics; and mathematics usefulness. Each of the subscales had 12 questions. The authors reported a split-half reliability of .87. Some of the further research on the scale considers the factor structure of the scale (Broadbooks et al., 1981; Frary & Ling, 1983; Kazelskis, 1998; Melancon, Thompson, & Becnel, 1994; Mulhern & Rae, 1998; O'Neal et al., 1988).

In one study (Broadbooks et al., 1981) only eight factors were found, rather than the nine that Fennema and Sherman (1976) posited. The items that were on the Confidence in Learning Math subscale and those on the Math Anxiety subscale both loaded on one factor. A later study had similar results (Melancon, et al., 1994). This study used elementary school teachers as the sample. All of the same factor structure and loadings emerged as when children were used. O’Neal et al. (1988) also saw the consolidation of the two scales onto one factor in her study of fifth grade students. Although she did not investigate all nine scales, two of the four that she did investigate were Confidence in Learning and Math Anxiety. They both loaded on the same factor, with Attitude toward Math loading on another and Effectance Motivation loading on a third. She found three factors among the four scales.

Mulhern and Rae (1998) not only investigated the factor structure of the scale, but tried to improve upon it. They found six factors among the nine scales in their study. They further studied the effect of shortening the scale. They retained only the top nine items in each of the first five factor loadings and the top six for the sixth factor. This new 51 item scale achieved a coefficient alpha of .85, very close to the .87 of the full scale. Given the much more parsimonious nature of the 51-item scale, that small discrepancy is far overshadowed by the ease of administering the shorter scale.

Betz adapted the Anxiety subscale of the FS-MAS (Betz, 1978) to assess math anxiety in college students. This ten-item Likert scale measure is generally referred to as the MAS. Betz reported a split half reliability coefficient of .92 between the five positively worded questions and the five negatively worded questions. Test-retest reliability levels of .93 and a Cronbach's alpha of .90 were also reported. Further investigation of this adaptation confirmed the high reliability for college (.96) high school (.91) and middle school (.87) students (Pajares & Urban, 1996). For all three age groups the two-factor structure was also maintained, with consistent item loadings.

Lesser known and used scales. The AD-MAS (Aiken & Dreger, 1961), MARS (Suinn et al., 1972), and FS-MAS (Fennema & Sherman, 1976), scales are very commonly used and revised scales. There have been other scales that have been created to measure math attitudes or anxiety, For example, the Math Anxiety Questionnaire (MAQ) (Wigfield & Meece, 1988) and the Anxiety Toward Mathematics Scale (ATMS) (Sandman, 1979). Two recently developed scales are the Attitudes Toward Mathematics Inventory (ATMI) (Tapia & Marsh, 2004) and the Mathematics Self-Efficacy Scale (MSES) (Nielsen & Moore, 2003). These two are discussed in more detail below.

Attitudes Toward Mathematics Inventory (ATMI). The Attitude Toward Mathematics Inventory (Tapia et al., 2004) is a more current scale than the AD-MAS (Aiken & Dreger, 1961) or FS-MAS (Fennema & Sherman, 1976). Some of the types of questions that were relevant in the sixties and seventies were no longer relevant by 2004. This scale, in its final form, has 40 items. They are 5-point Likert scale items ranging from 1 (strongly disagree) to 5 (strongly agree). The scale is purported to have four factors underlying its structure: self-confidence, value, enjoyment, and motivation. A sample item for the self-confidence factor is: Studying mathematics makes me feel nervous. A sample item for the value factor is: Mathematics is important in everyday life. For enjoyment: Mathematics is dull and boring. For motivation: I would like to avoid using mathematics in college. The score on the scale is the sum of the 40 Likert ratings.

The psychometric investigation of the scale (Tapia & Marsh, 2004) involved 545 high school students. The final version of the scale had an alpha level of .97, indicating very good internal consistency. The mean score for the group was 137.4, with a standard deviation of 28.9. A retest was conducted four months later to establish test-retest reliability. This correlation coefficient was .89. Scores on the test were stable over time.

The initial model was theorized to have two additional factors, math anxiety and parent/teacher expectations (Tapia & Marsh, 2004). The items that were expected to load on math anxiety were absorbed into the self-confidence factor. Those expected to load on parent/teacher expectations loaded on motivation. The final version of the ATMI is a reasonably parsimonious instrument, which can reveal high school students' attitudes about mathematics.

Mathematics Self-Efficacy Scale (MSES). Self- efficacy is a self-assessment of one's competence at performing a task in relation to actual performance. Mathematical self-efficacy is self-assessment of one's ability to perform a mathematical task. An early scale measuring mathematical self-efficacy focused on a three pronged approach, self-evaluation on tasks, courses and problem solving (Kranzler & Pajares, 1997). A newer scale, the Mathematics Self-Efficacy Scale (MSES), also purports to measure this construct (Nielson & Moore, 2003). The scale was constructed for ninth and tenth grade students and measured perceived, not demonstrated, skill, and used varied contexts. The nine-item scale asked students to assess their confidence in performing math tasks on a 5 point Likert scale. Sample items included, work with decimals, solving a simultaneous equation, and calculating values of areas and volume. Students were asked to complete the scale under two different contexts, if the problem was on a test, and if it was simply a problem solved in the classroom. There was a statistically significant difference in self-efficacy in the classroom context versus the test context. Students were much more likely to be confident that they could solve the problem in class as opposed to answering it on a test. Reliability was measured at an alpha level of .93. The self-efficacy ratings were highly correlated to actual performance. Those ranking themselves as confident performed better.

Math Anxiety and Attitudes in School

Because mathematics is addressed daily in school settings, the issue of math attitudes and anxiety is relevant for children in elementary school right through to adult learners in college. Some aspects of the impact of anxiety and attitudes on performance change over time. Therefore, school-aged children and college students are discussed separately below.

Math anxiety and attitudes in young children and adolescents. Attitudes toward mathematics are developed at a young age, do not change much over time, and are influenced greatly by the teachers' actions and attitudes (Middleton & Spanias, 1999). The effect of attitudes on achievement is significant at all grade levels with the biggest effect occurring in upper elementary school and middle school (Ma & Kishor, 1997). Anxiety in math grows over time. Elementary school children of both genders scored lower on the MAS than either high school or college students (Pajares & Urdan, 1999). Although males showed an increase in anxiety through time, females showed a much more striking rise in anxiety. Previous research indicated that differences in attitudes about math began at about the middle school level (Norman, 1977). These two outcomes are significant when combined together. If, as students get older anxiety grows, and, as students get older attitudes impact achievement more, then there is a critical point at the upper elementary or middle school level at which students are anxious and seeing this anxiety impact their performance.

Anxiety is inversely related to the number of years in high school mathematics and grades in high school mathematics (Brush, 1978). If a student is at the critical juncture at which anxiety is high and performance is being impacted, that student may choose not to take high school math, or may choose a less rigorous track. Self-efficacy in mathematics is also linked to interest in mathematics (Ozyurek, 2005). Students who are interested in mathematics perceive themselves as better at performing tasks. Students who had high math scores (on the California Test of Achievement) had higher feelings of self-worth, adequacy, and self-acceptance and scored better in making distinctions between right and wrong in their conduct (Jackson & Canada, 1995).

This issue of anxiety is an international one. Anxiety was shown to have a significant negative correlation with achievement not just in the United States but also in China and Taiwan (Ho et al., 2000).

Math anxiety in college students. At the college level there are differences in anxiety and attitudes reported based on academic level or academic major. For example, humanities majors scored higher on anxiety than social science majors, who scored higher than physical science majors (Brush, 1978). Elementary Education majors had higher anxiety levels than the college population in general (Bursal & Paznokas, 2006). Brush's study determined that anxiety is inversely related to the number of terms in calculus. Students in pre-calculus classes show more anxiety than those further along in the calculus sequence (Resnick et al., 1982). Students in math and science majors have far less anxiety than those in psychology or sociology majors (Bessant, 1995). Developmental math students show more anxiety than those in higher level courses (Woodward, 2004).

Students with high levels of anxiety are less fluent in math than students with lower anxiety, especially on timed tasks, even on low skill activities like whole number operations (Cates & Rhymer, 2003). When college students were asked to identify the sources of their efficacy about mathematics, they cited past performance, interest, effort, teaching quality, vicarious learning, familiarity, relevance, and physiological reaction (Lent, Brown, Gover, & Sukhvender, 1996). Past performance was mentioned in 58% of the responses and interest by 18%. These were by far the two most influential factors. The other sources mentioned appeared in a maximum of 5% of the responses.

One group of college students that is particularly important to consider is pre-service elementary school teachers. They are special because of their unique impact on future generations of students. Research supports the theory that attitudes of teachers are passed on to students (Austin et al., 1992; Peterson et al., 1989; Harkness et al., 2007; Middleton & Spanias, 1999; Trujillo & Hatfield, 1999). Students of teachers measured to have beliefs that were more in line with NCTM standards had different views and beliefs about math than students of teachers whose beliefs were not highly related to the standards (Carter & Norwood, 1997). Pre-service and in service teachers have statistically similar beliefs about mathematics (Austin et al., 1992). This means that the attitudes that they have while still in school are not changed when they get into classrooms of their own. Their early attitudes can be carried over to their future classrooms. Most importantly, math anxiety has been shown to have a significant negative correlation with confidence to teach math (Bursal & Paznokas, 2006).

Students report that teaching quality affects their mathematical self-efficacy (Lent et al., 1996). Math anxiety not only affects a student's mathematical self-efficacy, it also affects their teacher efficacy (Bursal & Paznokas, 2006; Swars, Daane, & Giesen, 2006). Students who were anxious had lower assessments of their ability to be a good teacher (Swars). A scale called the Mathematical Teaching Efficacy Belief Instrument (MTEBI) exists for measuring beliefs about teaching ability (Enochs, Smith, & Huinker, 2000). Math anxious students responding to the MTEBI consistently disagreed with statements like, "I can teach math effectively" and "I know procedures to effectively teach math concepts" (Bursal). When highly anxious pre-service teachers were interviewed about the roots of their math anxiety, they typically pointed to negative school experiences, lack of family support, and anxiety about testing in general (Trujillo & Hatfield, 1999). Other factors mentioned included insensitive teachers, non-participatory classroom settings, shyness, low self-esteem, and viewing math as a male domain.

In a study of learning styles, Sloan and colleagues (Sloan, Daane, & Giesen., 2002) found that global (right brain dominant) learners had significantly higher math anxiety than analytic (left brain dominant) learners. A second study supported this result (Gresham, 2007a). The Style Analysis Survey (SAS) was used to measure learning styles in this study. As the tendency toward a global style increased, so did the math anxiety. Of the 264 pre-service participants, 179 were categorized as global with another 77 partially global. This very high proportion of the pool tended toward a global style and tended toward higher anxiety.

In several analyses of student writing reflections about their math past, pre-service teachers expressed the impact that their teachers and their teachers' teaching styles, expectations and attitudes had on them (Cady & Reardon, 2007; Gresham, 2007b; Harkness et al., 2007; Liu, 2007). For one study, students wrote a mathematical autobiography at the beginning of the term and a reflection at the end of the term. It was clear from their responses that teachers and teaching styles affected these students (Harkness). The mathematical autobiography was used in another study that investigated pre-service teachers' beliefs about mathematics (Cady). In response to the prompt "Math is…" students responded with statements like, "Math is my enemy" and "Math is something I hate." In the study, 96% of participants indicated that their mathematics teacher influenced their beliefs about mathematics. Elementary teachers were said to have a generally positive influence and high school and college teachers negative.

Another important influence for students is their teacher's expectations. Two rival theories about students are the entity or fixed theory of ability and the incremental or malleable theory (Rattan, Good, & Dweck, 2011). The faculty believing the former tend to think that some students just are not good at math. The faculty believing in the later believe that all students have the ability to learn math. The former then, attribute lack of success more to ability and the later more to effort. In their study, Students who received feedback from their instructor that was comfort oriented (good try) instead of strategy oriented (you did not follow order of operations) perceived their teacher having low expectations. The students then reported themselves as less motivated and had lower expectations for their own performance. There was a strong relationship between whether the instructor thought that students could change and whether the students themselves thought they could change. A second study tied teacher beliefs about fixed versus malleable student mathematical ability to their own self confidence in mathematics. (Stipek, Givvin, Salmon, & MacGyvers, 2001). The found a significant negative correlation between teacher confidence and the fixed nature of ability. Teachers with low confidence saw students' ability as very fixed. Those with high confidence saw their students as having more malleable ability.

The good news is anxiety in pre-service teachers can be reduced. In fact there are even clinics that specialize in math anxiety reduction (Trujillo & Hatfield, 1999). Such a drastic step need not necessarily be undertaken though. When students took a math methods course that used manipulatives, cooperative learning, and problem solving techniques, they had lower anxiety at the end of the course than before (Sloan, Vinson, Haynes, & Gresham, 1997; Wilkins & Brand, 2004). Students were interviewed and reported that the way the course was taught was what made them feel more comfortable (Sloan). When they took pre- and post-tests of the Math Beliefs Instrument, they showed reduced anxiety (Wilkins). This theory is also supported by the findings of Middleton and Spanias.(1999) who found that mathematical motivation can be affected through careful instructional design. Pre-service teachers can be taught in a way that reduces their anxiety or can be provided with professional development that addresses such issues. There is further evidence that courses for pre-service teachers can be taught in such a way that students feel more comfortable with mathematical tasks (Gresham, 2007b; Harkness et al., 2007). Gresham's study involved administering the MARS, conducting a math methods course with a constructivist strategy, post-testing with the MARS and conducting interviews. There was a significant difference between pre- and post-test MARS scores. In the interviews, students attributed their reduction in anxiety to in class journal writing and the use of manipulatives in the classroom. They also noted that teacher enthusiasm and personality was important. Another study found that having an online forum for discussing anxiety significantly reduced students' anxiety toward teaching mathematics (Liu, 2007). Prompts were used by the instructor and students responded online. Their anxiety was measured with a pre- and post-test of the Attitudes Toward Teaching Mathematics scale (self-created by Liu). In the American Mathematical Association for Two Year College's *Crossroads: Standards for Introductory Mathematics before Calculus* they suggest that, "Since it is common for teachers to teach the way they were taught, faculty must use in their own classes the instructional techniques that prospective teacher will be expected to use" (1995, p. 46).

Such reduction in anxiety will not only help the student, but indirectly, it will help any student this future teacher interacts with. The use of anxiety reduction courses or books about math anxiety can be helpful. These are, of course, first order changes (Marzano et al., 2005). Reflective writing like that done in the Harkness et al study (2007) or the Gresham study (2007c) could lead to possible second order change in students. The best chance of a permanent cure for the problem is to uncover its root causes.

Math Anxiety and Performance

What does it matter whether a student feels anxiety or has a negative attitude about mathematics? Unless it can be shown that negative attitudes impact performance or limit career choices, why should we care if people do not like math?

A study of Chinese and American students showed no significant difference in performance between males and females in either country at eighth grade, but differences existed in college entrance tests in both countries (Tsui, 2007). Mean scores for boys were better than for girls and boys were overrepresented in the top 50% of scores. NAEP data also shows that boys consistently outperform girls (McGraw et al., 2006). This study also indicates that attitudes and self-concepts are more negative for girls than boys and purports a connection between the lower self-concept and negative attitudes and the lower performance. In another study, over 20% of the variance in performance on the Mathematics Achievement Test (MAT) is explainable by anxiety score on the MARS-A (Plake & Parker, 1982). This is similar to the variance explained in mathematical tasks in a study by Dew et al. (1984). Math anxiety accounted for 14-23% of the variance on tasks, while math ability (as measured by quantitative SAT score) accounted for 30-42%. Thus, anxiety may not be the highest correlate to math performance, but it is a significant one. High math anxiety is related to low course grades (Suinn & Edwards, 1982; Woodward, 2004). Students, especially females, exhibit math avoidance behavior when they are anxious (D'Ailly & Bergering, 1992). Math Anxiety is a negative correlate to performance on the D'Amore Test of Mathematics (Standing, 2006). Low mathematical self-efficacy is linked to lack of motivation and poor performance on mathematical achievement tests (Middleton & Spanias, 1999; Randhawa & Gupta, 2000) and the SAT (Walsh, 2008). When it comes to math performance, social learning variables like skills, incentives, efficacy expectations, and outcome expectations are significant predictors of performance (Siegel, Galassi, & Ware, 1985). Math aptitude was also a significant predictor, but math anxiety was not. In another example, when nursing students were considered, the top two predictors of ability to perform math calculations were past performance and math attitude (Flynn & Moore, 1990). A different study on community college nursing students found that math test anxiety correlated negatively with the scores on medication mathematics tests (Walsh, 2008); while number of courses taken and anxiety were not significant predictors. In fact, in a meta-analysis of 113 studies of math attitudes and math achievement, a statistical relationship was found (Ma & Kishor, 1997). Attitudes, including anxiety, do indeed impact performance.

Gender Issues

Anxiety. In general, females have scored higher on math anxiety than males (Brush, 1978; Dew, et al., 1983; Llabre & Suarez, 1985; Ruben, 1998). Females with anxiety have also exhibited math avoidance behavior (Acherman-Chor, Aladro, & Gupta, 2003; D'Ailly & Bergering, 1992). Not all females show these high levels of anxiety. In selected samples, like math majors or science majors, differences become obscured. Female college students did not have significantly higher anxiety when in higher level courses like Pre-Calculus and Calculus (French, 1962; Resnick, et al., 1982; Woodward, 2004). Women are also not necessarily more anxious about every type of mathematical task. Gender differences were more apparent on the items on the Numerical Anxiety subscale than the Test Anxiety subscale (Zettle & Raines, 2000). Anxiety levels vary across time. Although middle school boys and girls had no significant difference in anxiety levels, high school girls had higher anxiety and college women even higher anxiety than their peers or the younger students (Pajares & Urban, 1996). In a similar study, no difference in math anxiety for elementary aged children was found, but for high school and college students there were differences (Malinski, Ross, Pannells, & McJunkin, 2007). Gender differences also appeared in a MARS-A validation study of seventh through eleventh graders (Saigh & Khouri, 1983). In a study including over 2000 fifth grade children matched on ability, girls reported significantly less enjoyment and pride in math but significantly more anxiety, shame, and hopelessness (Frenzel, Pekrun, & Goetz, 2007). These results indicate that girls and boys with equal ability have very different feelings and emotions toward math. Further, adult or non-traditional college students demonstrated higher anxiety than their traditional peers. So while there are gender differences in anxiety under some conditions, they are not apparent under all conditions or for all age groups. However, women are more likely to avoid courses in mathematics than men (Shodahl & Diers, 1984) and avoid majors with two or more math courses (Ruben, 1998). This of course limits the college majors that they are willing to explore.

Attitudes and efficacy. An early study of gender differences in attitudes toward mathematics used nearly 2000 students from grades 2, 6, 7, 8, 9, 10 and college (Norman, 1977). It found that females did not have significantly poorer attitudes compared to males until grade 9, but had them consistently after that. Math reasoning also began testing lower at that age. For both genders favorable attitudes declined from second grade through to college. Females had a significant break between seventh and ninth grades. Prior to that gap, there was never a significant drop from one grade to the next. No such single gap appeared for males.

Inequities have existed in the ways in which girls in mathematics classes have been taught to view mathematics (Middleton & Spanias, 1999). They have been less likely to take upper level mathematics classes or pursue math-related careers (Acherman-Chor et al., 2003; Chipman, Krantz, & Silver, 1992; Llabre & Suarez, 1985; Meece, Parsons, Kaczala, Goff, & Futterman, 1982; Ruben, 1998; Shodahl & Diers, 1984). Unlike other countries, the United States had no female students competing in the International Math Olympiad from 1958 through 1998 (Cavanagh, 2008). Other countries like Canada, Russia, England and Germany had up to 20% female representation, which is still not a lot. When asked whether avoidance of math affected their career choices students responded affirmatively (Chipman et al). In the same study, math anxiety scores were significantly (negatively) related to interest in science careers. Although in some studies there was no difference in self-efficacy for males and females (Nielsen & Moore, 2003) in others there was a difference in self-efficacy for males and females (Gwilliam & Betz, 2001; Lent et al., 1996). In particular, women identified physiological reactions and teacher quality as influencing their self-efficacy while males did not. Self-efficacy is an important factor in career selection. Women have significantly lower self-efficacy in non-traditional female occupations including many that involve mathematics (Betz & Hackett, 1981). Self-efficacy is not just an American issue. When Canadian students were studied no difference was found between males and females, but for Indian students, there were differences (Randhawa & Gupta, 2000).

Although no differences were found in performance by first to third grade boys and girls, distinct differences in problem solving strategies were found (Fennema, Carpenter, Jacobs, Franke, & Levi, 1998a). Girls were far more likely to use counting or modeling strategies while boys used mental methods and invented algorithms. The authors posited that these differential strategies could explain performance gaps later. In rebuttal, some alternate theories were proposed (Fennema & Carpenter, 1998; Fennema, Carpenter, Jacobs, Franke, & Levi, 1998b). One theory was that the differential strategies were due to differential learning preferences, that girls preferred more concrete explanations than boys. Another was that the teacher exhibited behavior that played into gender stereotypes and elicited these responses. A third was that girls may be less interested in mathematics and the lower interest is affecting their performance, not their ability. This theory is that we are better at things we like. A second study of first-grade students agreed with these findings (Carr, Jessup & Fuller, 1999). Girls used very different strategies than boys. They also attributed their choice of strategy to what their teacher liked or what their parent liked. Again teacher influence becomes apparent. Finally, a multi-country study of seventh graders' perceptions of images of mathematicians yielded gender specific results (Picker & Berry, 2001). Over 95% of boys drew pictures of mathematicians that were men. Only about 50% of girls drew mathematicians that were women and nearly all of those were drawn as teachers. Both genders viewed mathematician and teacher as nearly synonymous. They did not have a clear view of what a mathematician is and does. Also, nearly all of the drawings depicted a "nerdy" figure (pocket protectors, glasses, pants that were too short, etc).

Many of the scales that are popularly used to measure attitudes are over thirty years old. It is reasonable to question their relevance today. A recent study of the FS-MAS subscale on Mathematics as a male domain is quite revealing (Forgasz, Leder, & Gardner, 1999). Students were as likely to believe math is a female domain as they were to identify it as a male domain. But when asked why they responded as they did, students indicated that females were better at math because they worked harder. Those who responded that males were better in math attributed the difference to intelligence. So although students no longer perceived math as something men do, they had differential opinions about what made someone successful in math. In the study, far fewer women viewed math as a male domain than men. A study of pre-service and in service elementary teachers revealed that a large majority disagreed with the idea that boys are better at math than girls (Austin, et al., 1992). But for the student population, this enlightened view may not hold. In a large scale study of boys and girls from elementary school to college, a significant majority still agreed with the idea that boys are better than math than girls (Malinski, et al. 2007). This replicated the results of Hyde et al. (1990). There were also significant differences in the relationship between math anxiety and social desirability (Zettle & Houghton, 1998). Males attached aptitude in math with being socially desirable, women did not.

Stereotype threat. Stereotype threat is being at risk of confirming, as a self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995). Since historically women have been perceived as being weaker or less interested in math, their performance may be influenced by knowledge of this stereotype (Spencer, et al., 1998). In study after study women live out the self-fulfilling prophesy that they will do poorly when they are told there will be gender differences and do not perform differentially when no such statement is made (Cadinu et al., 2003; Cullen & Waters, 2006; Ford et al., 2004; Keller, 2007; O'Brien & Crandall, 2003; Spencer et al., 1998). The women who expect to do poorly actually do poorly. There is not just one generic threat, there are multiple ways that stereotype threat can be exhibited: self-concept threat, group-concept threat, own reputation threat (outgroup), group reputation threat (outgroup), own reputation threat (ingroup), group reputation threat (ingroup) (Shapiro & Neuberg, 2007). These can be explained as, my view of me, my view of my group, how people outside my group view me, how people outside my group view my group, how people in my group view me, and how people in my group view my group, respectively. Any of these perspectives could cause threat.

Stereotype threat has not necessarily been confined to those in the highest achieving groups or those who identified themselves as interested in math (Keller & Dauenheimer, 2003). It was shown though that women performed worse on tasks that were more difficult than those that were considered easier (O'Brien & Crandall, 2003). Stereotype threat was more evident in items with lower difficulty, since many students of all types got the harder ones wrong but those under threat did worse on easier items too (Keller, 2007). Also, these gender differences appeared for women who were Whites, Latinos, and African Americans (Gonzales, Blanton, & Williams, 2002). The threat was identifiable as early as middle school (Huguet & Regner, 2007).

Mitigation. There are some strategies that can be used to mediate this stereotype threat. For example, women with a high coping sense of humor did not demonstrate as much performance difference as those with a lower coping sense of humor (Ford, et al., 2004). The good sense of humor seemed to be a buffer to the anxiety that caused poor performance. By blurring inter-group boundaries, women's performance can also be improved. When women performed a task that investigated overlapping characteristics that men and women shared, they were less likely to show a preference for stereotypical female careers in a later activity and performed better on math questions (Rosenthal & Crisp, 2006). Emotional variables also contributed to the intensity of stereotype threat. Women identifying themselves as feeling dejected performed significantly worse on performance tasks that those with less negative feelings (Keller & Dauenheimer, 2003). Those who identified themselves as worried also performed worse (Brodish & Devine, 2009). Answering a question about whether one was worried about results prior to taking a test led to significantly worse score that asking the same question after the test. Asking about being worried seemed to trigger the worry. Simply having a female test proctor was shown to affect women's performance (Marx & Roman, 2002). This was especially so if the woman was perceived to be competent in math or talked about women's abilities to do math prior to testing. Again, what happened prior to the test triggered different performance on the test. Simply having pleasant experiences, like recent contact with a grandchild, mitigated stereotype threat in math for nearly 150 septuagenarians (Abrams, Crisp, Marques, Fagg, Bedford, & Provias, 2008). Parental attitudes also play a part. A mother who does not ascribe to gender stereotypes can moderate the threat (Tomasetto, Alparone, & Cadinu, 2011). Shapiro and Neuberg (2007) warned that depending on the type of threat: self, group, in group, out group, etc. mitigation strategies should vary.

Race and Ethnicity Issues

Anxiety. It is important to consider anxiety issues for ethnic minority students separately from that of White students as they have different experiences than those in the majority (Safren, Gonzalez, Horner, Leung, Heimberg, & Juster, 2000). At the elementary level, no significant difference was found in the anxiety levels of Hispanic students and non-Hispanic students, regardless of gender (Suinn et al., 1989). Hispanic students have similar patterns of anxiety as White students, with anxiety increasing over time (Ramirez et al., 1990). Performance gaps exist between Hispanics and Whites and lower self-efficacy for Hispanics is one explanation why (Stevens, Olivarez, & Hamman, 2006). When White, Native American, African American, Hispanic, and Asian students were studied, Asian students had significantly lower anxiety and Hispanic students significantly higher anxiety than the other groups (Malinski et al. 2006). African American and White students had similar anxiety levels. At the graduate level, differences between Whites and African Americans were significant (Onwuegbuzie, 1999). This reinforces the previous findings that anxiety levels increase over time. Another finding was that when ethnic minorities become the majority in their school district, they are treated within their environment as the majority and some of their behaviors and attitudes change (Acherman-Chor et al., 2003).

Attitudes and self-efficacy. There was not a significant difference in self-efficacy between Whites and African Americans (Gwilliam & Betz, 2001). There were, though, differences in problem solving styles (Malloy & Jones, 1998), with African American students selecting holistic strategies more often than analytical ones. Students in India (both male and female) had significantly higher self-efficacy than Canadian students (Randhawa & Gupta, 2000). For Asian and African American students, attitudes and achievement were significantly related, but for Whites they were not (Ma & Kishor, 1997). Japanese students outperformed German students, but also had significantly different attitudes about math (Randel, Stevenson, & Witruk, 2000).

Stereotype threat. Stereotype threat in mathematics is not restricted to gender. Race and ethnicity also contribute to performance differences based on negative stereotypes (Aronson, Lustina, Good, Keough, Steele, & Brown, 1999; Cadinu et al., 2003; Gonzales et al., 2002; Osborne, 2001; Steele & Aronson, 1995). Ethnicity had an additive effect for Latinas. They performed worse than their White female peers as well as Latino peers (Gonzales et al., 2002). Blacks showed similar discrepancies in performance (Cadinu, et al.) when compared to Whites. In the same study Blacks who were Americans were shown to exhibit stereotype threat versus non-Americans. Half of the participants were told that Americans do worse in math than their international peers, and those participants did indeed perform worse. Black Americans who were told Americans did better, did perform better, despite their racial identity. When they identified themselves as American rather than as Black, the participants functioned as expected under the threat condition, not based on their race. White men showed the effects of stereotype threat when told Asians were superior in math (Aronson et al.). When achievement was considered, racial differences existed. Osborne (2001) investigated whether such achievement differences could be explained by differences in anxiety. Of the 23% of variance in achievement explained by race, 41% of that 23% could be explained by differences in anxiety. One of the key by products of threat conditions is that goals are modified (Ryan & Ryan, 2005). Black students may avoid certain courses or majors because of their stereotypical deficiencies rather than basing decisions on their individual abilities.

Conclusion

Math anxiety and math attitudes can be influential in students' selection of courses, their performance in those courses and their career aspirations. When this influence is differential, with males and females scoring differently, Hispanics and non-Hispanics scoring differently, or education majors and non-majors scoring differently, it can lead to inequities. It can also lead to dangerous stereotypes. Anxiety and performance differences do not appear early in children's academic lives, but do build over time. As students get older, the gap between female and male performance and attitudes widens. The same holds for Hispanic and non-Hispanic students. Differences appear based on college major as well. In particular, many future school teachers have been shown to exhibit high anxiety and low math self-efficacy. This perpetuates negative views about mathematics. Public attitudes are no better, when Barbie dolls (NCTM, 1993) and pop music icons (Buffet, 1999) say they hate math, the message is clear. Math hatred is acceptable. Unfortunately research shows that these negative feelings can impact career options and performance in school.

Chapter Four

Methodology

Introduction

This study was an exploration of Math Anxiety and Attitudes in Pre-Service Elementary School Teachers. In particular, the study explored whether significant change could be achieved in the attitudes and anxiety of pre-service elementary school teachers. Previous coursework revealed that math anxiety was alive and well at Camden County College (Jackson, 2008a; Jackson 2008b). Further, student interviews and classroom observations in the past supported the conclusion that there were negative attitudes about mathematics in students at the college. I wanted to see if this could be changed, and whether my actions in the classroom could improve attitudes and reduce anxiety, this late in a student's academic career. Thus, I believed action research was the appropriate research approach. Action research is a cyclical process of inquiry, conducted by those within a community with a goal of identifying actions that will generate improvement that the researcher and other stakeholders think is important (Bowling, 2002; Hinchey, 2008).

I believe that a change in these pre-service teachers' attitudes is more than important, it is essential. As the literature supports, their attitudes are likely to influence the attitudes of the children they teach later. Hinchey (2008) calls the steps in the action research process reflect, act, and evaluate. Bowling (2002) calls the stages: setting the stage, looking, thinking, and acting. Regardless of the vocabulary, action research is conducted in iterative cycles. I have always been reflective about the way I teach. Action research provided a framework for me to reflect in a systematic way on my past experience and create a plan, implement that plan, evaluate the success or failure of my objectives, and then begin to reflect and plan again. This felt very natural to me as an instructor.

In the literature, action research was not very prevalent as an approach in math education research by name. An examination of research methods in math education from 1995-2005, that considered over 1600 research articles in six prominent math journals did not even mention action research as a methodology (Hart, Smith, Swars, & Smith, 2009). It did note that that 50% used qualitative methods only, 29% quantitative methods only and 21% used a mixed methods approach. I searched electronically for action research projects in Math Education and found several that stated they used action research as the methodology. As early as 1993, students' attitudes about mathematics were considered through the lens of action research (Piper, 1993). Research on classroom strategies such as a "Minute Math" self- assessment (Brookhart, Andolina, Zuza, & Furman, 2004) and the implementation of "Counting on Mathematics Strategies" (Mean, & Maxwell, 2010) used an action research methodology to evaluate the benefit of specific activities on student learning. A study sponsored by NCTM considered the methodology itself as a tool for exploring change (Evitts, Kinzel, & Libby, 2004). More recently another NCTM journal article considered how action research can improve math instruction (Beckett, McIntosh, Byrd, & McKinney, 2011). In both of the above, there were mathematical research questions, but the methodology itself as a valid tool was the key question. Both research groups attributed the improvement to instruction to the action research that the teacher participated in. In both they claimed the teacher became a better teacher. In a follow-up to the Beckett study Kamii (2012) noted that promoting action research and encouraging the independent and creative thinking of students allows them to understand math concepts. Similarly, Raymond and Leinenbach (2000) considered the effects of collaborative action research on the mathematics teacher involved in the research. They concluded that the process of action research was transformative for the instructor. This literature supports action research as an appropriate approach to explore student attitudes in math, implementation of specific activities in the classroom, and the transformative effects of conducting a project on the researcher.

Context

For all cycles in this project, the study was conducted at Camden County College, a large Mid-Atlantic, community college. The target students were pre-service elementary teachers. All students in the study were required to take a course with an algebra pre-requisite that is equivalent to high school algebra one. This course is delivered by the math department. The course is rarely taught by a full time faculty member. Prior to this study it had not been taught by a full time faculty member since 2004. I am the only full time math faculty member who has ever taught the course. It has been taught by full time developmental faculty (twice) or adjuncts. To say it is a historically neglected course is an understatement.

Setting

Since 1967, Camden County College (CCC) has been the community college serving the county of Camden and its communities. Currently there are three physical locations, a main campus in Blackwood, and campuses in Camden City and Cherry Hill. There are satellite locations in Lakeland, Sicklerville, and elsewhere throughout the county. There are also substantial online offerings.

To understand the college, it might help to understand the student body. According to the Camden County College webpage (Key Facts, 2012), the unduplicated headcount of credit students served in the 2011 fiscal year (when the study was conducted) was 23,052. Another 15,000- plus non-credit students were also served. Since 1967, over a third of a million students have been served (341,313). The mean age of the current student body is 27. The student population is made up of 75.2% Camden County residents. Ninety six percent are New Jersey residents. Approximately 25% of current county high school graduates attend the College, including over 10% who are New Jersey Stars[1] students. Nearly 49% attend part-time and just over 51% attend full-time. Fifty-nine percent are females and 41% males. The federally designed ethnicity categories include: 53% Caucasian, 22% African-American, 5% Asian, 8% Hispanic, 2% more than one race, with 9% not reporting. The ethnicity breakdown of the county is 64%, 18%, 5%, 12% and 1% respectively.

Also, from the webpage (Key Facts, 2012), the budget for 2011 was just over 75.2 million dollars. The budget was funded as follows: 66% from student tuition and fees, 14% from the state, 14% from the county, and 6% from other sources. This did not mirror the theoretical funding formula of one-third tuition, one-third state, one-third county, but was not unlike other community colleges in the state. Tuition was 101 dollars per credit, which was one of the lower rates in the state. The college offered more than 150 degree programs (Academic Program Guide, 2012), almost equally divided between career certificates (54), Associate in Applied Science degrees (49), and Associate of Arts or

[1]New Jersey STARS is a scholarship program (exclusively for New Jersey residents) that covers the cost of tuition at New Jersey's 19 community colleges. Students who graduate in the top 15 percent of their high school class may be eligible.

Associate of Science degrees (47). One of those degrees was an Associate of Science Degree in Elementary and Secondary Education. The college ranked in the top ten nationally for associate's degrees granted in education (Camden County College Website, 2012).

The departments directly involved in the study included the Math department (eight full time faculty), the Academic Skills Math department (seven and later six full time faculty), and the Elementary and Secondary Education department (one full time faculty). The two math departments were in one academic division for most of the study, but as of fall 2011 fell under two separate divisional deans. Elementary and Secondary Education was always in a separate division. At the conclusion of the study, the three departments resided in three separate divisions.

Project Cycles

I carried out the project in five cycles beginning in spring 2009. Cycles one and three were classroom centered, cycle two was a preparation cycle, cycle four focused on institutional changes, and cycle five focused on my leadership theory in use. I received IRB approval from both Camden County College and Rowan University.

The research questions for the project were:

1. What attitudes and anxieties regarding mathematics are held by pre-service elementary school teachers in a large suburban community college?
2. To what extent can the activities in class influence pre-service teachers' attitudes about mathematics and reduce their anxiety?
3. To what extent can significant change in math attitudes occur based on classroom activities?

4. To what extent do I use a situational style of leadership and an ethic of care in my classroom when teaching courses to pre-service elementary teachers?
5. In what ways is my leadership outside the classroom similar to and different from inside the classroom?

Cycle One

The first cycle was intended to partially answer my research question one. I field tested the Math Anxiety and Attitudes Scale (MAAS) (Appendix A), conducted a focus group to help develop journal prompts, and field tested those journal prompts. I developed the MAAS in an earlier course (Jackson, 2008a) and field tested it in this cycle. The goal was to explore attitudes and anxieties that pre-service elementary school teachers feel towards math. The historical aspects of the development of those attitudes were determined through interviews and student journaling. Students identified what made them feel better about their ability in math or their view of math as a subject. Finally, they stated the extent to which they value math and what could be done to help increase the value they hold for math. Baseline information about attitudes and anxieties were noted for later cycles.

This portion of the study used a mixed methods approach including a survey, interviews, and journal prompts to reveal the answers to research question one. Creswell (2002, 2009) describes mixed methods as a collection or analyses of both quantitative and qualitative data in a single study. Data can be collected concurrently or sequentially. However, it should involve integration of the data at one or more stages in the process of research. The use of mixed methods for my study was useful for several reasons. First, one of the goals of the action research project in the long term was to measure changes in attitudes. One way that this was accomplished was through a pre- and post-test using a scale adapted from the literature on the subject. The survey used in this first cycle was to be used in later cycles as one way to analyze the extent of any changes and was analyzed with quantitative techniques. In this first cycle, it was field tested to establish reliability and validity for this population. Any issues with administration, readability, and interpretation of results were monitored. Preliminary information about the attitudes that pre-service teachers hold was gleaned from the survey. To consider the issue in more depth, two qualitative strategies were used, interviews and journaling (Bowling, 2002). In summary, in order to get a complete picture of students' math anxiety and attitudes, both quantitative and qualitative evidence were useful.

Participants. Students in two sections of Math Systems I: Structures (pre-service math course) for the Spring 2009 term participated. The course is typically referred to as MTH 105 or simply Structures. The two selected sections were the only classes offered two days a week. They were selected to participate because I believed the two day a week option offered the optimum opportunity to get journals back and forth between me and the students. This cycle included participation by 66 students. Students were asked if they would like to participate voluntarily in this study. Because participation was voluntary, the sample was not random. For the analyses in this cycle, the randomness assumption was not problematic. Students were notified that participation would not influence their grade in the course and no part of the data collected in this study would be used as part of their course grade. All students in both course sections chose to sign the consent form (Appendix B) and participate. They were not given extra credit for participation as this could have influenced their responses or lead to unfair pressure to participate. At the beginning of the semester, the 62 students present that day took a short math anxiety and attitudes scale (for items, see Appendix A). The ten students with the highest level of anxiety and negative attitudes were asked to participate in a focus group. One student declined, so an additional student was asked to participate, so the total of ten was reached. Later the student who declined reconsidered and asked to participate; therefore 11 students (8 women and 3 men) participated. I used the responses to the questions posed in the focus group (see protocol in Appendix C) with these eleven students to help create some of the prompts for a journaling project that both classes participated in later in the semester. In this project, the journal responses to these prompts, for 66 participating students, were also used as data. The combined responses to the surveys, journals, and the interviews were used to refine the activities planned for the fall cycle. Responses to surveys, interviews, and journal prompts were kept strictly confidential. No student who participated was personally identifiable in the reporting of results for this study. Students each created a pseudonym to be used for any quotes.

Data collection and analysis.

Instruments: Math Anxiety and Attitudes Scale. In order to conduct this study I used an instrument, the Math Anxiety and Attitudes Scale (MAAS), that combined items from Hopko's *Math Anxiety Rating Scale-Revised* (2003), from Fennema-Sherman's *Math Attitudes Scale* (1976) and demographic questions that determined gender and college major. The scale had 40 items. Twenty-four dealt with math anxiety, twelve with attitudes, and four were demographic. The 36 anxiety and attitude items were on a five-point Likert Scale. I piloted the MAAS during previous coursework (Jackson, 2008a; Jackson 2008b). It was found to be very reliable for that population and showed validity for measuring math anxiety and attitudes in community college math students. In this cycle, the scale was formally analyzed for reliability of scores and validity of the scale. I administered the MAAS to 62 students in math sections for pre-service teachers (those present on the day of administration), and analyzed the results using SPSS 16. Descriptive statistics including means and standard deviations were determined (Larson & Farber, 2012). The scale was also analyzed for reliability using coefficient alpha for each sub-scale (Allen & Yen, 1979; Traub, 1994). The attitudes scale was also analyzed using split-half reliability since the first six questions were asked in a positive way and the last six in a negative way. Although content validity was established through the literature, construct validity was analyzed using a factor analysis on each sub-scale (Allen & Yen, 1979; Wainer & Braun, 1988). Criterion validity was established by looking at predictive validity. Logistic regression was used to predict group membership (Elementary Education Majors) within the classroom as a further test of validity (Chatterjee & Price, 1991; Mosteller & Tukey, 1977; Tatsuoka, 1988; Tabachcnick, 1996). The results of the MAAS were used to determine which students exhibited the highest level of anxiety.

Interview protocol. The ten students with the highest level of anxiety and worst attitudes about mathematics, as determined by the results of the MAAS, were invited to participate in a focus group, (see Appendix C for Protocol). One student declined so the next student on the list was asked to participate. Later, the student who declined asked to be included, so 11 students participated. This sample included eleven students with high levels of anxiety about mathematics or negative attitudes about mathematics (or both). The dialogue was intended to reveal some of the underlying causes of the negative attitudes students feel. Questions were clustered into categories that considered the contributions of teachers, family, and friends to their attitudes, the age when bad experiences happened, the activities that they find most anxiety producing, and their general math history. To analyze the data, the interviews were recorded and field notes were taken as well. Interviews were transcribed word for word. I conducted a thematic analysis by developing a codebook to code the data and to search for trends in the responses (Bowling, 2002). I used these results to help inform the creation of the some of the journal prompts.

Journal prompts. The final source of student data was from the student journals. The responses to the interviews along with information gathered through the literature review were used to create the prompts for the students. During a four week stretch from week eight to week twelve, all 66 students participated in a journaling project. This activity was intended to help students reflect on what their attitudes were, where they came from, and why it was important to change any negative attitudes they might have. They were not asked to make a change, but to recognize underlying cause to their issues. The model being used was similar to that used in Weight Watchers or in Alcoholics Anonymous. The most successful changes for those folks come when they take the time to reflect on why they had bad behaviors in the first place and not just from trying to stop the behaviors. For the pre-service teachers, the goal was to have them see what influence their teachers had on them and then make the revelation that they did not want to be the teacher in the story 15 years from now. They did not want a student to hate math because of them. Argyris (1990) referred to single loop learners as those who correct an action to solve or avoid a mistake but double loop learners as those who also correct the underlying cause of the problematic action. The goal was to help my students complete what he would call the second loop, to change some of their cultural views about math and break the cycle through this journaling exercise.

Journals (blue books) were distributed to students and were collected back each class for four weeks. Students responded to prompts provided by me as well as having the option for free writing entries. I provided written feedback to students weekly. The entries in the journals were analyzed using codes from my codebook (Appendix D) that looked for trends in two areas (Bowling, 2002). First, they were analyzed for trends involving student attitudes and second for anxiety. I utilized the data from cycle one in cycle two to plan for cycle three, as is consistent with action research (Bowling, 2002).

Limitations.

Reliability and validity. With respect to scale reliability there are no issues. Both Hopko's *Math Anxiety Rating Scale-Revised* (2003), and Fennema-Sherman's *Math Attitudes Scale* (1976) (from which items for the Math Anxiety and Attitudes Scale were drawn) have been extensively researched. Psychometric data supports their reliability (see extensive discussion in Chapter Two). The MAAS itself was field tested in previous coursework with no reliability issues (Jackson, 2008a: Jackson 2008b). In terms of reliability in the coding process, consistency was ensured through the use of a codebook, a single scorer, and digital recording and word for word transcription of interview responses (Bowling, 2002). Because of the mixed methods approach, I could also triangulate the results in the questionnaire, interview, and journal responses (Bowling; Creswell, 2002, 2009).

Creswell (2002, 2009) mentions several potential threats to internal validity. Since this was not an experimental design, the issues of history, maturation, regression, selection, diffusion of treatment, and compensatory demoralization or rivalry were not at issue. Since there was not a pre-test and posttest, testing effects and instrumentation effects were not a problem. One threat to internal validity is appropriate to consider, mortality. By the time journaling took place we were half way through the semester. Seven students had stopped attending or withdrawn by that point. They were primarily those with low grades. Although it is not necessarily the case that low grades equate to bad attitudes, this loss of information could be meaningful. It should be noted that all 11 of the students identified as having the worst attitudes and highest anxiety and who participated in the focus group, were still in the class at the time of the journaling assignment.

Creswell (2002, 2009) also mentions three threats to external validity. First is the interaction between selection and treatment. When participants have a narrow set of characteristics, we cannot generalize to those without these characteristics. It would make sense then to only generalize to pre-service elementary teachers, not other groups. Second, there can be an interaction between setting and treatment. Since this study was conducted at a community college, it might not be appropriate to generalize to students in a four year program. Since this community college was predominantly White and English speaking, it might not be appropriate to generalize to students in more culturally diverse settings. Third, there can be an interaction of history and treatment. I may be wrong to generalize what happened this semester to what happened with students in the past or what may happen in the future. I may not be able to take what happens at Blackwood and generalize to what might happen in Camden.

Design limitations. In the design of this classroom study, certain limitations existed. First of all, this cohort was from spring semester courses. These students often came from a basic skills course in the fall. This fact may have skewed the results. Second, since there was one instructor for both sections there may be a loss of generalizability to other instructors teaching the same course. Leadership styles may be different with different teachers. If they are not working under the situational style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, Blanchard, & Hersey, 1976; Hersey & Blanchard, 1974, 1981, 1982), with an ethic of care (Gilligan, 1992; Noddings, 2003), the use of journaling may not have the same influence on their students. Thirdly, the journaling project lasted only a month. It is unknown whether years of accumulated negative feeling toward math could have been overcome in such a short time. Fourth, since the entire project was dependent on voluntary participation, there may have been loss of information due to students withdrawing from the course.

Finally, because of my quantitative background I was concerned if there was an issue because I was in the dual role of researcher and instructor. I struggled with my quantitative bias throughout this project. From my literature review to some of my own analysis of data, I wondered more than once in my journal about whether this was "real research." What was really under study was my effect on the students. That the researcher was the instructor made this a self-study. The key danger in the analysis then was that my instructor biases matched identically to my researcher biases. What I thought was good practice as an instructor matched identically to what I thought as a researcher. The same was true for my views about negative behavior. The analysis of the quantitative data should not be affected by this dynamic. The statistics speak for themselves. A significant result is a significant result regardless of the relationship of the researcher to the instructor. For the qualitative data it is more important that care be taken with interpreting the results (Bowling, 2002; Creswell, 2002, 2009). Student responses were used more than researcher observations to ensure some level of bias control. Students were speaking and writing for themselves, stating their own views. With these protections, hopefully it was less likely that the researcher/teacher bias was evident.

Coming from a traditional background which coveted Campbell and Stanley's Solomon Four Group Design (1963) as most desirable, I questioned my planned one group, pre-experimental, pre-test post-test model. I also worried that I would violate their eleventh threat to validity: reactive effects of experimental arrangements. This is what others might call the Hawthorne Effect (Gay, 1992). Would my students change because they knew I was studying whether they would change? As I became more comfortable with action research (Bowling, 2002), I realized that the Hawthorne Effect is not frowned upon in that arena in the same way as in traditional quantitative research. "Action research has a different view of the Hawthorne effect. Strong relationships between the researcher and his/her field subjects are considered essential to the successful outcomes of an action research project" (Cooms & Smith, 2003, p. 101). Further, the authors maintain that in action research the Hawthorne effect has a role in actually validating qualitative data obtained by a participatory action researcher within a social setting. Whereas I always believed that students and teachers needed to have solid relationships, as I prepared to create my main classroom experiment, I tried to embrace this new-to-me view of important researcher/participant relationships.

Cycle Two

The second cycle took place in summer 2009. It was a short planning cycle. Bowling (2002) would characterize this part of the action research process as setting the stage. As the action cycle usually involves reflecting, acting, and evaluating (Hinchey, 2008), I refer to this work as a cycle, with the reflection being the decisions about what materials I needed to create, the action being the creation of the materials, and the evaluation being the assessment of whether the materials were useful.

To facilitate the creation of the Course Outline for Math Systems I: Structures for the fall term, several data sources were used. First, the Math Department had its course master syllabus for MTH 105 (see Appendix E). The syllabus lists course goals and student learning outcomes. The course outline that I created needed to include a framework in which students could reasonably meet these goals and objectives. The syllabus allowed for the flexible implementation of individual strategies and course requirements by an instructor. As Course Coordinator for MTH 105, it has been part of my job to conduct an annual syllabus review and make recommendations for any changes that might be needed. In Cycle Two I conducted the syllabus review, suggested changes as needed, and then created my personal course outline based on these finalized goals and objectives. I also continued to keep a journal throughout this cycle.

During this time the course outline for the fall classes was developed. Based on a review of relevant literature and the outcomes from the cycle one, collaborative activities were developed. Prompts for the fall implementation were formalized. The plan for administering the Math Anxiety and Attitudes Scale (MAAS) was finalized as well. Information gleaned from the interviews and journal responses in the LAFS cycle were used to edit the prompts to be used in the fall semester. At that time there was still flexibility for the prompts. The research questions were not directly addressed in Cycle Two because I was designing the components of study I implemented in Cycle 3. I planned for the activities I thought should take place in class to help students learn math with minimum interference from anxiety. I also developed activities intended to improve students' attitudes. For each lesson day I tried to include a game, collaborative activity, manipulative demonstration or activity, or a math success strategy activity. Students might play "Signed Number War," use base 10 blocks to model a subtraction problem, work together on a "You be the Teacher" activity or identify what types of mistakes they made on a quiz. These types of activities are discussed in more detail in the next section and in Chapter Five and samples appear in Appendix F. I edited the existing journal prompts to ensure that responses to them could encourage students to reflect in ways that could lead to significant changes in their attitudes or reduce anxiety.

My second task was to evaluate the department adopted textbook. It was not an option to change that book for the fall term, so the book search I conducted was, in reality, for future terms. I also explored the ancillary materials that were available for students knowing that the book was in place for the fall. I requested desk copies of similar texts from four other companies. I reviewed these texts in depth and compared them to what we were currently using. After the second cycle, my textbook recommendations were made to the Mathematics Department Chair for future terms. As Course Coordinator for the MTH 105 course, it was my prerogative to recommend a change in text as needed. All faculty who teach this course must use the text that the department adopts. Textbook selection is not done by individual faculty.

In addition to the creation of the course outline and course materials, Cycle Two provided an opportunity to make final adjustments to the Math Anxiety and Attitudes Scale and to plan the journal activity for the fall term.

Cycle Three

Participants. This cycle involved 80 students registered for MTH 105 in the fall 2009 term. Students came from the 11:00 Tuesday, Thursday section and the 12:30 Tuesday, Thursday section on the Blackwood campus. These specific sections were chosen since they meet at similar times of day and days of the week and tend to have similar overall demographic characteristics. It is impossible for the overall experience of two different classes to be the same, but this kept all 80 students in as close to similar conditions as is possible. Students were not required to participate. If a student wanted to participate, he or she was asked to sign an informed consent form (Appendix B). Participation or lack thereof did not influence a student's grade. All students registered for the two course sections volunteered to participate. However, not all students participated in all parts of the study.

The actual "action" in the action research for this cycle (Bowling, 2002; Hinchey, 2008) was the use of three teaching techniques that I had not used with this group before and the use of a new grade scheme. For the first time I used physical manipulatives in class. I had used them in my basic skills course for years, but not at this level. The second change was the implementation of paper and pencil guided activities like the "Got Milk" activity created in Cycle Two, which I will describe in the next chapter. Third was the inclusion of success strategies into the class. Finally, I had a new grading system that considered more than just exams.

In every class session, one of three teaching techniques I used was different from how I had usually taught this course. First, I used physical manipulatives to show some concepts. For example, when teaching the lesson on set operations, I used attribute blocks. Each block in the set had a unique set of characteristics based on color (red, yellow, blue), thickness (thin, thick), size (big, small) and shape (circle, square, rectangle, hexagon, triangle). So, for example, there was one small, red, thin triangle and one big, blue, thick circle. We then used Venn Diagram maps to place shapes in regions. Where are the things that are red and triangles? We then formalized the language and talked about the idea of intersection. Finally, we looked at examples that were abstract, with no manipulatives to be sure the skills transferred. I used the attribute blocks, tangrams, pentominoes, dominoes, playing cards, dice, base ten blocks, and red and yellow chips to illustrate sets, fractions, perimeter and area, probability, place value, base-10 arithmetic, and operations with signed numbers respectively. The second technique was the use of paper and pencil games and activities to introduce, reinforce, or connect topics. Typically, this technique involved problem solving, applications, or real life situations where math was needed (See the “Got Milk” activity, Appendix F). The final technique was the incorporation of success strategies into the class. We overtly talked about goal setting, note taking, studying, reading the text, preparing for and taking a test, error analysis, and reflection (See activities in Appendix G). This is why I asked students to complete the journals. Students were encouraged to think about their learning and to take control of it. I shared with them a quote from the Association of Mathematics Teachers in

Two-Year Colleges *Beyond Crossroads* document, “In a standards-based learning environment, students are viewed as partners in the learning experience. To nurture that partnership, faculty may need to help students identify their academic strengths and weaknesses, develop strategies to minimize mathematics anxiety, and learn how to take responsibility for their own learning” (Blair, 2006, p.17). I let them know that my view of our relationship was as partners and that we both had responsibilities in the partnership.

The second change was with respect to grading. For this course I had always used three tests averaged together and no other grades. This term I introduced three new components to the grade. The first was quizzing. In many class sessions I gave students a very short quiz. It gave students an opportunity to see the problem types and difficulty level for a concept that I felt was appropriate. My hope was that this would take some of the pressure off come test time. The second new grade was for an oral report. For 20 of the 30 class periods, two students would give a very brief oral report/presentation (individual not together) on any math topic of their choosing. It could be a biography of a mathematician, an explanation of a math concept, a demonstration of how math is used in a sport or recreational activity, anything with a math connection was acceptable. They spoke for two to three minutes each. I had a few doubts about this activity. I was not sure if mixing public speaking with math would be the anxiety reducer I had hoped! As it turned out, they loved it. Finally there was the development of a portfolio (see Internet Scavenger Hunt in the Syllabus in Appendix E). Students had an outline of what was expected, and in many classes I would highlight websites that might be helpful to them. I might show a movie clip or video clip to begin a discussion. The three tests were worth

60% of the grade, but the quizzes (10%), oral report (10%), and portfolio (20%), were worth 40%. I was not studying the effect of this grade scheme change on student achievement, but rather their attitudes. Did they seem less anxious? Did they have better attitudes?

Data collection. Data about students came from three sources: the Math Anxiety and Attitudes Scale (MAAS), my journal, and the students' journals. Data about my leadership came from both journal types and from a survey that students completed after each test. The MAAS was administered at both the beginning and end of the term. The purpose of taking it at the beginning of the term was twofold: to have a baseline of responses for students and to see what level of anxiety was present at the start of the term and what attitudes were held with respect to math. The purpose for taking it at the end was to see what differences, if any, existed in responses from the beginning of the term to the end. Students who volunteered were given the scale on the first day of class and on the first class after the Thanksgiving break, prior to beginning final exam preparation.

Activities for the class were planned in Cycle Two. As described, there were increased collaborative activities, more use of manipulatives, and improved connection to real world examples compared to the Spring 2009 term. The primary function of the activities was to teach the students math. The secondary goal was to improve their attitudes and reduce their anxiety about math. I made observations in my journal after each class noting student behavior with respect to attitudes and anxiety. My journal was a source of data for both research questions about the students and about my leadership.

Additionally, the students' journals were a second source of information about their attitudes. Journal prompts were tentatively finalized in Cycle Two. Some prompts needed to be added, deleted, or edited within the term. The journals were a data source for the research questions about the students and also about my leadership. Journals were collected each Thursday and returned each Tuesday through the term. I made written responses to the students in the journals. I retained these journals at the end of the term.

In previous coursework I developed a survey for students to complete after each test (see After Test Survey in Appendix H) (Jackson 2008c). They answered three questions aimed at identifying how much academic direction I provided, how much emotional support they received, and their perceived level of knowledge of the topic prior to the lesson. This survey was anonymous. To find out how much direction I provided, they were asked to select which of two statements better described their feelings about the current content: “The instructor provided a lot of academic support to me” or “The instructor provided very little academic support to me.” Similarly, with respect to emotional support they received for the current content: “The instructor encouraged me and supported me” or “The instructor did not encourage and support me.” Finally, they were asked to assess their knowledge of the current material before the lesson happened: (1) I was very unfamiliar with this material, (2) I had seen this before but was never very good at it, (3) I was pretty good at this material before but needed to get better, or (4) I was very familiar with this material; it was a review for me.

Data analysis. Data from the MAAS was analyzed using SPSS 16. Descriptive statistics were completed for both the pre- and post-test. Chronbach’s alpha was calculated (Allen & Yen, 1979; Traub, 1994). A series of paired t tests were completed to consider differences between pre- and post-test anxiety levels and pre- and post-test attitudes (Larson & Farber, 2012). For all tests a .05 level of significance was used.

The journals were analyzed through coding. A preliminary codebook was developed in Cycle one (see Appendix D). A few new codes were added as different themes emerged from the data (Bowling, 2002). The purpose of analyzing the journals was twofold. First, I wanted to see if there was any evidence of a change in attitudes for these students. Second, I wanted to see if there was evidence that my espoused leadership theory was in line with my actual behavior.

Cycle Four

Cycle three generated a lot of data from my own classroom. As I transitioned from the action stage in the cycle to an evaluation and reflection period (Bowling 2002, Hinchey, 2008), I realized that if any lasting changes for our pre-service elementary teacher population were going to happen, I would need department, college, and even national support. In the fourth cycle, the emphasis was turned toward department and institutional policy and a broader national conversation about student success strategies. This cycle was ongoing from December 2009 until present. At the College, there were three departments within three different academic divisions impacted by outcomes of cycles one through three. These were the Math Department, the Academic Skills Math Department, and the Elementary/Secondary Education Department within the Math, Science and Health Careers (MSHC), Transitional Studies (TRAN), and Arts Humanities and Social Sciences (AHSS) Divisions respectively. There was also an effort to impact change through a national organization, The American Mathematical Association of Two Year Colleges (AMATYC). Finally, there was an effort to impact change through collaboration with a textbook publisher. Some of the opportunities for leadership that emerged included: a need to improve the MTH 105 course through department policies and transfer agreements with four year colleges, the desire to have the Academic Skills Math department provide success strategies to students at the developmental level that they could then use when they get to the higher level MTH 105 course, and the need to investigate the level of national interest in using success strategies with pre-service elementary teachers to improve their attitudes. In cycle three it was clear that non-content success strategies were as important to students' achievement as how I presented the content. I did not want success to be isolated to just my own students. I wanted to see what I might do to extend my ideas to a broader audience.

Several policy issues emerged that I wanted to address with the Mathematics Department. First there were indications that MTH 105 was not serving the population we thought it was. My classes were made up of only about 50% education majors. There were also students who wanted to teach high school math in the future (students who should really be math majors not education majors) in my classes. I worked with the department in this cycle to restrict registration to students who were education majors. I also worked to create a new degree option for those who wanted to be math teachers. The pre-requisite for MTH 105 is Elementary Algebra, a high school level course. Through this cycle there was a lengthy discourse on what the prerequisite for this course should be. We included transfer institutions in the conversation. There was also a need to discuss the companion course MTH 106. My students were reluctant to take it because it does not transfer well and they did not see the benefit in taking it. I also wanted to institute a common online homework option that faculty could use with their students to help students understand the math content in MTH 105 better. We went through all appropriate governance processes to achieve these goals.

In my classes about half of my students came from basic skills classes. I wanted to work with the ASM department to incorporate math success strategies in their courses so that students would come to their MTH 105 class with better skills in areas like goal setting, time management, organization, study skills, reading their book, and test taking. There was a three pronged approach to this initiative. The first was having the department conduct professional development for all part time faculty on incorporating success strategies into the classroom. The second proposal was having a chapter on success strategies added to the books used for developmental math courses. Finally, I proposed that a 1-credit math success course be added to the course offerings for our most at risk students. Again, the department went through governance channels to accomplish these important goals.

As the literature review indicated, improving math attitudes was not just a local issue, it was a national one. In this cycle I also tried to make an impact on the national conversation about math attitudes. I used my role as a member of AMATYC's academic committee on Teacher Preparation to bring to light some of my findings and to make suggestions at the annual meetings in 2009, 2010, and 2011 about possible professional development sessions that could be held at the future national meetings. Beyond the typical sessions and workshops offered at the conference in Austin in 2011, we were able to get a themed session on *Best Practices in Teacher Preparation* that included a piece about math anxiety and attitudes. At the same time I worked with a national textbook company to produce materials that students and faculty could use to increase the likelihood of success in math and improve attitudes about math. I have been invited to present a Poster Session at the 2012 AMATYC conference on the student success strategies I used with my students (email correspondence June 5, 2012).

I continued to journal and reflect about my leadership achievements and challenges as I worked through departmental politics, governance procedures, interactions with transfer institutions, and interactions with faculty at other colleges around the nation. The final cycle was one that ran side by side with all four previous cycles. It focused on the research questions about my leadership theory in use.

Cycle Five

I am referring to the analysis of my leadership as cycle five. During each of the previous four cycles I collected data about my leadership. I kept my own journal, I collected data from student journals, and students in Cycle three completed a survey after each test. Cycle five was an ongoing cycle and was intended to answer research questions four and five: to what extent does my espoused leadership theory match my behavior in and out of the classroom. I say that I am a situational leader who practices an ethic of care. Am I? Do I? When times get tough and deadlines get short, do I truly function the way that I claim to? Do I act differently outside the classroom than inside?

The data for this analysis came from four primary sources. First, I used my journals and reflections from throughout the program and study. Second, I used surveys completed by students each time they had a test (see Appendix H, After Test Survey). Third, I analyzed my responses to students in their journals (I kept these after the term). Finally, I used responses from the college’s faculty evaluations that the students complete.

Data analysis involved coding the data and looking for trends and themes (Bowling, 2002; Creswell, 2002, 2009). With four sources of data, I hoped to see clear evidence of what my leadership behaviors had been. Close to 80 students contributed data to this analysis.

Conclusion

Cycle one was intended to field test the instruments being used in later cycles and capture some preliminary information to answer research question one: What attitudes and anxieties regarding mathematics are held by pre-service elementary school teachers in a large suburban community college? Cycle two was a preparation cycle that took information captured in Cycle one to set the stage for Cycle three (Bowling, 2002). As there were some leadership challenges, I was able to collect data for research question five: In what ways is my leadership outside the classroom similar to and different from inside the classroom? Cycle three was the main classroom cycle and was intended to answer research questions one (stated above), two, and three. Research question two was: To what extent can the activities in class influence pre-service teachers' attitudes about mathematics and reduce their anxiety? Research question three was: To what extent can significant change in math attitudes occur based on classroom activities? Cycle three also allowed me to consider myself as a leader in the classroom and helped me answer research question four: To what extent do I use a situational style of leadership and an ethic of care in my classroom when teaching courses to pre-service elementary teachers? Cycle four was a leadership cycle and helped to answer research question five (stated above). In the next two chapters I present the results of the five cycles and then revisit these research questions.

Chapter Five

Results

Cycle One

I had three goals in Cycle One: field test the Math Anxiety and Attitudes Scale (MAAS), conduct a student focus group to help in the development of journal prompts, and field test those journal prompts. Along with the data I collected from the scale, focus group, and journals, I maintained a journal.

The Math Anxiety and Attitudes Scale. Sixty two students were present and volunteered to take the MAAS (Appendix A) during class. Thirty nine of the participants identified themselves as education majors and 23 did not. There were 14 males and 48 females. The items on the Anxiety Sub-scale used a five-point Likert Scale (Larson & Farber, 2012). For each item, the student identified his or her level of anxiety as: none, a little, average, a lot, very much. For analysis none =1, a little = 2, average = 3, a lot = 4, and very much = 5. Similarly, I used a five-point Likert Scale for the Attitudes Sub-scale: strongly disagree = 1, mildly disagree = 2, neutral = 3, mildly agree = 4, and strongly agree = 5. Strongly disagree corresponded to a strongly negative attitude, mildly disagree to a mildly bad attitude, etc.

Descriptive Statistics. For the 24 items involving Math Anxiety there was one item with a mean between 4.00 and 5.00, nine with means between 3.00 and 3.99, twelve with means between 2 and 2.99, and two with means between 1 and 1.99. The mean for the total Math Anxiety Sub-score was 66.0 with a standard deviation of 17.5. The mean response overall was 2.75 which is a higher than the 2.08 Suinn et al (1972) found in their original study. In a recent literature review of 45 studies (Zientek, Yetkiner,

&Thompson, 2010) the researchers used confidence intervals to consider math anxiety in a variety of groups including, adults not in college, remedial college students, pre-service and in-service teachers, students in university level courses, and seventh to twelfth grade students. They found that across studies, pre-service teachers had higher means than both adults not in college, and students in other university courses. They also had higher means than younger students who were currently in high school. The ten items from this study with the highest means are summarized below in Table 5.1.

Table 5.1

High Anxiety Items (Mean > 3)

21.	Taking an examination (final) in math class	4.24
20.	Being given a "pop" quiz in math class	3.85
16.	Being given a homework assignment of many difficult problems which is due the next class meeting	3.61
6.	Thinking about an upcoming math test one day before	3.55
18.	Waiting to get a math test returned in which you expected to do well	3.45
10.	Taking an examination (quiz) in a math course.	3.45
13.	Signing up for a course in statistics	3.40
4.	Reading a formula in Chemistry	3.15
14.	Getting ready to study for a math test	3.13
19.	Working on an abstract mathematical problem	3.05

Each has a mean above three, indicating, students identify that they have more than an "average" level of anxiety. Six of the ten items mention some type of quiz, test, or examination. Two involve solving difficult problems (performance) and two involve using math in other coursework like Chemistry or Statistics. Six items on the Attitudes Sub-scale were positive items (indicating a positive attitude) and six were worded in a negative manner (indicating a negative attitude). The latter were rescaled to correspond to a positive scale. The means for all items are presented in Table 5.2 with the rescaled items denoted with (r). Thus, for all items a higher score indicates a better attitude and a lower score a more negative attitude. No item on the scale achieved a mean between four and five. Thus, no item had a mean of a mildly to strongly positive attitude. Only two of the items on the Attitudes Sub-scale had means between three and four. "I am sure I can learn mathematics" and "I can get good grades in mathematics." These two, on average, are between a neutral and mildly positive attitude. The remaining ten items all had means between 2.00 and 2.99 indicating a mildly negative to neutral position. The mean and standard deviation for the rescaled subscale were 34.4 and 12.2 respectively. This indicates an overall rescaled mean response of 2.87 which indicates a mildly negative to neutral attitude.

Table 5.2

Poor Attitude Items (Mean < 3)

26. I am sure I could do advanced work in mathematics.	2.35
30. I have a lot of self-confidence when it comes to mathematics.	2.55
34. For some reason, even though I study, math seems unusually hard for me. (r)	2.55
36. Math has been my worst subject. (r)	2.63
35. Most subjects I can handle OK, but I have a knack for mucking up math. (r)	2.65
32. I don't think I could do advanced mathematics. (r)	2.76
33. I'm not the type to do well in mathematics. (r)	2.76
28. I think I could handle more difficult mathematics.	2.81
31. I am no good at mathematics.	2.95
25. Generally I have felt secure about attempting mathematics.	2.97

Reliability. After the scales were considered with respect to descriptive statistics, they were then analyzed to determine reliability. The most obvious way to establish reliability of scores for a scale is to look at the internal consistency measured by coefficient alpha (also known as Chronbach's alpha) (Allen & Yen, 1979; Traub, 1994). The two sub-scales were considered separately since they were scaled differently and really measured different constructs. The Math Anxiety subscale had a coefficient alpha of .934. The Math Attitudes subscale had a coefficient alpha of .946. Both of these reliability values indicate a very high level of internal consistency for the scores. The attitudes subscale was also analyzed using the split-half technique since the first six items asked questions in a positive way and the last six in a negative way, “I can…” versus “I can’t…” The correlation between the two halves was .804 with a Spearman Brown measure of .891 and a Guttman Split-Half Coefficient of .878 (Allen & Yen, 1979; Traub, 1994). These high values indicate that the reverse wording on the two halves did not lead to inconsistent results. Thus these results indicate both attitude and anxiety sub-scales were reliable for this population.

Validity. Establishing reliability is a necessary, but not sufficient, condition for establishing validity. Validity establishes whether a scale measures what it purports to measure (Allen & Yen, 1979; Wainer & Braun, 1988). This scale should be measuring math anxiety and attitudes. On its face the scale does just that. The content validity has been well established through the literature. To consider construct validity, factor analysis was used (Kline, 1994).

The anxiety subscale is based on Hopko’s (2003) revision to Suinn et al.’s (1972) original *Math Anxiety Rating Scale*. Factor analysis on the original scale yielded between two and five factors, but two common factors emerged as explaining most of the variance (Baloglu & Zelhart, 2007; Brush, 1978; Capraro, et al., 2001; Frary & Ling, 1983; Resnick, et al., 1982). The first was typically interpreted as evaluation anxiety and the second as performance anxiety. The first indication that these two factors exist in this data was that the top ten means discussed above (Table 5.1), which included items regarding quizzes, tests and exams, or performance of tough mathematical tasks. It has been questioned whether math anxiety is indeed a separate phenomenon than test anxiety

(Kazelskis, et al., 2000). Their own study coupled with those above indicates that there is anxiety related to math, different from mere test anxiety. When the principle components factor analysis was completed with a varimax rotation for interpretability (Kline, 1994), the first two factors extracted were the two that were consistent with earlier research: evaluation anxiety and performance anxiety. They explained most of the variance in the scale. Although other interpretable factors were extracted, they did not explain significantly more variance. The five interpretable factors extracted from the factor analysis included: evaluation (test related) anxiety, course and text related anxiety, performance anxiety, statistics related anxiety, and science related anxiety. This factor structure was similar to that found in the previous research mentioned above. Each interpretable factor is named and listed with the items that load on that factor in the table below.

Table 5.3

Anxiety Sub-scale: Interpretable Factors with Loadings

Factor One – Evaluation anxiety	
6. Thinking about an upcoming math test one day before	.704
10. Taking an examination (quiz) in a math course.	.979
14. Getting ready to study for a math test	.694
16. Being given a homework assignment of many difficult problems which is due the next class meeting	.543
18. Waiting to get a math test returned in which you expected to do well	.678
20. Being given a "pop" quiz in math class	.762
21. Taking an examination (final) in math class	.812
Factor Two – Math class and text related anxiety	
1. Looking through the pages in a math text	.637
2. Walking into a math class	.727
5. Buying a math textbook	.591
9. Picking up a math textbook to begin working on a homework assignment	.665
22. Starting a new chapter in a math book	.680
24. Walking on campus and thinking about a math course	.709
Factor Three – Performance anxiety	
3. Having to use the tables in the back of a math book	.527
7. Watching a teacher work an algebraic equation on the blackboard	.572
11. Reading and interpreting graphs or charts	.776
12. Solving a square root problem	.766
17. Listening to a lecture in a math class	.485
19. Working on an abstract mathematical problem	.471
Factor Four—Statistics related anxiety	
8. Being told how to interpret probability statements	.627
13. Signing up for a course in statistics	.691
15. Reading the word "statistics"	.736
23. Listening to another student explain a math formula	.578
Factor Five—Science related anxiety	
4. Reading a formula in Chemistry	.734

Some research on attitude scales for math have found a bidimensional construct, one factor for positively worded items and a second for negatively worded items (Bai, Wang, Pan , & Frey, 2009; Pajares & Urdan, 1996). The Fennema-Sherman scale from which this Attitudes subscale was derived had six positively worded and six negatively worded items, however, when it was researched exhaustively using factor analysis and other analyses to determine its psychometric properties (Broadbooks, et al., 1981; Frary & Ling, 1983; Kazelskis, 1998; Melancon, et al., 1994; Mulhern & Rae, 1998; O'Neal, et al., 1988) only one factor emerged.

Table 5.4

Attitudes Sub-scale: Factor loadings for single component rotated solution

Item	Loading
Generally I have felt secure about attempting mathematics.	.860
I am sure I could do advanced work in mathematics.	.742
I am sure I can learn mathematics.	.720
I think I could handle more difficult mathematics.	.802
I can get good grades in mathematics.	.760
I have a lot of self-confidence when it comes to mathematics.	.780
I am no good at mathematics.	.766
I don’t think I could do advanced mathematics.	.756
I’m not the type to do well in mathematics.	.889
For some reason, even though I study, math seems unusually hard for me.	.857
Most subjects I can handle OK, but I have a knack for mucking up math.	.759
Math has been my worst subject.	.853

Based on this literature review, the Attitudes subscale for this study should be uni-dimensional, measuring only one construct. This subscale should then have only one rotated factor. It did. The factor loadings for the rotated solution appear in Table 5.4 on the previous page.

Criterion validity was also considered (Allen & Yen, 1979; Wainer & Braun, 1988). How predictive could these scores be? There are two types of criterion based validity, concurrent and predictive. Concurrent validity measures how well a scale correlates with another scale (or activity) completed at the same time. When the total scores for the Anxiety Subscale and Attitudes Subscale were correlated, they were found to have a significant negative correlation ($r = -.480$, $p < .001$). The negative correlation indicates that as anxiety goes up positive attitudes go down. The proportion of variance explained is 23%. This means that 23% of the variability in attitude can be explained by variability in anxiety. This significant correlation also helps establish the concurrent validity of the scale.

To consider predictive validity, logistic regression was performed (Cahtterjee & Price, 1991; Mosteller & Tukey, 1977; Tatsuoka, 1988; Tabachcnick, 1996). I was interested in whether the item responses of future teachers were distinguishable from the non-majors. I used the dichotomous dependent variable of Education Major (0=no, 1=yes) and item responses as independent variables, and tested the model. The full model created a significant result. In fact, one could perfectly predict if a student was an education major or not simply by noting the response pattern on the scale.

Table 5.5

Logistic Regression Classification Table

	Predicted		
	Major	Non-major	
Observed			% Correct
Major	39	0	100%
Non-major	0	23	100%
Total			100%

We refer to a model's ability to correctly predict an occurrence (education major) as its sensitivity and its ability to find a non-occurrence (non-education major) as its specificity. In this model both were 100%. There were no false positives or false negatives in the prediction. Since we could perfectly predict whether a student was an education major by noting his or her response pattern, the scale showed predictive validity. It might be interesting to explore in the future why education majors have a different pattern of responses than non-majors and which items are most predictive of group membership. This result did help inform my decision to ask the math department to restrict the course to education majors only. Their needs are different that non-majors. The success in prediction with this group does not mean that this model would necessarily be predictive in other populations, but in this one it did quite well. With high reliability, both concurrent and predictive validity, and construct validity established through these analyses, it appeared that this scale was appropriate for use in this population.

Focus Group. I used a focus group to gather additional data related to answering research questions one, two, and three. I chose the focus group format because I wanted to delve deeper beneath the surface of the questionnaire responses to obtain the true meaning students' attributed to events (Bowling, 2002). I used a semi-structured interview (protocol Appendix C) starting with main questions, probing as needed and using follow up questions for clarification.

The eleven-student focus group came in over Spring Break for their interview. The students were candid in their responses. They were not afraid to say that they hated math and math teachers. One student claimed an, "intense aversion to math." Another characterized her feelings as, "uneasiness towards math." They were uninhibited in their willingness to explain how they perceived specific teachers as ruining their attitude about math. One noted, "I started algebra and realized most professors have no personality." A second characterized her teacher as a "mindless robot." Another was more specific, "In sixth grade I had a male teacher. He was the basketball coach. He was intimidating!" The most distressing response was, "In my experience all of my teachers made me feel dumb for not getting math right away and discouraged me greatly." She went on to say, "I feel as if I could have had a better grasp on it if I was encouraged, rather than discouraged for not being strong in the subject." As a group they had had some success with math; it was not that they could not achieve. To the person they all responded that they hated tests. They also indicated that they felt that the only way they could really learn was if the math was connected to real life situations or was taught in a fun way, "I liked it when a professor would give real life examples appealing to my generation." When pressed about what "fun" is, most of them talked about collaborative activities. One said, "I still remember games I played when learning my times tables." Other than testing situations, students mentioned being called on in class when their hand was not raised as causing them the most stress. Of the 11 students, all but one mentioned algebra or geometry as courses in which their attitudes changed. There were some intense responses like, "I started hating math when I started algebra." There were also some more thoughtful responses, "It all started for me when I was in middle school learning Geometry and Pre-Algebra. Sometimes I got it sometimes I didn't get it at all. I believe it probably carried on until I was in high school and even now." For some of these it was the subject itself, for others it was the algebra teacher or the teacher's style when teaching the course. One said, "In high school I had a lot of mediocre teachers which kind of sent me down the anti-math road I am on now. Plus, add in having [Bransky] for a class, math is painful." It seemed that when they were in the elementary model of one teacher who worked with them on all subjects, they were comfortable with that teacher. When they arrived in middle school or upper elementary when there was a separate math teacher things changed. This was an interesting result that I had not seen before in the literature, but seemed very reasonable.

The results of this focus group helped organize the twelve prompts that were created for the journaling part of the project. The interviews also gave further insight into what causes the anxiety and hatred of math. In part it was due to a perceived disconnect with the teacher. Students just did not feel as close to the math teacher, often identified as a man, as they did to the elementary style teacher, often identified as a woman. What seemed to appeal to students was the individual attention of the elementary style, which can be interpreted as a care ethic (Gilligan, 1982; Noddings, 2003) They were turned off by the rote memorization of algorithms that they perceived as being the way to do algebra. They definitely did not like just memorizing formulas. They did not like the abstractness of the algebra and never saw how it connected to them. When it came to lower level topics, they understood what it was used for and why they needed to know it, even if they were not particularly interested in it. With algebra they just saw it as a torture device, with no end, no purpose. This result was very telling.

Journals. Students completed a short journal project within the semester. Keeping a journal or diary can be useful when detailed information needs to be collected (Bowling, 2002). I used a pool of structured prompts for most of the activity. Students turned in the journals weekly and I responded to them. My responses sometimes elicited a reply that was not a part of the original set of prompts but delved deeper into a student's feelings about a particular issue.

The purpose of this cycle with respect to the journal prompts was first to create a pool of prompts intended to solicit data to assist with answering research questions two and three, which were: Where did the pre-service teachers' attitudes come from? How could they be improved? Second, the prompts were field tested to determine whether they were soliciting the expected level of detail, answers that were on point, and responses that could be analyzed with respect to the research questions. The prompts were created based on the literature, responses to the MAAS, and responses in the focus group conducted that term. The final journal prompts included the following items:

1. What is your first memory regarding your feelings about mathematics? Was it positive or negative? Do you feel the same about math now as you did then?
2. Give me a brief math autobiography. What courses did you take in high school and college?
3. How did the members in your household feel about math? Include anyone who was living with you when you were growing up.
4. What influence did your elementary school teacher have on your views about math?
5. What influence do you think you will have on your student's attitudes? What would you do differently than your "bad" teachers and the same as your "good" teachers to positively influence your students?
6. When you were growing up I am sure there was something that your parents did that made you think, "When I'm a parent, I will never…" Now think about school. "When I'm a teacher I will never…
7. Do you believe that there are gender differences in the way that males and females feel about math, achieve in math, or succeed in math related careers? If so describe the differences.
8. Do you believe that some people have a math mind and some people don't?

9. Describe a few things that you dislike about math class and a few things that you enjoy about math class.
10. Do you believe that math anxiety is really just the same as test anxiety, or do you believe that there is a special anxiety just related to numbers?
11. What percent of a student's success is attributable to their ability in math, what percent to their effort, and what percent to their teacher?
12. List three things that you think are the teacher's responsibility to help make a student succeed in math. Name three things that are the student's responsibility.

Items seven, eight, ten, and eleven were intended to capture information about what attitudes these students hold about math (research question one). Items one through four were intended to elicit responses about where the students' attitudes came from. Items five, six, nine, and twelve were intended to reveal the types of activities that could change math attitudes.

The autobiographical questions (one through four) did capture the students' mathematical background and their perception of where their attitudes came from. Some students attributed their ability to family. Roxy wrote "My whole family is bad at math." Adam responded "My brother is the math person in the family." Others talked about school. An older student remembered, "I had a really good third grade teacher." While a younger one noted, "I liked math until I got to 9th grade." One even posited, "I like to blame Catholic School, to (sic) much time in confession!" For students with a more positive attitude about math, the typical response was that they, “Always liked math.” For those with a more negative attitude there were three causes mentioned. In order of frequency they mentioned: a bad experience with a teacher, a course that was difficult, and lack of family support.

For the items that were intended to elicit some in depth responses about students’ attitudes, the results were not at the same level of quality. I realized that three of these prompts were worded to elicit a one word answer, yes or no. “Do you believe…?” Many students did expand on their answer, but far too many just answered with just a single word. The intent of the journal was to get deeper answers, so these items did not generally work as intended. There was good information about what the attitudes were. A large majority of students perceive males and females as being different in their abilities with math, think that people who are good at math have a math mind, and believe that math anxiety exists above and beyond test anxiety. Almost every student with a negative attitude about math attributed 50% or more of student success to the teacher, whereas those with a positive attitude attributed only 10 – 20%.

Finally, items that pertained to how to change attitudes were very effective. Students had very clear views about what activities in class made them feel motivated and excited and what activities made them feel bored and frustrated. Sally noted, “I know when I was a kid anytime there was games involved, they had my undivided attention [smiley face with exclamation points forming eyes, dot for nose, and smile].” Even more encouraging, many of the students identified that their attitude about math had changed based on some of the things that we did in class. For example Kate wrote, “Once I got to college I enjoyed math class again; much more than I ever have in the subject.” Penny agreed, “Now that I’m older I enjoy learning more in math.” They liked collaborative work, projects, real world examples, and physical models. They disliked lecture, algorithms, and, of course, anything that felt like a test. Again, most of these responses were in line with what the literature predicted.

It was not unexpected, but it was discouraging, to see how poorly these future teachers wrote. “I don’t think I need to learn alot of math cuz I’m gonna be a reading teacher.” They had so many grammar, spelling, and punctuation mistakes that it was actually distracting. The journaling activity was successful in providing the information needed for the next cycle (Bowling 2002; Hinchey, 2008), however, the four prompts pertaining to attitudes needed to be modified to elicit more in depth responses. The other eight prompts seemed to get at the information they are intended to. Overall, the project yielded the outcomes that it was intended to.

Cycle Two

From the feedback that I received from my spring semester students, I knew that students needed and wanted guidance in more than just the math. For them, success depended not just on the math content but strategies for success. In cycle two I needed to do some preparation. I began to develop materials to help them with success strategies (see samples in Appendix G).The first thing that I tried to develop were materials to help students organize themselves, set goals and reflect on their progress, and manage their time effectively. I developed several worksheets that they could simply print out and fill in. In one, they had a three-part form. First, at the beginning of the semester, they stated their grade goal and attendance goal for the term. They listed challenges that they might face to meet these goals and things they planned to do to face the challenges. At midterm they completed the second part of the form. They stated their current grade, evaluated whether or not it was what they wanted, and made a plan for moving forward to meet their original goal or make an edited goal. At the end of the term they filled out the third part with their final grade, and commented about what they did well and what they wanted to improve on for their next course. Other forms in this section included a time tracker, grade tracker, and forms to fill in with information about their instructor, course, and where help could be found. There was also a page of post-it notes with affirmations, a tip sheet about overcoming math anxiety, a sample notebook table of contents, and general tip sheets about self-management.

The second set of materials focused on learning styles. It included a self-created 24-item Math Learning Styles Survey that asked students questions about how they functioned in math class. Students had directions for how to score it and then had suggestions on success strategies particular to their stated strengths. For example, a strong visual learner might want to use colored pens to take notes. A strong auditory learner might like to record their lessons. A strong kinesthetic learner needs to do as many problems on their own as possible. The information emphasized that although we all learn in multiple ways; some methods may be more dominant than others.

The third section focused on tips for effective studying. It began with a suggestion to study with purpose, have a goal, and have a plan for study time. It then provided tip sheets for how to take notes, read the textbook, and approach homework assignments. There were also guides for how to get the most out of tutoring, how to have an effective study group, and how to make useful study materials. There were printable homework cover sheets, tutoring organizers, sample note cards and graphic organizers, and a note sheet for taking notes from the textbook.

Test taking strategies made up the fourth section. These materials focused on not just the typical before and during strategies, but also the after. Of course there were suggestions and tips about how to prepare for a test and how to take a test. What was different was a set of materials about what to do after the test. I helped students analyze the types of errors they made and how to correct or prevent them the next time. The four types of errors we identified were secretarial, computational, procedural, and conceptual. A secretarial error was defined as one where the student miscopied the problem, misread their handwriting, or misaligned their work. A computational error was an addition, subtraction, multiplication, or division error. A procedural error was one in which a student missed a step, could not complete all steps, or completed steps out of order. Finally a conceptual error was one which the student left the problem blank or used the wrong method. We looked for patterns in the errors. Suggestions were provided to minimize the most frequent mistakes on future exams. I strongly believed this post-test debriefing and reflection was an essential skill for math success.

I also tried to provide some advice for how to handle online or hybrid courses. These types of courses require special attention because students often have misconceptions about the time they will need to spend on the class, the effort it will take to succeed, and the organizational skills necessary to navigate a somewhat self-paced course. There were specialized sheets for note taking and homework in the online environment.

Students also made clear that they liked to understand what they were doing, not just how to do it. With this in mind I developed my classroom materials. Using the syllabus, the book, and resources from the literature, I created a course outline that included activities that were intended to both teach students the math and also to reduce their anxiety and improve their attitude about mathematics. One goal was that when students worked on a concept they would never wonder, "When am I ever going to use this." I wanted it to be apparent how the mathematics related to their lives. As an example, students often have difficulty understanding why they would ever need to compute in a base other than base 10. I created an activity "Got Milk" that helps students connect the math to a real world problem (Appendix F). They built a physical model using base 2 blocks that mimicked the base 10 blocks that they were familiar with. Three additional activities were created to monitor whether students could transfer their newly acquired skills in base 2 to other bases such as 5, 20 and 60. This introduction to the number systems of the Mayans and Babylonians exposed students to some mathematics that was a little less Euro-centric. I created a game called "I Have Who Has…" to further reinforce the skills through review and drill, but in a fun way. Finally, a quiz was developed to assess their knowledge of computing in these other bases. For each topic in the course, a similar plan of attack was developed. Materials were also created to help students set goals, manage time, study more effectively, and test take more effectively (see Appendix G for sample materials).

Cycle Two was a simple preparation cycle. Using information that I was given by my students in the spring courses, I developed materials for the fall sections. As I was not in the classroom for this cycle, I did not collect data for research questions one through three in this cycle. I was able to collect some data on my leadership, which is discussed in Chapter Six. Research questions two and three focused on whether changes in attitudes and anxiety can take place based on classroom activities. In this cycle, those activities were created. As I created activities I struggled with appropriate allocation of class time. Any time I spent in class playing a game or doing a collaborative activity was time away from direct instruction. I wanted to be sure it was worth it. I noted in my journal, "I have used the I Have /Who Has game with a lot of success in Fundamentals. Students spend a few minutes with the game and get to practice 24 problems." But I was concerned, "I hope I get as much bang for the buck at this level. I usually don't have students at this level doing classwork. I usually have them practice outside of class."

Cycle Three

During cycle three I taught two sections of a semester long course MTH 105. Prior to the semester, in cycle 2, I developed course materials that were intended to make the content more meaningful to students and also materials that addressed math success strategies such as goal setting, organization, study skills, and test taking skills. The course was taught in a traditional face to face setting. One section met on Tuesdays and Thursdays at 11:00 to 12:15 and the other on Tuesdays and Thursdays 12:30 to 1:45. The classes included lecture and collaborative activities and journaling throughout. The primary focus of the cycle was to see how anxiety and attitudes in these students changed (if at all) over the semester.

Seventy-three students volunteered to take the Math Anxiety and Attitudes Scale pre-test (Appendix A) on the first day of class (all those present on the first day). Of that group 69 took the post-test on the first class after Thanksgiving break, prior to final exam preparations. Forty two of the original respondents identified themselves as education majors and 21 did not. There were 19 males and 54 females.

The Math Anxiety and Attitudes Scale.

Reliability and correlation. As this test was field tested multiple times through coursework and cycle one, the reliability and validity of the test was assumed to hold for this group. In depth analysis was not completed. Coefficient alpha for the Anxiety portion of the pretest was .931 for the post-test it was .887. For the attitudes scale alpha values were .952 and .948 respectively (Allen & Yen, 1979; Traub, 1994). When the pre- and post-tests were correlated, an interesting outcome emerged. For the anxiety portion of the scale the Pearson correlation was .689, and for the attitudes portion it was .769. This means that for anxiety, the proportion of variance (Allen; Traub) in the post-test explained by the pre-test was 47%. This was an indication that classroom activities might be influencing anxiety levels. Students were definitely answering questions differently at the end of the term than at the beginning. Even if there was some Hawthorn Effect in the result (Gay, 1992), there was a substantial amount of unexplained variance to account for, part of which might be attributed to the classroom activities. Similarly, the proportion of variance in the post-test on attitudes explainable by its pre-test was 59%. Correlation is not causation, but there is some indication here that some of the classroom activities may have affected the post-test results. Additionally, in action research the existence of a Hawthorn Effect shows that the interaction between the teacher/researcher and the students has a positive effect on outcomes (Cooms & Smith, 2003). The journal responses were used to triangulate whether classroom activities could be given some credit for the change.

Descriptive Statistics. A summary of pre- and post-test means for the Anxiety Sub-scale appear in Table 5.6 and for the Attitudes Sub-scale in Table 5.7, with significant differences indicated. For the 24 item pre-test involving Math Anxiety there was one item with a mean between 4.00 and 5.00, eight with means between 3.00 and 3.99, fourteen with means between 2 and 2.99, and one with mean between 1 and 1.99. All items are summarized below with their pre- and post-test scores.

Table 5.6

Anxiety Sub-scale Pre and post-test means

	Question	Pre-	Post-
1.	Looking through the pages in a math text	3.82	1.94**
2.	Walking into a math class	2.15	2.00
3.	Having to use the tables in the back of a math book	2.08	1.90
4.	Reading a formula in Chemistry	3.40	3.31
5.	Buying a math textbook	1.82	1.79
6.	Thinking about an upcoming math test one day before	3.25	2.74**
7.	Watching a teacher work an algebraic equation on the blackboard	2.26	2.24
8.	Being told how to interpret probability statements	2.64	2.65
9.	Picking up a math textbook to begin working on a homework assignment	2.18	1.86**
10.	Taking an examination (quiz) in a math course.	3.19	2.79**
11.	Reading and interpreting graphs or charts	2.40	2.24
12.	Solving a square root problem	2.47	2.88
13.	Signing up for a course in statistics	3.34	3.08
14.	Getting ready to study for a math test	2.75	2.22**
15.	Reading the word "statistics"	2.42	2.14*
16.	Being given a homework assignment of many difficult problems which is due the next class meeting	3.34	2.83**
17.	Listening to a lecture in a math class	2.03	1.78**
18.	Waiting to get a math test returned which you expected to do well	3.29	2.69**
19.	Working on an abstract mathematical problem	2.95	2.56**
20.	Being given a "pop" quiz in math class	3.55	3.29**
21.	Taking an examination (final) in math class	3.99	3.14**
22.	Starting a new chapter in a math book	2.16	1.96*
23.	Listening to another student explain a math formula	2.12	1.93*
24.	Walking on campus and thinking about a math course	2.00	1.82

$p < .05$ *, $p < .01$ **

For interpretive purposes if we consider a score between 4.5 and 5 as rounded to 5 and interpreted as "Very much anxiety," no item had a mean in this range, although many students had individual scores in this range. If scores between 3.5 through 4.49 are considered rounded to 4, and therefore interpreted as "a lot" of anxiety, three items would meet this description. Items 1, 20, and 21 each have means in that range. These items refer to reading a math text, having a pop quiz, and taking a math exam respectively.

Only four of the nine items with pre-test means above three had means over three on the post-test. For the post-test no item mean exceeded 3.31. There were four items between 3.00 and 3.31, twelve items between 2.00 and 2.99, eight items between 1.00 and 1.99. By inspection it is clear that these means are small, but paired t-tests were performed to explore whether there was a significant reduction in anxiety level for the items (Larson & Farber, 2012). The largest reduction happened on items related to: looking through a math text, thinking about a test, working on a difficult homework problem, listening to a lecture, getting a test returned, and starting a new chapter. These are all topics directly addressed in the success strategies materials that students were working with throughout the term.

The summary statistics for the Attitudes Scale are displayed in Tables 5.7 below. For this scale, a higher number indicates a better, more positive attitude; with items 31 through 36 reverse coded to accommodate this interpretation (denoted in Table 5.7 with (r)). Of the twelve items on the pre-test, nine were between 2.00 and 2.99, two were between 3.00 and 3.99 and one was above 4. On the post-test, only one item was below 3.00, ten items were between 3.00 and 3.99 and one fell above 4.00. Again, at first glance this looks like very compelling evidence that attitudes improved. The t tests provided more evidence (Larson & Farber, 2012). For nine items the results were significant, five with $p < .05$ and four with $p < .01$.

Table 5.7

Attitude Sub-scale Pre and post-test means

Question	Pre-	Post
25. Generally I have felt secure about attempting mathematics.	2.90	3.26*
26. I am sure I could do advanced work in mathematics.	2.54	2.91*
27. I am sure I can learn mathematics.	4.04	4.03
28. I think I could handle more difficult mathematics.	2.96	3.51**
29. I can get good grades in mathematics.	3.78	3.96
30. I have a lot of self-confidence when it comes to mathematics.	2.67	3.04**
31. I am no good at mathematics.(r)	3.07	3.41*
32. I don't think I could do advanced mathematics. (r)	2.75	3.16*
33. I'm not the type to do well in mathematics. (r)	2.91	3.38**
34. For some reason, even though I study, math seems unusually hard for me. (r)	2.72	3.20**
35. Most subjects I can handle OK, but I have a knack for mucking up math.(r)	2.93	3.10
36. Math has been my worst subject. (r)	2.68	3.06*

p <.05 *, p < .01 **

Together, the reduction in anxiety and the improvement in attitudes are very positive results. In particular, the attitude results are encouraging. If I teach someone how to read their textbook and they are then less anxious about using their textbook, the result is not as meaningful as this knowledge making them have better self-esteem about math, feel more confident in math, and feel that they can do well in more difficult math classes. That there were nearly across the board improvements on these items was really heartening. Given that 53% of variability in the anxiety post-test was explained by the pre-test, as discussed above, I had some hope that there was some real improvement in attitudes and reduction of anxiety explaining the remaining 47%. These paired t-tests lent more credibility to that argument. I wanted to hear specifics from the students, though, so I went to their journals for more information.

Journal exercise. As I read through student journals I was looking for evidence of a change in attitude that might be long lasting. A good example came from Deneen, who said about teaching math, "This is something I could maybe do in my future. This class made me realize that in a fun way. Math doesn't need to be boring!!" She went on to say, "When I become a special education teacher I will most definitely use the teaching techniques you used." Matt philosophized, "This class reaffirmed my belief that with understanding comes growth...I've never understood the material for a math class as I did here." Maya added,

> Your attitude really helped us learn. You always look so motivated to teach us and find different ways of teaching it. The way you teach it helps us relate to what we have previously learned or experienced… [they] helped me look at it in a different way. A fun way I can introduce it to my future classroom.

I also wanted to look for evidence that students were being reflective and were seeing the connection between their attitudes and those of their future students. Caroline stated, "My attitude about the topic I will teach will definitely influence my students." I particularly liked Brittany's response, "I personally do not enjoy math. But implementing new ideas, and fun things, will help me to be encouraging and excited to teach math to my students." She was making a very important choice. Even though she is not in love with the subject she wants to be excited about teaching it. Ashley noted, "It is important for the teacher to enjoy what she is teaching and to have a good attitude about it so that the students have a good attitude about it." Steve reflected that, "I'm learning that teaching content matter doesn't have to be 'by the book' and it can and should be done in a way that helps the students learn it and enjoy learning it." Shana actually summed it up in equation form "Good teach = good grades."

Finally, I wanted to see indications that anxiety was reduced and perhaps why it was reduced. Felicia mentioned, "I was not nervous about any of the quizzes or tests because I understood the lessons taught." Karen noted, "I feel that when a class is based on just exams, anxiety levels rise. A students' grade hangs in the balance for those exams. When other things are added, it takes away that anxiety." Karen appreciated graded work that was not tests. Janice also found value in one of the non-test activities, "I really enjoyed working on the portfolio, I feel I will keep it and go back to it when I become a teacher." She also felt less nervous with less emphasis on tests, "I did not feel as nervous with test and quizzes because you gave us so much to be graded on that I felt I could keep my grade up if I did all the work and tried my best." Ellen wrote about the change in her anxiety, "My anxiety level throughout the course has changed. In the beginning I was just terrified of math in any form. Now I'm not as terrified…I definitely believe I will be able to do things that I lacked confidence in prior to this course." Simone noted the connection between activities and anxiety reductions,

> Mainly my anxiety comes when a lesson is being taught to (sic) fast. Having a teacher who teaches from a hands on point of view allows me to learn faster. Visually seeing something and being able to go back and read it in words allows me to understand the lesson clearly. Understanding made me more comfortable.

The above responses were representative of the whole. Students overwhelmingly stated that the portfolio, oral report project, and quizzes included in their grades made them less anxious. They saw a connection between my attitude and their own and many took it further to say that they wanted to be positive for their future students. It seems to me that, with the survey evidence and the journal evidence, there was definitely an, at least temporary, improvement in attitudes and reduction in anxiety. My hope is that it can be truly long lasting. My fear is that when some of these students have their next negative math experience (preparing for Praxis test) it could lead to a regression in their progress. I know I gave them tools to overcome that fear and to be successful with their next math hurdle. The real question is whether they will reach into the toolbox and take out those tools when the time comes. My second and third research questions related to whether a student's attitudes could be changed and anxiety reduced through classroom activities. I believe that I showed evidence that classroom activities did influence students' attitudes in a positive way and that there were at least some significant and long lasting changes made.

I do not think it is unusual for students to become attached to a teacher who they like, who is effective, or who they respect. I often have students who say, "I can only learn math from you." I know that is not true, but they do not. One of the things I began to think more about was students who are not in my class. I wanted to work with the department to make some changes in the course, do some professional development with faculty, and investigate what other support I could give to systematize some of the positive outcomes I saw. The next phase of my work focused on institutional issues.

Cycle Four

Math department initiatives. It became clear that there were some administrative questions emerging from the student journal responses. What should be the prerequisite for MTH 105? Who should really take the course? Should MTH 105 be followed by MTH 106? How can our students maximize the transferability of their courses? How can we reduce the cost burden of textbooks?

Who should take MTH 105*?* One of the surprising results that emerged from the students' journals was that only about half of them were actually majoring in Elementary/Secondary education. This concerned me for a few reasons. First, the course uses a text called Math for Elementary Teachers. It is intended for that audience. Second, the activities in the course include creating a portfolio of information that will be used for teaching in the future, Praxis information, an oral report to model giving a lesson, and an activity that incorporates math activities with reading a children's book. None of these activities are of use to non-education majors. I was not sure whether this was something unique to my sections or if it was a wider spread problem. In April 2010, I contacted the Assistant to the Vice President in the Academic Affairs area who handles requests for academic data and expressed my interest in investigating the majors of students in MTH 105 (personal correspondence). She was able to perform a three-year look back. Among the 1191 students who took MTH 105 in that time span, only 590 were majoring in education. This represents slightly less than half. These results were in line with what happened in my own section. In my journal, I reflected, "We need to work with the advisors to see why they are having students take a course that is obviously intended to be for teachers instead of one of the other math electives. My fear is that it is just an easier course than the other options."

At the May meeting of the Mathematics Department I reported these results to the group and asked them to consider changing the requirements to enter MTH 105 to include being an Education major. The group decided to consider the request and formally vote at the next scheduled meeting in August. They had a valid concern that this would displace about 200 students a year and we would need sections for them to move into in other electives. On August 31, 2010 that vote took place and they reported that, "The math department has decided to restrict enrollment in MTH-105 to education majors" (department minutes, 8/31/2010). That group is interpreted to include students enrolled in Instructional Aide Paraprofessional Core Certificate Program (IAP.CT), Liberal Arts and Sciences: Early Childhood Education Option (ECE.AA), or Elementary/Secondary Education (EDU.AS). All of these specify MTH 105 as a requirement. I speculated in my reflection that, "This should lead to a more homogeneous group of students in the future. Faculty will be able to teach the course differently when they know that everyone in the class purports to be involved in education."

A second result that emerged from the student journals was that a few students were in the class who had intentions to teach math or science at the middle school or secondary level. MTH 105 is not at all intended for these students. I again noted in my journal my exasperation about advisement, "I am surprised that the advisors aren't catching this. Some of these students think they will become math teachers and have never taken Trigonometry or Calculus yet. They think that because they liked Algebra in high school that they will be good math teachers." These students should be majoring in Math or Science. In a meeting with the department chair I brought up my concerns. I felt we were misleading these students into thinking they would be juniors upon transfer, when in fact they had not taken the freshman level Calculus that they would be expected to take. In a convenient coincidence, there was at the time a simultaneous desire by the

Dean of Math, Science, and Health Careers to support the development of separate degree options for students planning to major in Math or Science education.

Throughout summer 2010, a subgroup of Math department faculty created a degree program that would be better for students who desired to teach secondary math (science faculty also proposed new options for their area) rather than the current Elementary/Secondary Education degree. At the Math, Science, and Health Careers Chairs and Coordinators Meeting on August 31, 2010,the new Liberal Arts and Sciences: Math Education Option (SEM.AS) was approved. The rationale provided for the creation of the option was,

> Students wishing to pursue a degree in secondary education are required to complete a baccalaureate degree in their subject area, and a degree or certificate in secondary education. This curriculum will provide students with the necessary math, science, and general education requirements to successfully transfer to both programs offered by their desired transfer institution (minutes, 8/31/2010).

The proposal was forwarded to the Curriculum Committee for consideration. At the October 19, 2010 meeting of the Curriculum Committee the proposal was presented by the Math Department chair and was unanimously approved (minutes, 10/19/2010). Per the Constitution and By Laws of the Faculty Assembly (2000), the proposal was posted for faculty evaluation. It was posted on November 16, 2010 with all required signatures and forms. After a 10 day vetting period, without challenge, it was finally considered approved. This was a proud moment in the history of curriculum development. I wrote in my journal, “Wow! We started in August and had everything passed by November, who says educators function at glacial speed?”

In concert, these two changes created a much more homogeneous group in MTH 105. First, only education majors were allowed in. Second, those who wanted to teach math or science were taking Calculus courses rather than this Liberal Arts course.

Should we still offer MTH 106? The companion course to MTH 105 is MTH 106. The course uses the same book and primarily covers chapters involving Geometry. Unfortunately, only one of the three closest transfer institutions accepts the course in transfer into their education program. One school does not accept it at all, even as just a liberal arts transfer course. A second accepts it as a liberal arts transfer course but not to meet an education degree requirement. They have recently made the second level math course in their degree program a third year course so that it cannot be completed at our institution. As of February 2010 the only students the Math Department reported as still registering for MTH 106 were automotive students. This is in line with the registration patterns of my own students. In a follow up made in Spring 2012, not one of the 80 students originally registered for my two MTH 105 sections had registered for MTH 106 (Student Transcripts, 2/1/2012). At the February 9, 2010 Mathematics Department meeting "The announcement was made of the intention to discontinue offering MTH 106, Math Systems II-Geometry" (minutes, 2/9/2010). The automotive area, which had been requiring the Geometry course, said they were willing to switch to MTH 107, Math for Liberal Arts. It seemed that MTH 106 was destined to be discontinued, or so we thought.

The coordinator for Elementary and Secondary Education brought up an issue when we consulted her. She had received feedback from both students and transfer institutions that our students were weak on the Praxis Exam in the areas covered in MTH 106 (Personal communication, 3/1/2010). Our dilemma became clear: students do not want to take courses that they cannot transfer, but they need the skills in the course. Throughout the spring, the department chair and I continued to brainstorm ways to make the MTH 106 course usable for our education majors. The deactivation discussion was tabled for almost a year. Throughout that time, our attention was focused on trying to get a college level pre-requisite for the MTH-105 course. After much discussion the department agreed to make Math for Liberal Arts (MTH 107) the pre-requisite for MTH 105. At the November 9, 2010 department meeting a three-member team including me, another full time faculty member, and an adjunct faculty member was charged with creating a proposal (department minutes, 11/09/2010). We proceeded to make a tentative proposal to present to the local four-year schools. We wanted to ensure transferability of our courses before making any formal changes.

Our group developed a proposal that included Math for Liberal Arts (107) as a prerequisite and a new course called MTH 115 that combined content from 105 and 106. We did this for two major reasons. First, it was awkward to propose a course with a higher number (107) as a prerequisite for a lower numbered course (105). Second, there is overlap between the content in 105 and 107. By having students take 107 first, some of the content could be removed from 105 and the Praxis content needed from 106 could be included in the new course. We thought we had come up with a great compromise. First, students were getting more mathematics before entering the math education course. Second, we were keeping to only two courses (107 and 115) instead of three (107, 105, 106). Finally, students would be getting more of the skills they needed for the Praxis exam.

We sent emails to the math education faculty at the two transfer schools on November 29, 2010. On December 1, 2010 we received a reply from both schools. The response from the first school was that they were making their second level math education course a third year course beginning in fall 2012, so it could no longer be taken at the community college. Since our students could only transfer MTH 105, they suggested that students only take that one math course at our college (email correspondence, 12/1/2010). The response from the second school was that, “You can require any prerequisite for your courses that you choose” (email correspondence, 12/1/2010). They went on to mention that they use Intermediate Algebra as a prerequisite for their course. Since they already accept both MTH 105 and 106 in transfer, they strongly preferred that we not drop MTH 106 as planned. Neither school liked the new course we created. It was unlikely that either would accept it in transfer. I was particularly frustrated with this reaction. Writing, “I wish they would walk a day in our shoes. They really have no idea what we do here. Students with A’s in our classes, the type that they accept in transfer, are very capable students. I am not asking them to take a C or D student.”

The decision at the time was to keep MTH 105, 106, and 107 as they were. MTH 107 would not be an official prerequisite for MTH 105. The program coordinator did agree to advise students that if they were planning to take 105 and 107 as their two electives it would be most beneficial to take 107 first. MTH 106 was to stay on the books although few students register for it. We all agreed that it would benefit our students if we could improve MTH 106 in some way.

On Thursday September 1, 2011, I was charged, along with an adjunct faculty member, to propose some improvements to MTH 106 that might make it more useful and desirable to students. We speculated that students would appreciate a direct review for the Praxis in the course. We did a textbook search and found review materials to be fairly similar. We were able to find a custom package with our current text provider that included a Praxis review manual.

Academic Skills Math department initiatives. It was apparent that my students had issues that were about more than just the math. They expressed all sorts of weaknesses with time management, goal setting, study skills, reading their book, test taking, and life skills. This was not shocking since 39 of the 80 students had to take a basic skills algebra course prior to taking their MTH 105, and 25 of the 80 had to take an arithmetic course as well. I began developing some materials that I could post on my course website that would help my students cope with these issues. I also started incorporating success strategies into my classes (see samples in Appendix G). In my private moments, my shock at my students' lack of knowledge about how to be a student and weak basic skills in areas such as long division in math and use of capital letters and punctuation in written work sometimes overwhelmed me, "If I ever see ___ in my child's classroom, I will look into homeschooling!"

In April 2011, I suggested that our Academic Skills Math (ASM) Department include a session on "Math Success Strategies" in our orientation for part time faculty (Minutes, 4/12/2011). The idea was unanimously accepted by the faculty. We decided that each faculty member would share a best practice strategy. We also planned to invite adjuncts to share their ideas as well. It was also decided that we would create a tip sheet or handout that could be shared at the meeting at that we would give everyone permission to reproduce and use in their classes. I was very excited that we decided to tackle this and looked forward to hearing what other people had to say. I wrote, “Being a good teacher is about stealing good ideas from anyone you can and adapting them to your own situation.”

The orientation took place on Saturday August 20th 2011 at 9:00 am. We arranged for a small continental breakfast. Throughout the event there were drawings for door prizes that included manipulatives for classroom use. The event was attended by all of the full time faculty members in our department as well as about 25 adjuncts. Throughout the two hour session we talked about classroom management, brainstormed on strategies to improve retention and success, and shared our tips for helping students succeed in math. Adjuncts also shared their ideas and best practices..

At the November meeting of the ASM Department I made two proposals that related to student success. First, I suggested that we customize our text to include a chapter on Math Success Strategies. The department enthusiastically agreed (Minutes, 11/8/2011). We decided to pilot the Chapter in our own sections in the spring 2012 semester so that we could make implementation suggestions to part time faculty. We also decided it would become a major part of our 2012 orientation in August. The second proposal was the development of a one-credit course on Math Success Strategies to be taken in conjunction with our lower level course for students at risk. This proposal was also received very positively. I volunteered to work with another faculty member to develop a syllabus for the course (Appendix I). That syllabus was passed by our department in February 2012 (ASM minutes, 2/14/2012), and by the Division Chairs and

Coordinators in March (Transitional Studies C&C minutes, 3/27/2012). The course began to be offered in fall 2012.

A nationwide initiative. In February 2010, at a Developmental Math Symposium, I opened a dialogue with a sponsoring editor for developmental math at a large national textbook publishing company. I bent his ear about how much I believed that publishers could make a significant difference in students' success in math if they made materials available to students that went beyond the math content and addressed success strategies. He challenged me to make a proposal. I was excited to say the least, I challenged myself in my journal, "Time to put up or shut up, Jackson. You have been preaching the need for this for a long time. Now you need to make the argument for real."

Over the next seven months I adapted some materials that I used in my own classes and developed others until had about 100 pages worth of materials that students could use to help them be more successful in their math classes. The materials could be used from computation to calculus. I clustered the materials into six categories: time management and goal setting, learning styles, study skills, test taking, online and blended classes, and reference materials (samples in Appendix G).

By October 2010 I had a draft ready for consideration. By this time a new sponsoring editor was in position. She was unaware that I was developing a proposal. On October 27th we made contact and decided to meet on November 11th at the meeting of the Association of Mathematics Teachers of Two Year Colleges in Boston. I was quite disappointed that my work may have been in vain. Writing, "I can't believe he just left and never let me know or let her know that there was a proposal in the pipeline." At the meeting, I reiterated my belief that students need more than just exposure to math content to be successful. She agreed and was pleased with the materials I had developed. However, at the time the company was preparing to publish a new series in developmental math and the authors planned to include success strategies in their book. She mentioned they had drafted a chapter on success strategies, but it was not as fully developed as what I created. At that time she did not think the company would be interested in a stand-alone manual on math success. She asked if I would be willing to read and critique the authors' chapter and make suggestions for improvement. I agreed, and in January 2011 she sent me a draft of their work (email correspondence, 1/11/2011). I reviewed the Chapter and made suggestions. This was not exactly what I was dreaming of, as I noted in my journal, "What was I thinking? That I'd be the next Paulos or Devlin doing NPR and retiring on my book royalties." I was proud that they wanted me to consult, but was a more than a little disappointed that the scale of my project was cut back so much.

The company invited me to a Symposium in March 2011 that included the author team. They were bringing in faculty from around the country to assess their interest in using student success materials. We met from March 3rd to 6th in Laguna, California. At the meeting, the authors' draft was shared with the group, as were my materials. The assembled faculty were asked how they would use the chapter (if at all) and whether they would use my materials, if available. The response was an overwhelming "Yes!" They wanted to have access to all of the materials. We brainstormed about the format. Did they want a printed book? Did they want downloadable PDF's? Did they want Microsoft Word documents that could be edited to suit individual needs? They wanted it all. The consensus was to have all of these options available and let schools choose what would be best for them. With that advice in hand, the company then asked the author team whether they wanted to go in this direction. They did. The author team approached me to see if I would be willing to give their chapter a facelift. Could I incorporate some of my ideas, organize it more effectively, and make it more student-friendly? I decided to take on the challenge. Between March and May I developed a draft of the Chapter. The draft was turned over to the authors in May 2011 for their last edits. It is ironic that back in the November 2010 meeting that I was told that my idea of a stand-alone print book, digital book, and chapter was not desirable, because that is exactly what the company ended up doing. “Hmm, this idea sounds familiar,” I noted in my journal.

The company then contacted me to ask me to flesh out the Success Strategies Manual, develop an Instructor’s Resource Manual, and develop a template for a Guided Student Notebook for each of the three texts in the series (email correspondence, 7/2011). The first priority was the Guided Student Notebooks. These would ultimately contain about 1000 pages. I coauthored these three ancillary books with two other faculty and was listed as lead author. The second priority was the Student Success Strategies Manual. That was completed and turned over to one of the authors for her edits and additions. We share author credit, but I am listed as the lead author. She and I are still developing the Instructor Resource Manual.

The next step for the company was professional development of faculty on how to use these materials in their classrooms. In November 2011 I was asked to participate in a focus group at the national AMATYC meeting in Austin, Texas. This was the first public display of the textbooks, and the first time drafts of the ancillaries were shared with faculty for feedback. In February 2012 I was asked to attend the annual meeting of the

National Association of Developmental Education. I participated in two workshops and two focus groups and shared best practice strategies for implementing the materials from the books. Finally, throughout February and March one of the authors and I have conducted five webinar workshops for faculty nationwide. These are free professional development workshops for faculty offered by the company. The participants have included faculty from all over the country, some who teach online and some face-to-face, developmental and college level, two-year and four-year. The diversity of the participants is evidence that the issue is pervasive. Faculty in widely different teaching situations recognize their students need more than just the math.

Discussion

Cycles one, two, and three were used to collect data about my first three research questions. What attitudes and anxieties regarding mathematics do pre-service elementary school teachers hold in a large suburban community college? To what extent can the activities in class influence pre-service teachers' attitudes about mathematics and reduce their anxiety? To what extent can significant change in math attitudes occur based on classroom activities?

For question one, I wanted to know what attitudes and anxieties my students hold. According to their responses on the Math Anxiety Rating Scale in cycles one and three, some of the top anxiety producing activities included: taking an exam (final) in math class, being given a pop quiz, being given a homework assignment with difficult problems, thinking about a test on the day before, and waiting to get a test returned. Their most negative attitudes were with respect to their self-esteem in math and their ability to do advanced work in mathematics. Before I tried to change their attitudes, I first wanted them to be aware of where their attitudes came from through a reflective journal.

Researchers posit that student teachers benefit from meaningful reflective practice (Chamoso, Caceres, & Azcatate, 2012; Fletcher, 1997; Harford & MacRuairc, 2008). In particular, reflection can help a pre-service teacher transition from thinking of themselves in the role of learner to the role of teacher (Chamoso, et al). As these authors note, often when students are in their methods course, they are still worried about learning the content themselves and do not envision themselves as math teachers. Further, reflective writing can cause physiological changes in the brain that allow working memory and therefore performance to improve (Lyons & Beilock, 2012: Ramirez & Beilock, 2011; Young, Wu, & Menon, 2012). My experience supports this. On the first day of class I always ask who is going to be a teacher, by a raise of hands. Then I ask who is going to be an elementary school teacher. Finally, I ask who is going to be a math teacher. Every semester all hands drop on that last question. I then explain that everyone who had their hand up indicating that they were going to be an elementary school teacher is also going to be a math teacher. This is a shocking realization to some. I then discuss that one purpose of our course is to help students envision how topics can be taught, not just how they can be learned. In the fall 2009, cycle-three semester I also used this opportunity to begin to develop a culture of reflection (Harford & MacRuairc) in the classroom. I wanted students to think about what they have done, what they are doing, and what they will do. I wanted them to reflect with purpose on where their math attitudes came from. As Maloney and Beilock (2012, p. 404) point out, “Understanding the antecedents of math anxiety provides clues about how to prevent its occurrence.”

The literature indicated that student motivations toward mathematics are developed early, are highly stable over time, and are influenced greatly by teacher actions and attitudes (Beilock, Gunderson, Ramirez, & Levine, 2010; Bekdemir, 2010; Middleton & Spanias, 1999). The literature also indicated that bad attitudes in teachers could be contagious and spread to the children they teach (Austin, et al., 1992; Harkness, et al., 2007; Middleton & Spanias, 1999; Peterson, Fennema, Carpenter, & Loef, 1989; Trujillo & Hatfield, 1999). The data that I collected in the student focus group in cycle one supported these findings. One student identified a sixth grade teacher, who was also a basketball coach, who she found intimidating. Another mentioned that all of her teachers made her feel dumb. A third noted that her problems began in middle school and persisted to the present. In the first cycle journals, student mentioned family members, elementary teachers and even just being in Catholic school as triggers to bad attitudes. I also had students in the third cycle reflect in their journals on the subject. A student mentioned a college teacher that had caused her difficulties recently. Bekdemir (2010) found that there was a significant difference in anxiety levels for students expressing a bad negative experience in a previous math class versus those not reporting a strong negative experience. In that research some of the bad experiences reported were as much as ten years prior to the study. Follow up interviews indicated that math anxieties were caused by teachers' behavior and teaching approaches. Not everything about attitudes in teachers reported by my students was negative. One student claimed that my attitude helped students learn. Another proposed that if teachers have good attitudes about math then their students will too. My students were claiming that whether good or bad, a teacher's attitude could affect them.

One component of attitude is self-esteem. For both the cycle-one and cycle-three groups, the two lowest scores on the attitude scale were, “I am sure I could do advanced work in mathematics” and “I have a lot of self-confidence when it comes to mathematics.” With respect to advanced work, the cycle-one group had a mean response of 2.35 and the cycle-three group 2.54. For the self-confidence item the scores were 2.55 and 2.67 respectively. The cycle-one group did not have a post-test. In cycle three, the post-test score for advanced work was 2.91 and the self-confidence item was 3.04. Each difference was significant $p < .01$. The results of the initial survey (pre-test) indicated that self-esteem was an issue and the results of the later (post-test) showed that there was improvement. For the cycle-one group the item on advanced work showed a reciprocal relationship ($r = -.349$) to the total math anxiety score, $p < .01$ with over 12% of the variability explained. The self-confidence item had a similar outcome with almost 15% of the variance explained ($r = -.383$, $p < .01$). These two items were directly related to self-esteem and showed strong reciprocal relationships to math anxiety.

Research has connected self-esteem to math anxiety, showing a strong reciprocal relationship (Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Bekdemir, 2010; Isikal, Curran, Koc, &Ashkun, 2009; Jain & Dowson, 2009). Further, a cyclical relationship was also found, with self-esteem issues leading to anxiety and anxiety leading to self-esteem issues (Ahmed). In a longitudinal study the authors found that a low score on self-esteem was predictive of a high score on anxiety at a later date, controlling for the anxiety score on the earlier administration. Similarly, a high anxiety score was predictive of a low self-esteem score on a later administration, controlling for scores on the earlier esteem scale. The authors used structural equation modeling and found that the magnitude of the path from self-esteem to anxiety was twice that of from anxiety to self-esteem. In another study the reciprocal relationship was supported with a group specifically comprised of pre-service teachers (Isikal). This study went on to analyze how the way that pre-service teachers were given their courses (content separate from methods or one course with both) influenced anxiety. They determined that students who took the two courses separately had less anxiety, first learning the content and then learning how to teach it. This matched the results of the study on reflective practice discussed above (Chamoso, et al., 2012). It also matched those of another study (Johnson & vanderSandt, 2011) which looked at offering a freshman content course and sophomore methods course to students in pre-service majors in early childhood education, elementary education, special education, and education of the deaf. There was strong evidence that two separate courses benefitted these students. In cycle four one of the key discussions we had was about what the pre-requisite should be for our methods course. Should it be developmental math, or a college level content course? We tried to implement the later, but ran into issues with our four-year college partners. Finally, a study by Liu (2007) addressed the issue of anxiety toward teaching mathematics, not just the mathematics itself. The scale looked at anxiety toward math, toward teaching math, and toward peoples' perception of them teaching math. The author makes the point that math anxiety is learned and that it is contagious. However, anxiety can be mitigated through classroom activities in methods courses, strategies as simple as discussion. Liu found that making anxiety a topic for reflection and discussion online could reduce the anxiety. Another method, proposed by Burton (2012) involved drawing. She had students "draw math" at the beginning and end of the term, with discussion about the drawings in the interim. I attempted to introduce the idea of discussion in the journal exercises my students took part in.

Another relevant factor in considering math anxiety is self-regulation. This includes academic strategies like goal setting, planning, and evaluation of progress. Jain and Dowson (2009) showed that both self-esteem and self-regulation had reciprocal relationships to math anxiety. They were also significantly related to one another, with almost 25% of the variance explained. The self-esteem measure was linked to math anxiety with about 23% of the variance explained. Self-regulation accounted for another 6.5% of the variance in math anxiety. Strategies for self-regulation were directly addressed in our class. By helping students to better self-regulate, reduced math anxiety could be an outcome. As the authors posited, “Strategies are necessary for a reduction in anxiety not because they directly impact on anxiety, but because they directly enhance perceptions of personal capacity, with the later resulting in a direct reduction in anxiety” (p. 246). I considered the effect of classroom activities on attitudes and anxiety in my second research question.

In this second question I investigated whether classroom activities could improve attitudes and decrease anxiety. I have seen research that suggests that educational materials can induce stereotype threat in students (Heerboth & Mason, 2012). I wanted to see if the opposite was true; could my materials and class activities relieve some of the pressures and stress my students feel? The quantitative results came from a pre- and post-test of the Math Anxiety and Attitudes Scale in cycle three. There was a reduction in anxiety in 23 of the 24 items related to anxiety, 14 at a significant level. Attitudes improved in 11 of the 12 attitude items, nine at a significant level. In addition to the quantitative data, I also collected data from student journals about changes in their attitudes or anxieties. One student began an entry by noting that her anxiety level through the class had changed. Another wrote that she did not feel as nervous. A third claimed she had positive feelings in my course because she had never understood material in a math class as well as she did in that class. They attributed at least some of their success to what went on in class, noting that games helped them to practice in a fun way, that they appreciated my teaching techniques, that they noticed that I varied my methods of teaching, and that they realized math did not need to be boring. There seemed to be both quantitative and qualitative evidence that many of my students had improved attitudes and reduced anxiety and they attributed it to my classroom activities.

One of the first activities that we worked on together was an investigation of Learning Styles. The students completed my Math Learning Styles Survey (appears in the activities in Appendix G). I then gave the students tips sheets with techniques they could use to maximize their strengths. The stress was on their strengths, not on their weaknesses. My goal was to build them up, keep them confident, and draw attention to things they did well. A study on the relationship between learning styles and math anxiety in pre-service teachers showed that when teaching methods matched a student's learning style, there was less anxiety (Ertekin, Dilmac, & Yazici, 2009). In particular, they found that tactile and kinesthetic activities were helpful. Many of the content-related activities that we did in class used manipulatives, models, and physical objects to connect the concrete to the abstract. For example, we used base ten blocks to explore whole number operations.

As I implemented my instructional strategy I considered what type of feedback students needed to remain confident and positive. I did not want to be a cheerleader giving them empty, “good try” type feedback. However, I did not want them to feel demoralized and stop trying. I am not a person that believes in a fixed theory of ability for my math students; I definitely believe they are incremental/malleable learners (Rattan, et al., 2012). I did not want to demotivate my students by lowering expectations as these authors warned. My solution was to grade in a different way than I had previously. I gave no partial credit for any items on a test, no matter how close to the right answers. Initially an item was simply right or wrong. After the students got their tests back they were then given an opportunity to revise work to gain partial credit. In order to get partial credit they had to show that they could do the work correctly. Students also analyzed whether their errors were secretarial, computational, procedural, or conceptual in nature. We spent time analyzing how one could fix each type of mistake type on future tests. By working on corrections in a non-test environment, pressure was very low. Students were relaxed, able to investigate their errors, fix them, improve their grade, and make a plan for future tests. At the same time, they were never given credit for doing something wrong. There were no points for trying hard. This became a very positive feedback framework. Some students indicated that they learned more after the test than before.

My third research question was whether a significant change could happen. By this I did not just mean significant in a statistical sense, as described above. I meant a profound or lasting change. I looked for responses in the students’ journals that projected into the future, entries where they did not just say they liked my class, but that they would be different in the future. Students wrote things about what they would do when they became teachers, how they would use techniques from my class when they were teachers, and they noted that they were aware that their own attitudes could influence their future students. This was exactly the type of reflection I was looking for. I realize that there is always the risk that there was a Hawthorne effect (Gay, 1992). But as Coombs and Smith (2003) mentioned, in action research this can be a good thing. Just because change happened because someone knew they were being studied, does not mean that the change did not happen. We just need to be careful about how we generalize and interpret the results. I would like to think that every class I walk into is to some degree a study for me. I try methods, see how they work, revise as needed, try again; each new class, is a new study. I am a very self-confident instructor. A teacher's self-confidence as a math teacher is significantly associated with their students' self-confidence as mathematical learners (Stipek, et al., 2001). Further, exposure to successful role models can improve performance that had been impaired by stereotype threat (McIntyre, Paulson, Taylor, Morin, & Lord, 2011). I believe that my students trust me, I believe that I am a great teacher, and I believe that I change the way my students learn.

My goal in my theoretical framework was to see whether I could influence the attitudes of my students in order to break the cycle of math hatred. Argyris (1990) notes that when we fix a conflict, without investigating the underlying reason for the conflict, we can only achieve a first order change. When we go on to investigate underlying causes, we can forge a more permanent and significant change. He calls it the second order. In a later article (2002) Argyris begins by saying, "Learning may be defined as the detection and correction of error" (p. 206). So far so good, we worked directly on correcting mistakes on tests. But he goes on to say that single loop learning occurs when errors are corrected without altering underlying values. Only when errors are corrected by changing values and then actions can double loop learning occur. We tried to do that. By not just writing down the right answer, but by investigating the type of mistake (secretarial, computational, procedural, conceptual) and then making a plan for how to reduce these error types in the future, we attempted to get to that second loop. However, changing values is more than just "Tweaking the current system by adding the innovation du jour" (Tagg, 2010, p.57). He goes on to note that the first pre-requisite for individuals to learn is a learning environment in which they can receive meaningful feedback on the consequences of their actions. Jones (2009) discusses that transformational learning depends on changing habits of mind. She proposes a theory called "LEARnT" that incorporates three learning approaches: reflexive, adaptive, and transformative. Learning (L) evolves as Efficacy (E) informs Actions (A), and Reflection (Rn) impacts Theory building (T). She advocates teaching students how to reflect and theory build. Through the use of their journals, portfolios, and error analysis activities, I believe I did instruct my students to be good reflective learners.

There was a part of my theoretical framework that I did not have embedded within a research question. In earlier coursework and field testing, I had tried to see if I could detect stereotype threat in this population. I was never successful in finding it. The literature indicated that stereotype threat is being at risk of confirming, as a self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995). Since historically women have been perceived as being weaker or less interested in math, their performance may be influenced by knowledge of this stereotype (Spencer, et al., 1998). In study after study women lived out the self-fulfilling prophesy that they would do poorly when they were told there would be gender differences and did not perform differentially when no such statement was made (Cadinu et al., 2003; Cullen & Waters, 2006; Ford et al., 2004; Keller, 2007; O'Brien & Crandall, 2003; Spencer et al., 1998). The women who expected to do poorly actually did poorly. It is possible that the reason that I was unable to find stereotype threat in my investigations is that I was dealing with a predominantly female community of learners in a non-STEM course. Previous research showed that in a small liberal arts institution, where there was a personal and nurturing learning environment, stereotype threat was not detected (Rivaro, Rhodes, & Klein, 2008). This may have been the case here. In the pre-service math courses, women swamp the men in registration numbers. In my combined first and third cycles there were 33 males and 102 females. The women were not a minority, were not viewed as less likely to succeed (women become teachers in far larger numbers than men), and were not in an intimidating position academically. I was a strong female presence who did not suffer from math anxiety.

I would like to propose a counterfactual situation in which stereotype threat did exist in my students at the start of the term. One way that stereotype threat is reinforced is with a female teacher who shows anxiety or a poor attitude with respect to math (Beilock, et al., 2010; McIntyre, et al., 2011). My students never experienced that with me. Our course was not a STEM course, which is much more fertile ground for threat (Shapiro & Williams, 2012). I provided students with relevant tasks, which is a threat-reducing strategy (Rosenthal, Crisp, & Suen, 2006). They participated in reflective writing, which in anxiety reducing, and helps improve working memory capacity and thus performance (Lyons & Beilock, 2012; Ramirez & Beilock, 2011; Ramirez, Gunderson, Levine, &

Beilock, 2013; Young, et al., 2012). Since there is evidence that stereotype threat can reduce working memory capacity (Derks, Inzlicht, & Kang, 2008; Schmader & Johns, 2003), reducing threat would help in keeping working memory available for mathematical tasks. Although I had not found evidence that stereotype threat was an issue in my classes, I do believe that the strategies I used would have mitigated its impact based on strategies posited in the mentioned literature.

There is a hole in the literature about stereotype threat for the pre-service teacher population. It is unclear whether there is no threat, or whether it just has not been studied in depth. This certainly is a topic that could be investigated in further studies.

To summarize, one goal with my students was to have them reflect on their past experiences, so that they could see where their attitudes came from. Time will tell whether the cycle of hatred has indeed been broken. I think that there is ample evidence that my students attitudes were changed during their semester with me (a first order change) and that they had intentions of keeping that positive attitude when they become teachers (potential second order change) (Argyris, 1990; 2002). My remaining research questions pertained not to my students, but to me. The next chapter investigates me as a leader and change agent.

Chapter Six

Leadership Reflection

Introduction

When I wrote my Leadership Theory, I identified my primary mode of leading as the Situational Style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). I also posited that I use an Ethic of Care (Gilligan, 1992; Noddings, 2003). Two of my research questions for this study touched on whether my stated style was something that I actually practiced. Through action research, I used student surveys, email feedback, student journal responses, and my own journal entries to investigate this question.

I freely admit that when I entered the Rowan Educational Leadership Program I had a pro-quantitative method bias. "Hello, my name is Kelly and I am a number-holic." I like to count things and measure things. I jokingly refer to "the program" or "Rowan rehab" when I talk about the process of learning about qualitative methods and action research. The most important thing I learned to do, however, was formalize my reflection process. I have always been reflective, but I did not journal. I learned to appreciate the value of being able to look back on several written reflections to look at patterns that emerged. Dieters are usually encouraged to write down what they eat, and anything that triggered bad eating behavior. Similarly, I learned to use a journal to reflect on my teaching and my leadership challenges and successes. Before the Rowan Program, I would not have considered journal entries, student surveys, or emails as data. As I learned to de-emphasize numbers in favor of other types of data, I learned quite a bit about myself.

How has this number rehab process made me different as a leader? First, I think it has helped me reframe (Bolman & Deal, 2003) some of the things I already do as a leader by changing my definition of evidence. For example, I have always had my students write and talk about mathematics as part of our class. In the past it was always as part of ungraded classwork or as part of extra credit projects (each student can raise one test grade one letter grade by completing a project on a math topic). Students can write a paper, do an oral presentation, create a poster, build a model, or complete a problem set to earn their points. These activities were always extra credit because I did not regard them as evidence that the student mastered course material. With my new lens, I see that these activities should be required and given appropriate status in the grade calculation. There is evidence beyond test grades that I should be considering. Similarly, as I work with faculty in my role as Faculty Assembly Chair, I have revised my view of what evidence is, what data is, and what data based decision making is.

Secondly, I have always been a reflective person. I think about my teaching, student learning, and campus issues and how I can improve in those arenas. Before Rowan I never formalized my reflections in writing. It was through my Rowan coursework that I learned that skill, and then decided to implement it in my own classes to a large degree. I work with my students at all levels about being reflective. I talk to them about goal setting, reflecting on the progress, making changes, reflecting on the outcomes of those changes, setting new goals, etc. This has become part of my standard operating procedures as an instructor and a leader in general.

As I proceeded through my coursework and through the cycles of this project, I collected evidence about my leadership style, challenges that I faced to my leadership, and successes that I celebrated as a leader. I wanted to see whether I walked my talk (Senge, et al., 1999). I claimed that I am a situational leader (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) who practices an ethic of care (Gilligan, 1992; Noddings, 2003). Do I live that? The answer was a resounding, “not entirely.”

Classroom Interactions

In the language of situational leadership (Blanchard, et al., 1970) there are three parts to a circumstance: the leader, the follower, and the situation. In a classroom, the instructor (me) is the leader, the students are the followers, and each lesson is its own situation. Follower levels are not a constant. For one topic a student may be at a completely different developmental level than for another. A student may be great at decimals but not so good with fractions.

One way that I tested to see whether my leadership style matched students’ developmental level was through a series of surveys. In Cycle 3, after each test, students completed an anonymous survey (Appendix A). They were asked two questions, one which identified the level of support they felt they received and the other the level of direction they felt they received. Direction was defined to mean instruction or academic help given beyond the regular lesson. This could include answering a homework question, tutoring in my office, help through email, responses to questions a student asked in class, and support through my website. Support was defined to be non-academic encouragement, verbal cheerleading, advice about effort, or personal support. These two responses together yielded the students’ view of my leadership style as an instructor. High direction but low support (S1: directing), high direction and high support (S2:

coaching), Low direction and high support (S3: supporting), and Low on both directing and supporting (S4: delegating) (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). They were then asked about their own level of knowledge of the topic prior to our lessons. This established their view of their developmental level. To be the most effective leader, my style should match the students' level closely. The results of the survey are summarized in Table 6.1 below. These results represent roughly 72 students per test, for three tests. My impression of my students' developmental levels did not match their own perceptions. Roughly eight students defined themselves as D1 (lowest), seventeen students D2, thirty three D3, and twenty-four D4. The surveys were anonymous, so I do not know which students identified themselves at which levels. Based on the grades achieved on tests, the number of homework questions I fielded, the tutoring I did, and the emails I answered, there were only twelve students that I would identify as D4 and fifteen I would identify as D3.

To show success at using the Situational style, I need to have a close match between the students' developmental level and my leader style. For example, for a student who is D1 (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) I should be using a style that is S1 for a perfect match. To use a style of S4 would be a complete mismatch. In Table 6.1, the columns represent the leader's (my) style according to the student' survey answers to questions one and two and the rows students' developmental levels, from their responses to survey question three. Each student had up to four response levels represented in the table. They could claim to be D1 on one test, but D4 for another. The developmental level is situation (test) specific.

Table 6.1

Situational Leadership Survey Results

	Leader Style				
Follower Level	S1	S2	S3	S4	Total
D1	6	10	7	0	23
D2	4	41	5	0	50
D3	8	53	31	9	101
D4	8	18	30	16	72
Total	26	122	73	25	246

There were 151 responses in which students identified themselves at the D2 or D3 levels (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). For these levels, support is warranted. The styles with high support are S2 and S3. Considering the four cells where D2 and D3 intersect with S2 and S3, a total of 130 students responded that they were receiving support. Thus, students who needed support reported receiving it. In the cells where D2 and D3 intersect with S1 and S4, 21 students reported that they were not given support. Thus, according to this theory, 21 students who needed support reported they did not receive it. This is an almost 87% match rate. However, there were also 95 responses in which students placed themselves at the D1 or D4 levels, which do not require support, however 65 of the 95 identified my leader style at S2 or S3, meaning that they were getting support. This represents a false positive mismatch rate of 68% (65/95) and false negative rate of 13% (21/130). For the most part, from the students' view, students needing support were getting it, students not needing support were still getting it, but a not inconsequential percentage of students who should have been getting support were not (13%).

With respect to the need for additional instruction, 73 students rated themselves at the D1 or D2 levels (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). At these levels, high direction (instruction) was appropriate. The leadership styles using high direction are S1 and S2. If we consider the cells where D1 and D2 intersect with S1 and S2, there are 61 responses indicating instruction was given (84%). Of the 173 students who self-rated themselves at the D3 and D4 levels, which indicates they do not believe they need additional instruction beyond the regular lesson, 87 reported they received instruction (intersection of D3 and D4 with S1 and S2). Slightly more than half were mismatched as false positive (getting instruction they thought they did not need). Moreover, there was also group representing 16% (12/73) of the D1/D2 cohort who identified themselves as needing direction, but who claimed they were not receiving it.

I interpret these findings to mean that for the most part students' primary needs are being fulfilled. Of those needing support (D2, D3), 87% identified that they received it and of those needing direction (D1, D2) 84% received it (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). Yet, there are still students that I am not reaching completely. It may be that they are not asking for help or that I am not recognizing they need it, but there is a mismatch for some. I am not as concerned about the false positives as the false negatives. First of all, as mentioned earlier, I think that some students overestimated their developmental level. Secondly, what happens if students do not need instruction but get it? Perhaps they are bored. If they do not need support but get it, is there a real downside? Getting attention when it is not needed is not likely to cause a negative outcome. The results of the survey were in my mind an affirmation that I do use situational leadership to a large extent. Most deviations from a match can be explained by functioning in a classroom setting where most interactions are heard by all. If a student asks a question, thereby receiving direction from me, students who do not need direction are still hearing it. This is difficult to avoid in a classroom setting. I think I do a good job at balancing, giving good help to students who need it without boring the other students to distraction. Perhaps this is a good example of the Goldilocks principal I strive for, not too much, not too little, just right

In addition to the collected survey data, two unsolicited emails made me feel confident that my teaching style was focusing on the students as individuals and meeting individual needs. One student responded, "I am writing you this email to thank you for all of your help last semester. I learned a lot about the subject matter that you taught and I learned a lot from you as a teacher. I truly appreciate the opportunity to take your class and the consideration you give to each student." Another responded,

> Thanks again for being so understanding and nice throughout the course. You really helped motivate myself and many of your other students in my class to properly prepare for our last exam and do well. And it showed. You were an excellent and informative teacher throughout the semester and I wish I could have you as an instructor again for the spring

semester next year. Nevertheless, I wish you the merriest of holidays and

hope that you continue to teach in the wonderful way that you do.

Both of these young men indicated that they received direction and support and saw it given to their classmates. When I get cards and letters (emails) of thanks from students like the above, I know that my care ethic is working. A key element is the completion of the cycle (Nodding, 2003). The students have accepted and internalized the care.

Leadership Challenges

During cycle two, which was a planning cycle, I did not interact with students, but there was a significant leadership challenge that emerged. The primary purpose of the cycle was preparation for the fall term. One part of that process was a textbook evaluation. Students had expressed to me through their journals in cycle one that textbook cost was an important issue to them. As I was looking at books, I was trying to keep cost in mind. I worked with a textbook representative to offer students our exact same text but in a 3-hole punched notebook. The differently packaged book would cost one third the price of the hardcover. As the course coordinator and only full time faculty teaching the course, I was in charge of recommending the text. I made my suggestion to the chair. Shortly thereafter I received an email that the chair had spoken to the Dean and she had denied my request (email correspondence, 8/12/2009). The reason cited was that the notebook could not be sold back to the bookstore. I encouraged her to challenge the Dean, as it was not within her authority to veto a textbook choice. The chair was not willing to enter into that conflict. For the first time in my 20 years at the college, I contacted the faculty association. I did not believe it was within the Dean's authority to veto a textbook selection. I was found to be correct. I went back to the chair, but in the intervening time she had signed a three year contract with the publisher to keep our current text. They had offered to drop the price 10% for a three year commitment.

This challenge was one of positional power (Bass, 1995; Burns, 1978) and failed situational leadership (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) on my part. I was unable to implement a change that I knew was good, because those in positions of power above me were uninformed. If this had been a classroom setting I believe I would have recognized that the chair needed instruction (direction). The chair did not know that the Dean did not have the authority to veto our textbook selection. She then signed a three year contract without asking me if it was okay to do so, because she thought the 10% discount was a good deal. Neither of them thought through the actual cost to students. Under my plan the $120 book would have cost $40. The Dean's plan had them buying for $120 and selling back for $60 for a net cost of $60. Even with the chair's discount, it was $108 to buy and $54 to sell back, for a net cost of $54. Did I mention this was a Mathematics chair and a Math, Science, and Health Careers Dean? I clearly failed at situational leadership in this instance. Although leading from below, I was in a leadership position, as course coordinator, at the time of my request. I knew she was very inexperienced, not yet an advocate for the department, and did not yet know "the rules." I should have evaluated her developmental level in the D1 or D2 range (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). By delegating to her the task of textbook adoption, without supporting her or instructing her, I mismatched my leadership style and her developmental level. As Argyris (1990) would have predicted when the espoused leadership does not match the actions there is ineffective leadership, this outcome was bad for students. This was an early indication that my classroom leadership style might not match the leadership style I use with peers and supervisors.

Some of my journal entries showed my frustration with the Chair, Dean, and myself. At first, I blamed the Chair, “I’m not sure why she went to the Dean in the first place. [Robin] doesn’t have a say in this.” I was angry at the Dean for actually inserting herself in the situation, “Does [Robin] approve other book requests? She never approved mine when I was chair.” I also felt indignant that I felt I had to go to the union, “I talked to [Bob] today and he confirmed what I knew, the Dean does not have the authority to veto a book order.” As I look back, this action was more about proving I was right and being able to say “I told you so” to the Dean, than about actually adopting the book. It was too late to change the adoption. At the time my need to prove I was right was stronger than my desire to keep the peace with the Dean. There was at least some part of my action that was also protective of the Chair. I wanted her to know that the Dean is not always right, “I gave her a copy of the email from [Bob], so in the future she will know that [Robin] can’t veto our book orders.” At the time, I also felt that the Dean would owe me, since she had made a mistake. This was the transactional leader (Bass, 1985; Burns, 1978) in me showing. Rather than earning some future considerations, I expended some of my good will with the Dean by pointing out her error.

I was not proud of the way I handled this as a situational leader, however, because if I had treated the Chair at the appropriate developmental level (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982), students may have ended up with a more cost effective textbook option. I identified transactional leadership (Bass, 1985; Burns, 1978) as a supporting leadership style that I sometimes employ. I failed at this as well. To effectively implement a transactional style using management by exception (Bass, Burns), I should have used an active style rather than a passive one. I waited until the chair made the mistake rather than anticipating the possible issue. This was a good example of the difficulty of diagnosing a problem (Machiavelli, 2006). By the time I diagnosed that there was an issue, the chair had already signed a contract with the book company. This was the most disappointing example of my behavior as a leader within the scope of this project.

Organizational Challenges

Cycle four focused on organizational changes. I identified several issues during cycle three of my study: not all students taking MTH 105 were education majors, students would benefit from a pre-requisite for the course, and the course was not consistently accepted in transfer. In my organization I wear many hats. I am the senior member of the Academic Skills Math (ASM) department and have chaired the department, so hold a great deal of prestige there. I hold a dual appointment in the Math department. There, I am third of nine in seniority, but lowest in prestige. There are a few in the department who question my academic credentials and who question whether I should even be allowed to teach in their area. I have been chair of the Faculty Assembly (our college governance body) for the last 13 years. This puts me in a unique power position on campus. In Gladwell's (2000) nomenclature, I am the ultimate "Maven" on campus, the collector of knowledge. I know the detailed history of college governance for the past 24 years. I know who the connectors and salesmen are. I know the people who spread the word and who help get the votes we need for an issue to pass. I know who is toxic and who put up barriers. In the words of the College's President to the Vice President of Academic Affairs as a recent sensitive curriculum issue was passed unanimously, "The smartest thing you did was get Kelly involved. She is smart and everybody listens to her." I am an admitted know-it-all. The role of Maven fits me. I am comfortable when I feel like one of the smartest or most knowledgeable people in the room. The downside is that I am not so good when I am not in control. In the ASM department I feel I can control the conversation; in Assembly I am confident I can control the room. I had a high level administrator tell me that she watches me at Assembly at marvels at how I can set up an issue and prepare the group for a vote. She told me that she learned that often it is not the issue, but how it is presented, that is the key. She complimented my ability to make the presentation. However, during this study when I was working with the math department, dealing with transfer institutions, or working with textbook companies, I did not have the positional power or status of Maven to rely on. As I tried to implement changes, identified in Cycle Three, I learned I had to rely on other leadership skills.

The issues at hand that I needed to work through with the Math Department included pre-requisites, course requirements, transferability, and curriculum. These conflicts all fell under the umbrella of Bolman and Deal's Structural frame (2003, 2007). I needed to convince the group of our organizational goals, external environment, and lines of authority with respect to college governance and transfer institutions. One key goal was to involve people other than myself in the tasks. As I reflected, "I am hoping I can get [John] and [Carol] on board with this. [Carol] used to be a chair, so she knows the players at Rutgers and Rowan." No other department member had even taught this course before. No one had a real stake in its success. For syllabus creation, I suggested to the chair that we form a subcommittee. Another full time faculty member and two adjunct faculty members were recruited to participate. The full time faculty member eventually took on the leadership role in contacting the transfer institutions to coordinate with them. I felt like this was a big accomplishment, "I am glad [Carol] is taking this on, she has experience with the 4-years." For curriculum items, the department chair needed to be involved. He was able to successfully introduce a new curriculum for those interested in Secondary Math.

The department as a whole came to consensus about reserving MTH 105 for education majors, to eliminating and later remediating MTH 106 as a course, and to the new curriculum proposal. The key to having a successful outcome was data. This was a Math department, so quantitative data was most useful. I showed them the percent of students in MTH 105 who were not education majors, the transfer data for our local institutions, and the success rates of students in our courses based on what pre-requisites they took. From a situational leadership standpoint (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982), they needed support but not additional direction. Since chairs rotate every two years, everyone in the department had chaired the department in the past. They knew what they had to do, but left to their own, they would never have done it. These are the characteristics of followers at the D3 level. They knew the processes but were not excited about engaging in it. Martin Luther King said, "A genuine leader is not a searcher for consensus but a molder of consensus" (November 1967, National Labor Leadership Assembly for Peace). It is not enough to just figure out what we can all agree on and try to implement that. It is sometimes necessary to create agreement on an issue. In this case, the department needed some molding. Individuals agreed that changes should be made, but did not really want to play a role in making them. This was a case when my situational, supporting style worked. Ultimately, getting the chair, one other full timer and two adjuncts to participate in the process was good. We formed an effective little coalition (Kotter, 1996). It was not a group that needed to convince others that the work should be done; it was a group that needed to actually do the work. It may not sound like much of an accomplishment to get four people to work together, but in the culture of this department it was. I reflected in my journal, “I’m not an island in this anymore. It’s good to have some allies in this initiative.”

One of the unexpected outcomes in this study was my realization that I use many political skills in my leadership outside of the classroom. Bolman and Deal (2007) identified four key skills for a leader as politician: agenda setting, mapping the terrain, networking and forming coalitions, and bargaining and negotiating. I think I really demonstrated each of these skills. I got the issues on the department’s radar and discussed at department meetings. I knew who could be allies and might like to work on the project, what steps would be involved, and what work needed to be done (terrain). I approached the chair and suggested other possible subcommittee members. The sub-group debated possible solutions and eventually brought a proposed solution to the full department. Not only was I using situational skills, (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) I was using political skills (Bolman & Deal).

I must admit that I bristled a bit at the notion that I am a political leader when the subject first came up (Bolman & Deal, 2007). I had a negative view of that term and thought of the designation as pejorative. As I looked at the characteristics of the political leader mentioned above, I realized that political leadership does not need to mean backroom bargains, lies, and empty promises. There is nothing wrong with negotiation, agenda setting, and coalition building. It is all about balance. Going back to my Aristotelian ideal (Aristotle, 2004), not too much and it is a good thing. The political style has been an effective one for me.

The standard attitude for the math department toward a department member who has an initiative they would like to pursue is either "No" or "Good luck let us know how it goes." For example, when one faculty member wanted to start offering dual credit to high school students who were in calculus, the group let him pursue it, but no one helped. When his schedule no longer permitted him to continue, no one picked up the initiative; it just went away. When another faulty member wanted to offer a new course, he was encouraged to develop it, but no one else has ever taught the course. Faculty like to work on their own pet projects but not necessarily the projects of others. They tend to work alone and then check in with the group. The chair will announce "Professor X made a departmental exam for course Y; take a look and see if there are any changes." There typically are not. The culture of apathy in the department was not going to be overcome over my issue, but it did not get in the way of progress. I believe that I helped make great first order, first loop (Argyris, 1990) changes for the MTH 105 students. I do not know that any permanent or transformational changes to the departmental culture were made.

Perhaps a model for future work was developed, with respect to using part time faculty more. I noted in my journal, “Next time I need something done, I’m going to recruit, [Ricki]. She jumped right in.” I can say that we had a successful outcome for all efforts that were in our control and for the one that was not (transfer) rather than dropping the idea of change altogether and just keeping the status quo; we made other smaller changes that helped students but did not need to involve the transfer schools. This is a small example of coalition building (Kotter, 1996). I believe that my situational style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982), providing support and encouragement to the chair and sub-committee members, and my political skills (Bolman & Deal, 2007) traversing departmental policy and procedure, helped get these tasks accomplished.

The Academic Skills Math (ASM) Department was much different to work with. When the ideas about implementing math success strategies came up, it was not data that I used to make my point, but vignettes from my classes. In this case the terrain (Bolman & Deal, 2007) was different. The ASM faculty do not believe in data as much as their own eyes. If one tries to convince them to try something based on a journal article or report, with data, they will not be convinced. If one tells them a story, if the scenario is personalized, they respond. In a generic sense I started the conversation about wanting to improve pass rates, but specific data were never discussed. We talked more about people. We talked about deficiencies in goal setting, test taking skills, textbook reading, and attendance to name a few. We all had stories of a student who did not know how to be a student. No molding was necessary; we were all on the same page. The group brainstormed about what help we could give students. I made the suggestion about an orientation for part time faculty and everyone agreed and volunteered for a topic. When a syllabus needed to be developed, another member quickly volunteered to work up a draft with me. I noted in my journal, “I can always count on [Judy] to support me when my brainstorming leads to work.” I do not want to give the impression that there is not apathy in the department; there is. The difference is that once something is voted on and work needs to be done, there is not as much reluctance to participate. People volunteer to do the work. At the orientation there was full and enthusiastic participation (on a Saturday in August) by the full time faculty and about 25 part time faculty. For this group, a delegating style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) will almost always be successful. If someone is assigned a task (or volunteers), he or she does the task. It is done well and on time. Once we decided to do the orientation, there was no need to check up on anyone to see if they were progressing, needed help, or would be ready. We all knew that when the day came the group would perform commendably. In fact, I stole and later implemented several good ideas that were shared. I noted, “I always walk away from the orientation with a good idea or two. [Danielle’s] grading document was really good, and [Michelle’s] notebook Table of Contents is a winner.”

Of course the most difficult interactions were the ones in which I had the least control, those with the four year colleges. We have no control at all over what they do, what they accept in transfer and what they do not. They have complete positional power over us (Bass, 1985; Burns, 1978). They can pretty much decline to accept a course any time they want. One of the most frustrating examples of this was one school’s decision to take a 200 level course and rebrand it as a 300 level course so that students could only take it at their institution. The other simply said follow our syllabus whole cloth or we will not accept the credits (email correspondence 12/1/2010). This was viewed by us as an insulting display of both positional power and transactional leadership (Bass; Burns). I criticized their attitude in my journal, “Do what we say and we will accept your students credits, deviate at all and we will punish them by not taking their credits.” What we were able to create for students was a flexible set of options. For their major at CCC, they need two college level math courses. For those transferring to one school, MTH 105 and 106 were still available and transferrable, and MTH 106 had been improved to include a PRAXIS review. For those transferring to the other, we advised them to take MTH 107 before their MTH 105 course to help them understand the math more clearly. My one fear was about advisement, “I hope the advisors understand this and get the right students in the right classes!” For all MTH 105 students, we provided more support. First, in basic skills classes we implemented strategies to help them be better math students overall. Second, we became strict about who was in the MTH 105 classes so that a more homogeneous group existed. There was a time when the failure to get our new course approved by the four year schools would have led to no change at all. We would have just left everything as is there was demonstrated growth by the department in continuing to strive for change after the initial negative outcome.

I attribute some of that to the fact that growth to the fact that more than just one person was involved in the process. The fact that the chair, another faculty member, and I, all had some emotional stake in the success of this initiative led us to brainstorm about what else we might be able to do. Our little “interested in education majors” coalition (Kotter, 1996) was able to keep the issue on the table for discussion (Bolman & Deal, 2007). Kotter (1996) claimed that in order for a guiding coalition to be effective there needs to be enough key players so that those left out cannot block progress, relevant points of view should be represented so that informed intelligent decisions can be made, the group should be seen and respected by those in the organization so that the group's pronouncements will be taken seriously by others, and the group should have enough proven leaders to be able to drive the change process. With the current Chair, two former Chairs (including me) and a well-respected adjunct with a lot of elementary school experience on board, we had such a group. Viewing the department through the lens of the political frame (Bolman & Deal, 2003), our coalition did not avoid conflict, we dealt with it. We volunteered to take on the burden of the work and that eliminated a major obstacle to agreement. We did not create additional work for the other department members.

In my journal, one of the conclusions I drew about this experience had to do with our relationships with the High Schools. Why the High Schools? It is an ironic twist that the four-year schools do not like to accept our math courses in transfer because they view students as under-prepared and sometimes question the rigor of what we do. We get very upset with this. How dare they question what we do! Then we do exactly the same thing to the High Schools. We question why students are under-prepared when they get to us. We question the rigor of what high school teachers do. We make assumptions about what they do and do not do well. In my journal I noted, "I want to talk to [Barney] about what else we can do to partner with the high schools to communicate our expectations to students and teachers there. There is a disconnect that we need to fix." Since that time I have been appointed as a representative for the state of New Jersey in the Partnership for the Assessment of Readiness for College and Career (PARCC), a 24-state national initiative to find a common core of skills that will ensure that high school students will be prepared to enter a work or post-secondary environment. I am also the College's Academic Skills Math *College Express* liaison. Through this program we offer high school students an opportunity to meet our basic skills requirements before they come to us.

PARCC is one way that I moved outside of my own college environment with respect to math content. I have also shown leadership in the area of math success strategies. A national textbook company has started to use my success chapter and reported receiving glowing feedback from students in surveys they completed (Email correspondence, 4/4/12). I organized the list of quotes they sent to me in that email in Table 6.2.

Table 6.2

Student Feedback

Success	
	"after using CH S, I think I did better in my math class."
	"I had the hardest time taking tests before. I feel a lot more confident and I can tell it made a difference with my test scores."
Specific Skills	
	" I realized that endless note-taking did not help as much as just listening to lectures and taking small notes- PRICELESS!"
	"Ch S helped me improve my Test taking skills"
	" CH S helped me study more effectively"
	"I'm not used to setting my own goals and managing my time. But I found this helpful."
Attitudes	
	"I appreciate that our instructor chose to show us this chapter"
	"Ch S impacted me for the better"
	"Didn't feel forced or unrelated"
	"CH S gave me a sense of knowing my problem I have with math. So, I acknowledged it and did something differently…."
	"Fun to do something like Ch S other than only NUMBERS."
	"Ch S helped me concentrate during this course."

Typically the changes I see in students in math are evolutionary, not revolutionary. Attitudes, though, can be changed dramatically and quickly (for the good or bad). I sense that my work on the Math Success chapter has the potential for some revolutionary changes in student behaviors and attitudes. It is early in the implementation, but feedback is promising.

Discussion

In completing this project I wanted to see if my espoused leadership style was indeed situational and if there was evidence of a care ethic with my students. I believe that the evidence indicates that I am using a situational style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) in many, but not all, situations and that I am using it effectively with respect to students. When students responded, by survey, about their perceived developmental level and my style of leadership, the match rate was about 85%. Both students who needed additional direction and those who needed additional support claimed they were receiving it. Additionally, student comments in emails showed my care ethic (Gilligan, 1982; Noddings, 2003).

I believe that with respect to organizational change in a higher education environment, I have been able to accomplish an extraordinary amount in a two-year time frame. After I conducted cycle 3 in fall 2009, I helped shepherd through several policy changes in the math and basic skills math departments at the college. We stopped allowing non-education majors to take the course, we improved the subsequent course to improve transferability, we changed the way students were advised to take their courses so that they typically took an additional math course before this one, and we began offering support in basic skills for non-content skills like goal setting, study and reading skills, test taking strategies, and learning styles. To accomplish these tasks, I used situational skills (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982), political skills (Bolman & Deal, 2007), coalition building (Kotter, 1996), transactional management (Bass, 1985; Burns, 1978) and used some of my skills as a Maven (Gladwell, 2000) on campus and as a positional leader as Faculty Assembly Chair and as a former department Chair.

I worked with a national publisher to begin offering materials related to non-content skills to developmental math students. I also helped with professional development of faculty both at my college and through the company's Spring Webinar Series. In this effort, my status as a Maven (Gladwell, 2000) was of great use, and I also needed to use situational techniques (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982). Some groups had different professional development needs than others. In addition, I began working on a national committee that considers the content needs high school students have in mathematics with respect to careers or post-secondary studies. On the national stage I do not have the positional power that I do on campus, but the fact that my Academic Vice President nominated me to serve on the committee establishes me as knowledgeable on the subject and puts me in place as a legitimate member of this guiding coalition (Kotter, 1996).

Conclusion

Some of the key outcomes of this project discussed in Chapter Five and Six were improved attitudes and less anxiety for my students, a better curriculum for majors, and a new awareness within the department about the issues for this population. I believe that throughout this project I did use a situational style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) and demonstrated an ethic of care (Gilligan, 1982; Noddings, 2003) with my students, and I expanded my arsenal of leadership strategies to include some coalition building (Kotter, 1996), political maneuvering (Bolman & Deal, 2007) use of my status as a Maven (Gladwell, 2000), and my positional power (Bass, 1985; Burns, 1978) to attain positive outcomes with my departments and with a national publisher. My fourth research question, asked whether I indeed practice a Situational Style and an Ethic of Care? I believe that the evidence I presented indicated that I often do, especially with students. I do, however, employ other styles with positive results in my work within the department and outside the College.

Research question five asked whether I used similar styles inside and outside the classroom. Certainly the title as Maven (Gladwell, 2000) was appropriate in both arenas. To my students I was an all-knowing sage. There was not an arithmetic or algebra question that I could not answer. Outside the classroom, as a full professor, with tenure, a former department chair and 13-year Chair of the Faculty Assembly, I knew the college, its policies, its politics, and its processes well. I employed transactional techniques (Bass, 1985; Burns, 1978) as well. With my students I traded grades for work. If they did what was expected of them, then they got good grades. If not, then they earned low grades. Outside the classroom, in my role as Chair of the Assembly I had to regularly diagnose issues with curriculum and policy to determine what needed to come before the group. I also needed to use political skills and conflict resolution techniques (Bolman & Deal, 2003, 2007). I also used coalition building (Kotter, 1996) techniques in many of my roles. I have demonstrated throughout this document that I used a situational style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) in and out of the classroom. In sum, I did use many of the same skills, but employed some political and coalition building techniques outside the classroom I did not use within.

In my "Leadership Theory in Use," (Chapter 2 in this dissertation) I provided a mission statement: use my gifts to help others achieve their potential by working with them on their terms at their level to achieve their goals. I said that we would work together based on the follower and situation and develop a plan of attack. I noted that to implement this mission I would need to recognize where people are, where they want to go, and how we can best get there. I believe that my behavior, as analyzed above, is in line with my stated mission.

As I look to the future, I want to continue to work in my classroom to improve my students' attitudes and reduce their anxieties. I want to work with the Math and Academic Skills Math departments to evaluate and improve our course offerings in math. I want to work with the high schools to coordinate what students can do in secondary school to prepare for post-secondary and with the four-year institutions to coordinate what our students need to do to prepare for transfer. I also want to continue my dialogue with publishers, who have an unavoidable influence on what we do in our classes. As a leader I want to continue to use my situational style (Blanchard, 2007; Blanchard & Hersey, 1970, 1996; Gates, et al., 1976; Hersey & Blanchard, 1974, 1981, 1982) and ethic of care (Gilligan, 1982; Noddings, 2003) with my students. I also want to continue to use coalition building (Kotter, 1996), political skills (Bolman & Deal, 2007) and use of my status as a Maven (Gladwell, 2000) with my colleagues on campus.

This project included many topics that only received a surface look and others that were not able to be considered at all. There are many opportunities for future research by me and for others. Several activities were used during the semester and it is not possible to tease out which ones had what effects on attitudes and anxiety. For example, one could simply look at how study skills alone influence attitude, anxiety, or even achievement. Similarly, one could consider just the active learning, or just the journaling. My class included many techniques that were intended to improve attitudes when experienced in concert. It is unclear if some of these activities were more influential than others. It is also unknown whether this change in attitudes will persist. Will in last beyond my class? Will these teachers actually be different in their own classrooms, because of their work with me? Will they face math challenges with less fear and a better attitude? Perhaps future research can be completed that is more longitudinal in nature, following these students further into their careers.

Since my earlier field tests during coursework failed to find significant stereotype threat, I chose not to investigate stereotype threat for this population. That would be interesting research. There is also the issue of teacher expectations. How do the instructor's expectations influence the attitudes of the students? It has been a long time since the anxiety and attitudes scales were developed. One vein of future research could be the development of new tools to measure anxiety and attitudes in the twenty-first century. Additionally, I think an untapped resource is the publisher's influence on student achievement and attitudes. Another possible research thread is how published materials, whether in print or online, affect student attitudes, anxiety, and achievement. For every answer I think I find, with it I find more questions. Success is a moving target for me. I am sure that I will continue to experiment in my classroom and continue to read about projects that others take on related to student attitudes, anxiety, and achievement. With this study I am convinced that change can happen and that I can be a factor in that change.

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Appendix A

Math Anxiety and Attitudes Scale

Math Anxiety and Attitudes Scale

For items 1 – 24, indicate the level of anxiety you feel performing the specified task.

1. Looking through the pages in a math text
   □ none □ a little □ average □ a lot □ very much
2. Walking into a math class
   □ none □ a little □ average □ a lot □ very much
3. Having to use the tables in the back of a math book
   □ none □ a little □ average □ a lot □ very much
4. Reading a formula in Chemistry
   □ none □ a little □ average □ a lot □ very much
5. Buying a math textbook
   □ none □ a little □ average □ a lot □ very much
6. Thinking about an upcoming math test one day before
   □ none □ a little □ average □ a lot □ very much
7. Watching a teacher work an algebraic equation on the blackboard
   □ none □ a little □ average □ a lot □ very much
8. Being told how to interpret probability statements
   □ none □ a little □ average □ a lot □ very much
9. Picking up a math textbook to begin working on a homework assignment
   □ none □ a little □ average □ a lot □ very much
10. Taking an examination (quiz) in a math course.
    □ none □ a little □ average □ a lot □ very much
11. Reading and interpreting graphs or charts
    □ none □ a little □ average □ a lot □ very much
12. Solving a square root problem
    □ none □ a little □ average □ a lot □ very much
13. Signing up for a course in statistics
    □ none □ a little □ average □ a lot □ very much
14. Getting ready to study for a math test
    □ none □ a little □ average □ a lot □ very much
15. Reading the word “statistics”
    □ none □ a little □ average □ a lot □ very much
16. Being given a homework assignment of difficult problems due the next class meeting
    □ none □ a little □ average □ a lot □ very much
17. Listening to a lecture in a math class
    □ none □ a little □ average □ a lot □ very much
18. Waiting to get a math test returned in which you expected to do well
    □ none □ a little □ average □ a lot □ very much
19. Working on an abstract mathematical problem
    □ none □ a little □ average □ a lot □ very much
20. Being given a “pop” quiz in math class
    □ none □ a little □ average □ a lot □ very much
21. Taking an examination (final) in math class
    □ none □ a little □ average □ a lot □ very much
22. Starting a new chapter in a math book
    □ none □ a little □ average □ a lot □ very much
23. Listening to another student explain a math formula
    □ none □ a little □ average □ a lot □ very much
24. Walking on campus and thinking about a math course
    □ none □ a little □ average □ a lot □ very much

For Items 25 – 36, indicate your level of agreement with the statement

25. Generally I have felt secure about attempting mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

26. I am sure I could do advanced work in mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

27. I am sure I can learn mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

28. I think I could handle more difficult mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

29. I can get good grades in mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

30. I have a lot of self-confidence when it comes to mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

31. I am no good at mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

32. I don’t think I could do advanced mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

33. I’m not the type to do well in mathematics.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

34. For some reason, even though I study, math seems unusually hard for me.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

35. Most subjects I can handle OK, but I have a knack for mucking up math.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

36. Math has been my worst subject.
□ strongly disagree □ mildly disagree □ neutral □ mildly agree □ strongly agree

For items 37 to 40 please identify the category that best describes you

37. □ Male □ Female

38. □ White □ Non-White

39. □ Hispanic □ Non-Hispanic

40. □ First language is English □ First language NOT English

Appendix B

Consent Form

Consent Form
Math Systems I

CAMDEN COUNTY COLLEGE

I agree to participate in a study entitled "Math Anxiety and Attitudes in Pre-Service Elementary Education Majors" which is being conducted by Professor Kelly Jackson of the Mathematics Department, Camden County College.

The purpose of this study is to determine what the attitudes and anxieties regarding math are for pre-service elementary education majors, to identify the history of these attitudes, and to reveal what strategies might be used to improve these attitudes. The data collected in this study will be used in a classroom project and Dissertation for Rowan University's Doctoral Program in Educational Leadership.

I understand that I will be asked to take a survey, and I may be asked to participate in a follow up interview. I will also be completing a journal project.

I understand that my responses will be anonymous and that all the data gathered will be confidential. I agree that any information obtained from this study may be used in any way thought best for publication or education provided that I am in no way identified and my name is not used.

I understand that there are no physical or psychological risks involved in this study, and that I am free to withdraw my participation at any time without penalty. Participation or lack or participation will not influence my grade in this course.

I am 18 years of age or older.

I understand that my participation does not imply employment with the state of New Jersey, Rowan University, Camden County College the principal investigator, or any other project facilitator.

If I have any questions or problems concerning my participation in this study, I may contact Professor Kelly Jackson at (856) 227 -7200 x 4570 or at KJackson@camdencc.edu or Dr. David Hespe (Advisor) at (856) 256-4702 or at Hespe@rowan.edu

______________________________ ____________________

(Signature of Participant) (Date)

______________________________ ____________________

(Signature of Investigator) (Date)

Appendix C

Student Interview Protocol

Student Interview Protocol

Main Question 1: I want each of you to think about how anxious you are about math class. Think of a scale where 1 means no anxiety at all and 5 means total nervous breakdown. Where do you see yourself?

Follow up 1: What makes your ordinary level of discomfort go up even more?

Follow up 2: What things that go on in math class make you feel less anxious.

What activities reduce your stress?

Main Question 2: Think about the subject math and how much you like it. One means it is your least favorite subject and five means it is your favorite subject.

Follow up 1: I want you to think about your current attitude about math and tell me when you started feeling this way. If you like it, when did you start liking it? If you hate it, when did that happen? Was it back in elementary school? Did you like it till you got to algebra, then started to change your mind? When did your current feelings first start?

Follow up 2: A few of you mentioned teachers. What can teachers do to make it more likely that you succeed in math?

Follow up 3: What are some of the behaviors that students have in class that inhibit you from doing your best? What do other students in class do that affect you in a negative way?

Main Question 3: How do you think calculators influence your understanding of math? Do you think they improve your understanding or inhibit you from really understanding the work?

Main Question 4: Let's talk a little about homework. In college different teachers have different policies ranging from collecting and grading it, to spot checking, to not caring if you do it or not. What do you think is the best policy for your achievement? Do you think you do better if you are forced to do it or if you get to pick and choose what you need to practice?

Follow up 1: Think about classroom policies that are in place. Things like cell phones, attendance, lateness, etc. What policies do you think interfere with your ability to function successfully in the classroom?

Follow up 2: Suppose your teacher has one of those no make-up policies. In the syllabus it says no make ups, but then they let a student make up a test when their deathly illness gets better. What do you think about that? Do you expect teachers to enforce their policies to the letter to be fair or to decide on things case by case in a more arbitrary way?

Main Question 5: This next question is about your success in math class. What proportion of your success do you attribute to your skill, your effort, and your teacher?

Follow up 1: What is something that you could do to make it more likely that you will succeed in math class and what is one thing your teacher could do to make it more likely that you will succeed?

Appendix D

Code Book

Code Book

Gender Codes
- M = Male
- F = Female

Ethnicity Codes
- W = White
- B = African American
- H = Hispanic
- A = Asian

Age Codes
- T = Traditional Student (appears to be 22 or younger)
- NT = Non-traditional student (appears to be over 22)

Anxiety Codes
- AX = Unspecified anxiety
- TA = Test anxiety
- PA = Performance anxiety
- BT = Blames Teacher
- BS = Blames Self

Attitude Codes
- AP = Attitude Positive
- AN = Attitude Negative

Learning Style Codes
- CO = Cooperative Learning
- RL = Real Life
- HT = Help or Tutoring
- TM = Time

Behavior Codes
- BOR = Bored
- DIS = Disrespectful Behavior
- TLK = Talking off topic
- PHO = Using Phone
- LEV = Leave the Room
- LAT = Late Arrival
- EAR = Leave Early
- EAT = Eating in Class
- SLP = Sleeping in Class

Appendix E

Syllabus for MTH 105

Course Syllabus
Camden County College
Blackwood, New Jersey

Course Title: Mathematical Systems I: Structures

Course Number: MTH-105

Date of Last Revision: February 2006

Department/Program Affiliation: Mathematics

Credits: 3
Contact Hours: **Lecture**: 3
Lab: 0

Prerequisites: MTH-029 Elementary Algebra Traditional OR MTH-030 Elementary Algebra Accelerated, and ENG-013 (Reading Skills III) OR proper placement exam scores.

Corequisites: None
Course Description/Goals:
This course is designed for education majors, with the exception of students intending to become secondary math or science teachers. This course presents the development of number systems such as the natural numbers, integers, rational and real numbers. Mathematics as the study of patterns is examined in the context of elementary number theory, sequences and functions. The notions of conjecture and proof as central to this discipline are presented. Mathematical relationships and algorithms are studied by means of equations, inequalities, functions and their graphs. Mathematical systems derived from clock and modular arithmetic are examined. A calculator, such as the TI Explorer, is recommended.

The general objectives of this course are:

- To have students become familiar with several topics in contemporary math, their significance, terminology and symbolic representation.
- To provide students with the needed manipulative skills to solve problems presented in this course and to assess the reasonableness of their solutions.
- To show students the usefulness and practical value of mathematics.
- To teach students to think in a mathematically correct and rigorous way.
- To have students examine problems and their solutions from multiple perspectives.
- To have students learn the significance of conjecture, abstraction, proof and generalization in a mathematical context.
- To have students appreciate the intellectual and aesthetic value of many mathematical ideas.
- To show how historical and social conditions influenced the creation of mathematics.
- To establish the interconnection between mathematics and other disciplines and to illustrate how mathematical ideas and procedures are used in other fields.
- To exhibit, and have students get involved in, the use of modern technology in the representation and solution of mathematical problems.

Course Objectives/Student Learning Outcomes

Thinking Critically
(Sections 1.1 through 1.5 in the textbook by Long et al.)
Upon the completion of this unit, the student will be able to:
Know the difference between inductive and deductive reasoning.
Describe the meaning of the terms “conjecture” and “counterexample”.
Determine the properties of sequences.
Develop problem-solving strategies.
Understand and implement correctly an algebraic approach to certain problems.
Understand the role of logic and correct reasoning in mathematics.
Sets and Whole Numbers
(Sections 2.1 through 2.4 in the textbook by Long et al.)
Upon completion of this unit, the student will be able to:
Describe sets, their diagrams, operations and properties using the appropriate notation and terminology.
Understand the meaning, properties and applications of addition, subtraction, multiplication and division with whole numbers.
Understand the meaning of exponents and their properties
Understand the order of operations.
Understand and apply correctly the Division Algorithm.
Numeration and Computation
(Sections 3.1 through 3.5 in the textbook by Long et al.)
Upon completion of this unit, the student will be able to:
1. Describe the historic development and assumptions underlying numeration systems.
Convert a number from one system to another.
Add and subtract in different numeration systems.
Understand and apply correctly algorithms for whole-number operations.
Estimate and perform mental arithmetic
Number Theory
(Sections 4.1 through 4.3 in the textbook by Long et al.)
Upon completion of this unit, the student will be able to:
Understand the relation of divisibility among integers and its properties.
Apply correctly various divisibility tests.
Distinguish between prime and composite numbers and know some of their properties.
Understand and apply the Fundamental Theorem of Arithmetic.
Describe some of the attributes of prime numbers.
Understand the argument showing that there are infinitely many primes.
Find the GCF and the LCM of two natural numbers.
Become familiar with unsolved problems involving primes.
Integers
(Sections 5.1 through 5.4 in the textbook Long et al.)
Understand the meaning and properties of addition, subtraction, multiplication and division of integers.
Understand order of operations and the ordering of the integers.
Perform clock and modular arithmetic operations.
Construct modular arithmetic tables.

Rational Numbers and Fractions
(Sections 6.1 through 6.3 in the textbook by Long.)
Upon completion of this unit, the student will be able to:
Correctly define the set of rational numbers and its properties.
Simplify fractions and determine when two fractions are equal.
Understand the property stating that the set of all rational numbers is dense.
Correctly add, subtract, multiply and divide rational numbers.
Apply properties of exponents with rational numbers.
Solve problems and equations involving proportions.
Decimals, Percents, and Real Numbers
(Sections 7.1 through 7.4 in the textbook by Long et al.)
Upon completion of this unit, the student will be able to:
Understand the decimal representation of numbers.
Convert fractions to decimals and vice versa.
Know the meaning of the scientific notation and perform the corresponding conversions.
Perform operations with decimal numbers.
Convert non-terminating decimals to fractions involving integers.
Know the meaning of percent and apply this in solving practical problems.
Solve problems involving the computation of interest.
Know what an irrational number is and what a real number is.
Understand square roots as well as other roots.
Justify why $\sqrt{2}$ is irrational.
Know general properties of the set of real numbers & the operations of addition and multiplication: closure, commutative, associative, identity, inverse, distributive and denseness properties. In this regard, know the definitions of group and field.
Understand properties of radicals and fractional exponents.
Define and distinguish between natural numbers, integers, rationals and real numbers and the ways they are related.

Course Outline:
Chapter 1: Thinking Critically
1.1 An Introduction to Problem Solving
Polya's Problem Solving Principles
More Problem Solving Strategies
Additional Problem Solving Strategies
Reasoning Mathematically
Chapter 2: Sets and Whole Numbers
2.1 Sets and Operations on Sets
2.2 Sets, Counting, and Whole Numbers
2.3 Addition and Subtraction of Whole Numbers
2.4 Multiplication and Division of Whole Numbers
Chapter 3: Numeration and Computation
3.1 Numeration Systems Past and Present
3.2 Nondecimal Positional Systems
3.3 Algorithms for Adding and Subtracting Whole Numbers
3.4 Algorithm for Multiplication and Division
3.5 Mental Mathematics and Estimation

Chapter 4: Number Theory
- 4.1 Divisibility of Natural Numbers
- 4.2 Test for Divisibility
- 4.3 Greatest Common Divisor and Least Common Multiple
- 4.4 Codes and Credit Card Numbers (Optional Topic)

Chapter 5:Integers
- 5.1 Representations of Integers
- 5.2 Addition and Subtraction of Integers
- 5.3 Multiplication and Division of Integers
- 5.4 Clock Arithmetic

Chapter 6: Rational Numbers and Fractions
- 6.1 The Basic concepts of Fractions and Rational Numbers
- 6.2 Arithmetic of Rational Numbers
- 6.3 The Rational Number System

Chapter 7: Decimals, Percents, and Real Numbers
- 7.1 Decimals
- 7.2 Computations with Decimals
- 7.3 Ratio and Proportion
- 7.4 Percents

Course Activities:
The classroom activities will consist of formal and informal lectures, group projects, assignments, and presentations by students at the instructor's discretion. Students will be encouraged to participate fully and actively in the exploration of new concepts by means of hands-on activities and a problem solving approach.

Student Evaluation:
The student will receive a grade based on several examinations, individual homework, projects, presentations, essays, etc.

Grading will be based on student performance on the previously designated areas. The individual instructor will assign percentages, and grades will be assigned as follows:

A 90-100%
B 80-89%
C 70-79%
D 60-69%
F Below 60%
I Incomplete (assigned in extreme circumstances) Must be completed within one semester.
NA Not Attending
XA Never Attended
W Withdraw

Course Materials:
Textbooks: *Mathematical Reasoning for Elementary School Teachers* (4th. Edition), by Long and DeTemple, Addison Wesley Longman

Supplemental Materials:
- My Math Lab
- Calculator (TI 34 recommended)

Internet Scavenger Hunt

Assignment: Create a portfolio with at least 100 points worth of information. Your grade for this assignment is the number of points associated with the information you put in your portfolio. The maximum number of points allowed is 100. (You may include more than 100 points worth of information, but the highest grade attainable is a 100)

Standards and Assessment

Find the website for the NCTM (National Council of Teachers of Mathematics). Print out the Executive Summary (a six page document) of the NCTM'S Principles and Standards for School Mathematics. (10 points)

New Jersey has a website for the state government, www.nj.gov. Under Departments, access the Department of Education. On the menu called "Overview of DOE Programs" select Assessment and Evaluation. You can explore information about state testing in NJ. Print out some test specifications or sample questions for the mathematics portion of the NJASK, GEPA, and/or HSPA. (3 points each, total of 9 points)

Rowan University houses a program called MCSIIP. The web page for this program contains a condensed version of the New Jersey Core Curriculum Mathematics Standards (condensed by Janet Caldwell). Print out a copy of the Standards, Process Standards and Topic Standards. (10 points)

The PRAXIS is a licensure exam. The Educational Testing Service has information about the test on its website. Use the ETS website to find information about what tests are required for licensing in New Jersey for various subjects and levels. Print out the New Jersey requirements. (10 points)

Educator Resources

List the contact information (phone and website) for the organizations listed below. What is the function of each? NCTM, South Jersey Math Alliance, AMTNJ. (3 points)

Compile a list of websites that have lesson plans for mathematics (any level). (1 point for each site up to 10 sites, total of 10 points)

Find a website that has a list of Children's books that incorporate mathematics. Print the list and include it in the portfolio. Be sure the website address appears somewhere on this printout. (You may write it on the page.) (5 points)

Use the website www.enc.org/cc (or another of your choosing) to find an activity for Pi Day, Golden Mean Day, Powers of Ten Day, 100th Day of School, or other math related dates. (3 points for each different Math Day you find an activity for, maximum of 15 points)

Marilyn Burns is a world-renowned expert on teaching mathematics to youngsters. Her website is www.mathsolutions.com . Print out a listing of the books she has written (2 points) and/or a copy of a lesson from her archives of lessons (3 points).

List the contact information (phone and website) for 3 companies that sell math manipulatives. (3 points)

List professional journals in the field of mathematics or education that address teaching mathematics in elementary school, middle school, or high school. (1 point each, up to 5 points)

Go to www.everydaymath.uchicago.edu. This is the website for the University of Chicago School Mathematics Project. Access the Educator's Homeroom. Print one of the sample lessons. (3 points)

Student Resources

Math Counts is a competition for Middle School Students. On their website they have a Coaching Kit. In that kit is a MATHCOUNTS Toolbox. This is a 9-page document with facts, formulas, and tricks for solving math problems. Print this PDF file. (You will find it is a nice reference for you!) (3 points)

"24" is a wonderful game for reinforcing basic arithmetic facts and order of operations. The website for the game is www.24game.com. Select the "First in Math" online program. Select "Visitor". Select "Educators". Select sample games and experiment with different levels. Print out a copy of the screen for two of your games. (3 points)

"Equate is a Scrabble-like math game. Students create equations rather than words. The website for the product is www.conceptualmathmedia.com. Explore the site. Print out the page on school use. (3 points)

www.cut-the-knot.org is a website with all kinds of math puzzles, games, proofs and mathematical information. Try some of the interactive activities. Print the screen for an activity. (1 point a piece for up to 5 activities)

The *MacTutor History of Mathematics Archive* is a great website for finding information about the History of Mathematics (good for both students and instructors). Check out some of the mathematical contributions of various cultures and biographies that are available there. Print out one cultural history and one biography. (3 points each, 6 points total)

Access the website www.mathpower.com. Take the Math Anxiety Test. Print out Professor Freedman's suggestions for overcoming math anxiety. (3 points)

Access the *Ask Dr. Math* Website. Find a question/answer about an algebra topic. Print out Dr. Math's response. (3 points)

Funbrain.com has lots of educational, interactive games for kids (and adults?) access the site. Find the game called *Fresh Baked Fractions*. Play the game and print your screen at some point. (3 points)

Scholastic puts out a classroom magazine for children in grades 3-6 called Dynamath and for grades 6-9 called Scholastic Math. Print out the editorial calendar for the magazines. (2 points each, total of 4 points)

Compile a list of websites that have interactive mathematics games (any level). (1 point for each site up to 10 sites, total of 10 points)

Appendix F

Activities for MTH 105

Got Milk?

Suppose you are the person in charge of the kindergarten milk program at your school. Since the school never wants to waste milk, you always buy exactly the amount you need. The school also wants to save money, so you always buy in the biggest quantities possible (for example, you would never buy 2 pints, you would buy a quart instead). Milk is available by the cup, pint, quart, half-gallon or gallon (keep in mind there are 2 cups in a pint, 2 pints in a quart, 2 quarts in a half-gallon, and 2 half gallons in a gallon). Each child receives one cup of milk at snack time.

1 pint = ______ cups

1 quart = ______ cups

1 half-gallon = ______ cups

1 gallon = ______ cups

If you need to serve milk to 14 children, how should you make your purchase?

If you need to serve milk to 30 children, how should you make your purchase?

How many children can be served with 1 gallon, one pint and one cup?

How many children can be served with 1 gallon, 1half-gallon, and one quart?

Fill out the chart below. Use a “1” to indicate that you will buy 1 container of the specified size and “0” to indicate you will not need one of that size.

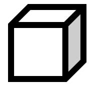
	16	8	4	2	1
# of Children	Gallons	½ Gallons	Quarts	Pints	Cups
1					1
2				1	0
3				1	1
4			1	0	0
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

The numbers to the left are base 10 numbers.
The numbers that fill up the chart are their base 2 representations.

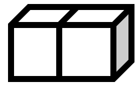
The place values in the base 2 system are the 1’s, 2’s, 4’s, 8’s, 16’s, etc where each place value is a power of 2. Two create a base two number we use building blocks that are based on the powers of two.

Base 2 Blocks

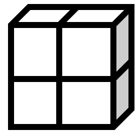
$2^0 = 1$



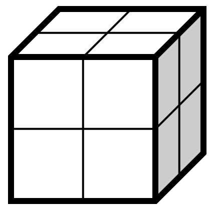
$^{1} = 2$



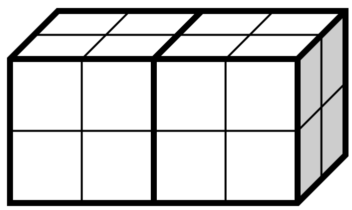
$2^2 = 4$



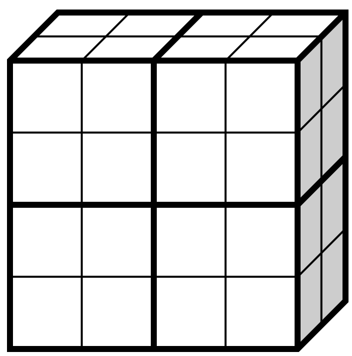
$2^3 = 8$



$2^4 = 16$



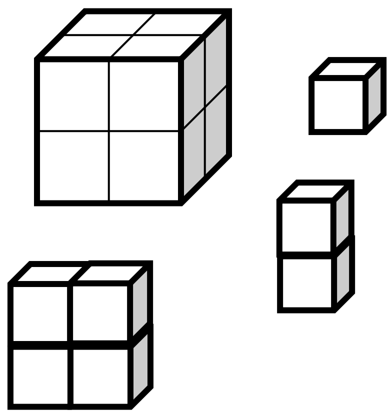
$2^5 = 32$



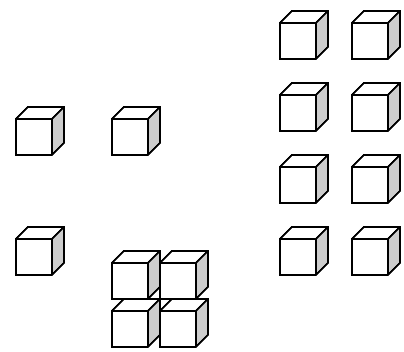
Base 2 Blocks

(Converting base 2 to base 10)

Suppose we have 4 base two blocks: blocks 1, 2, 4, and 8
What base ten number would they represent?



1111_{base2}



15

Which blocks would you need to represent 10011_{base2}?

What base 10 number does that represent?

Which blocks would you need to represent 101010_{base2}?

What base 10 number does that represent?

Which blocks would you need to represent 11011011_{base2}?

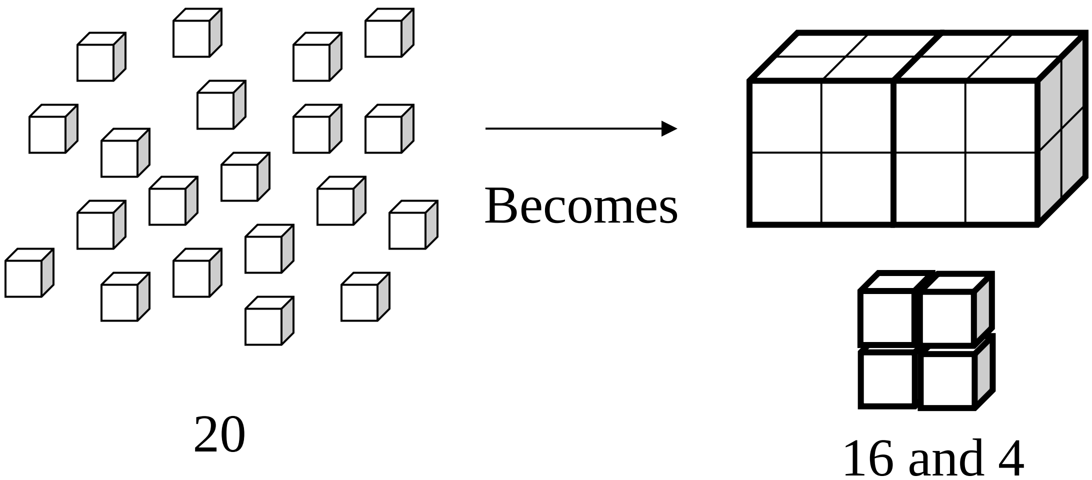
What base 10 number does that represent?

What is the smallest number that can't be represented using the smallest 6 base 2 blocks?

Base 2 Blocks

(Converting base 10 to base 2)

Suppose you have 20 individual blocks. How many base 2 blocks could you make from your pile if you wanted as few base 2 blocks as possible?



16 is the 5^{th} place value in the base 2 system and 4 is in the 3^{rd} place value. We will need to use "1" in those place value positions. Since we did not create any blocks of size 1, 2, or 8 we will put "0" in those place value positions. Therefore:

$20 = 10100_{base2}$

Suppose we want to represent the number 25 using base 2 blocks. Which blocks would we need to use? What base 2 number does that represent?

Suppose we want to represent the number 31 using base 2 blocks. Which blocks would we need to use? What base 2 number does that represent?

Suppose we want to represent the number 39 using base 2 blocks. Whaich blocks would we need to use? What base 2 number does that represent?

What is the largest number that can be represented by the first 7 base 2 blocks?

Base Two

Now lets try converting without the blocks:

(These are really the milk problems in disguise)

Write 14 as a number in base 2 $\underline{\quad}$ $\underline{\quad}$ $\underline{\quad}$ $\underline{\quad}$

2^3 2^2 2^1 2^0

Write 30 as a number in base 2 $\underline{\quad}$ $\underline{\quad}$ $\underline{\quad}$ $\underline{\quad}$ $\underline{\quad}$

2^4 2^3 2^2 2^1 2^0

Write $10010_{\text{base 2}}$ as a number in base 10

2^4	2^3	2^2	2^1	2^0
1	0	0	1	0

Write $11100_{\text{base 2}}$ as a number in base 10

2^4	2^3	2^2	2^1	2^0
1	1	1	0	0

Making Cents

How many pennies, nickels, and quarters would be required in order to create the amount of money indicated, if we want to use as few coins as possible?

1¢			1
2¢			2
3¢			3
4¢			4
5¢		1	0
6¢		1	1
11¢		2	1
26¢			
36¢			
50¢			
67¢			
76¢			
99¢			
111¢			

The numbers on the left are base 10 numbers.
The numbers on the right are their base 5 equivalents.

Base 5 Conversions

List the first 5 place values in the base 5 system.
Hint: the names correspond to 5^0, 5^1, 5^2, etc

What digits are used in the base 5 system?

In the base 5 number 3124_{base5} what is the meaning of the digit:

1

2

4

3

What base 10 number is equivalent to 213_{base5}?

What base 10 number is equivalent to 3003_{base5}?

Suppose we have the number 257. How would we represent it using base 5? (If it is helpful there are some pictures of base 5 blocks on the other side of this handout.)

Suppose we have the number 3000. How would we represent it using base 5?

What is the biggest base 10 number that can be created using only the first four place values in base 5?

The Babylonian Number System
(Time for Base 60)

Fill in the chart below with the number of seconds that pass by during the given time span

Hours	Minutes	Seconds	Total Seconds
		21	
	12	3	
10	20	10	
10		2	
1	21	2	
11	11	11	
20	2		
	21	30	

We can use the way we convert hours, minutes and seconds into seconds to see the way that the Babylonians represented numbers.

Babylonians used a positional system where each position represented a power of 60. They did not use numerical symbols as we know them today. They used 2 symbols:

‹ will represent 5 and ▼will represent 1

60^2	60^1	60^0	Base 10 Value
		‹‹▼	
	‹▼▼	▼▼▼	
‹	‹‹	‹	
‹		▼▼	
▼	‹‹▼	▼▼	
‹▼	‹▼	‹▼	
‹‹	▼▼		
	‹‹▼	‹‹‹	

Convert 100 into Babylonian symbols

Convert 225 into Babylonian symbols

Convert 5500 into Babylonian symbols

Convert 7210 into Babylonian symbols

Convert 20000 into Babylonian symbols

Appendix G

Sample Math Success Strategies

Goal Setting Worksheet

Complete at the BEGINNING of your course:
I hope to get a grade of _____ in this course.
Three things I can do to ensure that I meet this goal are:

1.
2.
3.

I plan to spend ____ hours per week OUTSIDE of class for this course.
Three things I can do to be sure that I have enough time to devote to math:

1.
2.
3.

At most I will miss _____classes this semester.
Three things I can do to be sure I can get to class each time it meets:

1.
2.
3.

Complete at the MIDTERM point of your course

Right now my grade is _____
Am I on target to get to my Grade Goal? yes/no
Can I still attain my goal? yes/no
My goal grade at this point is _____
Three things I can do to ensure that I meet this goal are:

1.
2.
3.

Complete at the END of your course:

The grade I earned in this course ______

Did I meet my initial Grade Goal? yes/no

Did I meet my midterm Grade Goal? yes/no

What are three things that I did that contributed to my course grade?

What are three things that I did NOT do that contributed to my course grade?

Did I meet my attendance goal? Why or why not?

Was I able to budget appropriate time for this course? yes/no

What more do I need to do to get ready for my next course?

Math Affirmations

I am becoming a good math student

I am learning more math each day

I am capable of learning math

My math improves each day

Math will help me get where I want to go

My way of doing math is a good one

I remember more math each day

I can understand math if I give myself a chance

Math Learning Styles Survey

Answer each question below with the number "3" if you agree most of the time, "2" if you agree sometimes, and "1" if you agree rarely or do not agree.

_____ 1. When there is talking or noise in class I get easily distracted.
_____ 2. If a problem is written on the board I have difficulty following the steps unless the teacher verbally explains the steps.
_____ 3. I find it easier to have someone explain something to me than to read it in my Math book.
_____ 4. If I know how the math is used in real life, it is easier for me to learn.
_____ 5. To remember formulas and definitions I need to write them down.
_____ 6. I like just listening to the lecture rather than taking notes.
_____ 7. Using manipulatives, hands on activities, or games helps me learn math concepts.
_____ 8. When solving a problem, I try to picture working it out in my mind first
_____ 9. Quiet places are the best place to study math.
_____ 10. Talking myself through a math problem helps me solve it.
_____ 11. When I write things down I remember them better.
_____ 12. I have to do a math problem myself to learn it. I can't really know it by watching someone else do it.
_____ 13. If someone lectures about math without writing things down, I find it Difficult to follow.
_____ 14. When I take a math test, I recall more of what was said to me than what I read in my notes or in my math book.
_____ 15. When I take a math test I can picture my notes or problems on the board in my head.
_____ 16. I can do math problems sometimes, but can't verbally explain what I did.
_____ 17. Reading math makes my eyes feel tired or strained.
_____ 18. When I study math I need to take a lot of breaks.
_____ 19. I am good at using my intuition to know how to solve a math problem.
_____ 20. I can learn math fast when someone explains it to me.
_____ 21. Puzzles and games are a good way to practice math.
_____ 22. When I work a math problem I say the numbers I am working with to myself.
_____ 23. I try to write down everything and take a lot of notes in math class.
_____ 24. I do best with math if I just roll up my sleeves and work on problems.

Math Learning Styles Tally Sheet

Carefully copy your responses (1, 2, or 3) to the questions on the survey into the spaces below.

Visual:	____ +	____ +	____ +	____ +	____ +	____ +	____ +	____ =	_____
	1	5	8	9	11	13	15	23	V-Total
Auditory:	____ +	____ +	____ +	____ +	____ +	____ +	____ +	____ =	_____
	2	3	6	10	14	17	20	22	A-Total
Kinesthetic:	____ +	____ +	____ +	____ +	____ +	____ +	____ +	____ =	______
	4	7	12	16	18	19	21	24	K-Total

Overall Total = V-Total + A-Total + K-Total = _______

Visual Percentage = (V-Total ÷ Overall Total) × 100 _______
Auditory Percentage = (A-Total ÷ Overall Total) × 100 _______
Kinesthetic Percentage = (K-Total ÷ Overall Total) × 100 _______

> Very few people learn math only one way. We hear things, see things, and do things that help us understand math better. One style may dominate the others though. On the following pages there are suggestions for things you can do to improve your success in math class based on which style(s) you think are your strongest for math.

Tips for Strong Visual Learners

- Take written notes during your lesson
- Request written directions or ask your instructor, "Could you write that on the board, please."
- Create flashcards to help memorize formulas, definitions, algorithms, etc.
- Write as much as you can when you study. Work a lot of problems.
- Draw diagrams or pictures to help solve problems.
- Try to look at another math book. Looking at other worked examples may be useful.
- Use computer programs that generate problems for you and guide you through solutions.
- Take advantage of workbooks, study guides, student manuals, and handouts.
- Read through your notes and textbook frequently.
- Write in your book. Underline things. Highlight them. Put sticky notes to remind you of important ideas so you can come back and read them again.
- Use colored pencils, markers, or highlighters to annotate your notes and note cards.
- Sit near the front of the room to avoid visual distractions.
- Visualize problems in your mind.
- Watch videos and take notes from the videos.
- If your teacher allows it, make an audio recording of your class.
- Set the counter to zero at the beginning of class.
- Periodically write the counter number next to your notes so you know where on the recording you can find the audio to go with the notes.
- If you are unclear of something note the counter number. Later go back and listen to that part of the lecture again with your notes in front of you.
- Write down information from the recording that you missed the first time.

Tips for Strong Auditory Learners

- Sit near the front of the class so you can hear your teacher.
- Sit away from any auditory distractions (air conditioner, door, etc.)
- Don't be afraid to ask your teacher to repeat or restate something.
- Take part in discussions.
- Form a study group to talk about math class.
- Ask and answer questions in class.
- Dialogue with a tutor to hear explanations and to put concepts in your own words.
- Listen carefully to what the teacher is saying, and then copy down what was said or written.
- Team up with a visual learner. Ask if you can make a copy of their notes.
- Recite important information from your book or notes out loud. Say the steps and formulas instead of just reading them.
- Make an audio recording of important ideas and concepts that you can listen to later (like audio flashcards).
- Restate concepts into your own words.
- Record your class and then listen to it (or parts of it) while driving, exercising, riding the bus, etc.
- Pay attention to tone of voice, inflection, and volume to get cues from the teacher that something is important.
- Read problems out loud, and then talk through the steps.
- Use computer programs or online sources that have tutorials with an audio track.
- Use songs, rhymes, and other auditory memory devices.
- Record class, if your instructor will allow it.
- In your notebook make notations of the counter number when important ideas are discussed. Go back later to listen again.

Tips for Strong Kinesthetic Learners

- DO! DO! DO! Practice, practice, practice. Because you prefer a hands-on approach to learning you need to work as many problems as possible.
- Use physical objects like measuring cups, toothpicks, seeds, stones, marbles, paperclips, rulers, etc to model your math problems.
- Investigate manipulatives that can be used to investigate the concept you are studying (base 10 blocks, algebra tiles, Cuisenaire rods).
- Use your fingers to count and calculate as needed.
- Use a calculator (if allowed).
- Rewrite your class notes, don't just read them.
- Take frequent breaks when studying.
- Try multiple ways to solve a problem until you find the way that feels natural to you.
- If someone shows you a problem ask if you can try a similar one to be sure you understand how to do it.
- Try to connect concepts to concrete ideas with real-life meaning to you. Look at the application problems to see how the concept is used in a real situation.
- When walking or exercising, think about math ideas and concepts.
- Make graphic organizers to emphasize connections between topics.
- Ask your teacher or tutor a question by writing it on the board or in your notebook. As they answer, you write in the steps.
- Form a study group where you work problems together. Try to meet in a classroom where you can stand up and write on the board.
- Use computer programs and online applets that guide you through problems step by step, with you entering information throughout.

Chapter Preview

Chapter #   Pages:

What is the title of the chapter?

Is there a chapter preview/pre-test at the beginning of the chapter?

Pg _______________ Complete this as soon as possible.

Is there a chapter summary at the end of the chapter?

Pg _______________ Complete this before the test on this material.

What are the section subheadings in this chapter:

1. _______________________ p _____   5. _______________________ p _____

2. _______________________ p _____   6. _______________________ p _____

3. _______________________ p _____   7. _______________________ p _____

4. _______________________ p _____   8. _______________________ p _____

Describe 1 or 2 illustrations, graphs, charts, pictures or cartoons that stood out as you surveyed the chapter.

Are there study questions listed at the end of the chapter? Pg _______

Are there key vocabulary words or formulas listed at the end of the chapter? Pg. _______

Describe in one or two sentences what this chapter will be about.

Homework Helper

- In order to optimize its usefulness homework should be done early and often! "Early" means get started as soon after class as possible and "often" means do some each day.
- If a doctor gave you a 30-day prescription and suggests you take one pill a day for 30 days, do you think you would get the same result if you just took all 30 on the last day? Of course not! Similarly, you will learn your math best if you interact with it frequently.
- If you plan to spend 6 hours per week on math, you are better off spending an hour a day than one big cram session on Sunday afternoon.
- Homework should be neat and organized enough to use as a reference later
- Date your notes and identify the chapter, section and page number that the work relates to.
- Don't just write out your calculations, list your steps. Later when you are looking back to study for a test or final exam, you want to be able to remember why you did what you did.
- Don't be afraid to annotate your homework with color, highlighting, or post it notes.
- If you are doing online homework, either print out your results or keep a record of your work.
- Store homework in a binder or filing system.
- Try every problem. If you can't do it right away, copy it down and leave space to fill in later. After tutoring, a consultation with your instructor, or at the next class meeting, you can ask for help with that problem.
- Use your class notes and textbook to help you through rough spots.
- If you are using an online homework system that provides hints or guided help, use it. .
- Note any problems that you couldn't figure out. Try using the ***Homework Coversheet*** to help organize your questions.
- Save all of your homework until the end of the term. If there is a question about your grade you will want to have all of your work to show your instructor.
- Your class notes, homework and textbook are your three-pronged tool for studying for tests. Be sure homework is not a weak link.

Homework Cover Sheet

Chapter _______ Title _______________________

Section _______ Title _______________________

Page(s) __________

Problem(s) __________________________________

Date Due ____________________ Graded? Yes/No

I have questions about problem(s):

I need a clarification about:

Tutoring Tips

To get the most out of tutoring there are a few basic things to remember

- You are in control of the tutoring session.
- You pick the topic.
- You pick whether you use or don't use calculator.
- You decide what method you would like to use when there is a choice.
- The better you articulate what is confusing you, the easier it will be for the tutor to give you useful help.

Prepare for the tutoring before you go to maximize what you accomplish in limited time.

- Have your questions marked with post it notes or other markers
- Don't have unorganized loose papers to shuffle through
- Know what chapter, section, and pages your questions relate to
- Use the ***Tutoring Organizer*** to help you
- Go to tutoring sooner rather than later. Don't wait until things have snowballed into a big problem.
- Allot an appropriate amount of time to meet your goals.

Many students arrive at tutoring and by the time they shuffle through papers, vent about their teacher, and tell their life story there is not much time for the actual tutoring session.

5 ineffective tutoring starters…

- I am totally lost…
- I don't know what section we are on…
- I don't know how my teacher does it…
- My teacher is awful because…
- Let me look for my ______....

5 great question starters…

- I am OK with steps one and two but I don't understand where this number came from in step three.
- I don't fully understand what the word_______ means.
- Could you review the steps for ______________ with me?
- In this formula I don't understand what the symbol ____ represents.
- Here is the way my teacher does it (show the tutor your notes), I would like you to show me how to do it using that method.

- Test Preparation Worksheet

Test Date: Time: Place:

Length of test in minutes: ______

My Grade Goal for this test is:

Number of Problems: ______

Are all problems worth the same number of points? ____

Will there be bonus or extra credit problems? _______

Details:

Chapter(s) and Section(s) covered:

Problem types	# of Problems	# of points
Definitions or Formulas	_____	_____
Multiple Choice	_____	_____
True/False	_____	_____
Matching	_____	_____
Free Response	_____	_____
Extra Credit	_____	_____

Notes or References Allowed? Yes No
If Yes, what?

Calculator allowed? Yes/No

Was I given a study guide? Yes/No
If yes, did I complete it? Yes/No

What study materials do I have?

What study materials do I still need?

After the Test: Error Analysis

It is important to understand whether the errors you make are Conceptual, Procedural, or Computational. A CONCEPTUAL error really shows no understanding of the underlying concept or procedure. In a PROCEDURAL error, the correct process is selected but there is a mistake made with the steps. Finally, a COMPUTATIONAL error is an arithmetic mistake.

Evaluate

$24 + 6 \div 2 \times 3$

$\underline{24 + 6} \div 2 \times 3$ Add

$\underline{30 \div 2} \times 3$ Divide

15×3 Multiply

45

In this example, the student shows no understanding at all of the idea of "Order of Operations." They just work straight through from left to right. This is an example of a CONCEPTUAL error

Evaluate

$24 + 6 \div 2 \times 3$

PEMDAS

$24 + 6 \div \underline{2 \times 3}$ Multiply

$24 + \underline{6 \div 6}$ Divide

$24 + 1$ Add

25

The student clearly identifies that "Order of Operations is being used (they use the acronym PEMDAS) They knew the right process. However, they thought that they must multiply THEN divide, rather than the correct rule: multiplication and division are done as they occur, from left to right. This mistake in the steps is a PROCEDURAL error.

Evaluate

$24 + 6 \div 2 \times 3$

PEMDAS

$24 + \underline{6 \div 2} \times 3$ Divide

$24 + \underline{3 \times 3}$ Multiply

$24 + 9$ Add

32

The student clearly identifies that "Order of Operations" is being used (they use the acronym PEMDAS). They do all of the right steps, but at the end they added incorrectly, a COMPUTATIONAL mistake.

A fourth type of mistake is simply SECRETARIAL. This type of mistake includes miscopying any part of the problem, misreading your handwriting, misaligning the problem, or any other non-math related issue with how you write out your work.

Post-Test Debriefing

Grade on Test _____

Did I meet my grade goal?

If the grade was less than 100, list three things I could have done to get a better grade.

Can the test be retaken for a better grade? Under what conditions, when, where?

Will this material be on future tests, final exam, etc.?

Write out all incorrect problems with correct answers (attach additional paper as needed).

Test Problem (including directions)

Textbook Reference:
Chapter:
Section:
Example #

Solution

Explanation of Steps

My mistake on this problem was:
- Computational ☐
- Procedural ☐
- Conceptual ☐
- Secretarial ☐

Appendix H

After Test Survey

After Test Survey

1. For the content on THIS test which statement is more accurate?

The instructor provided a lot of academic support to me ______

The instructor provided very little academic support to me ______

2. For the content on THIS test which statement is more accurate?

The instructor encouraged me and supported me ______

The instructor did not encourage and support me ______

3. For the content on THIS test which statement is most accurate?

I was very unfamiliar with this material ______

I had seen this before but was never very good at it ______

I was pretty good at this material before but needed to get better ______

I was very familiar with this material it was a review for me ______

Appendix I

Syllabus for MTH 012

Department Master Syllabus
Camden County College
Blackwood, New Jersey

Course Title: Math Essentials

Course Number: MTH-012

Department/Program Affiliation: Academic Skills Math

Date of Review: February 2012

Date of Last Revision: February 2012

Credits: 1

Contact Hours: Lecture**__1_(non graduation)** Lab__**0**__ Other ____

Prerequisites: None

Co-requisites: Math Fundamentals

Course Description: This course is designed for the college student who needs development in basic numerical processes with whole numbers, fractions, decimals, ratios, proportions and percents, and their applications and needs to develop strategies to help them remember and reconstruct important mathematical ideas (credits do not apply toward graduation requirements).

Course Student Learning Outcomes:

Upon completion of this course, the student will be able to:

1. Perform basic numerical calculations with whole numbers, fractions, decimals, ratios, proportions and percents, and their applications
2. Identify, articulate, and remedy deficiencies in mathematical content as well as study strategies.
3. Implement coping strategies that allow them to function successfully in a mathematics classroom.
4. Define their role in the learning process

Course Outline Math Content:

Whole Numbers	Percents
Fractions	Measurement
Decimals	Data Analysis
Ratio/Proportion	Integers

Course Outline Non-Math Content:

Goal Setting	Reading the Text
Organization	Homework Strategies
Time Management	Study Skills
Test Taking Skills	

Course Activities:

The classroom activities will include formal and informal lectures where material and assigned problems from MTH 011 classes will be explained. Students will have the opportunity to contribute to the discussion and to ask questions about the material. Orientation to computerized tutorials that come packaged with the texts will be conducted. Students will maintain a notebook/portfolio for their MTH 011 course as part of this course. Students will actively engage in identifying issues they having, create a plan of intervention, and implement that plan.

Assessment of Student Learning Outcomes:
At the beginning of the term the instructor is to inform the class of his/her policies concerning all factors that will be considered in arriving at the final grade.

Grading:
P – Passing notebook and satisfactory progress on weekly plans
MP – Failing notebook or unsatisfactory progress on weekly plans
W - Withdrawal
I - incomplete assignments made up within one semester
NA - non-attend
XA – never attended

Factors that are to be considered for the final grade:

A. Attendance.
   Students are expected to attend 100% of the class meetings. A policy by the instructor may include
B. Classwork and homework.
C. Notebook/portfolio
D. Weekly Plans
E. Exam

Course Materials:
Textbooks: Basic Mathematical Skills with Geometry by Hutchison, Baratto & Bergman, 8th Ed.
Math Fundamentals Workbook by Bogardus, Flacche, Freedman, Jackson, Owens, Tannen

Computerized Tutorials: Access Card to Website, Mathzone by McGraw-Hill