

BELIEFS OF COLLEGE ALGEBRA INSTRUCTORS

by

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(Under the Direction of Denise A. Spangler)

ABSTRACT

The high failure rate in College Algebra is a problem for the instructors who teach the course, the administrators of the institutions that offer the course, and the communities those institutions serve. And clearly, failing the course is a problem for the students because it often affects their future course taking and therefore career options. In this study I sought to give voice to instructors because few, if any, studies have considered this problem from the point of view of the instructor and because instructors represent the intersection of the four groups affected by the problem.

The six participants in this study were affiliated with open-admission institutions in Georgia, had at least 10 years experience teaching, and had taught College Algebra multiple times. The participants represented a variety of educational backgrounds and work experiences. Each participant completed a background questionnaire and three interviews. During the third interview, participants were given an opportunity to member check the initial analysis. A second member check was conducted after the third interview.

A modified version of Ernest's (1989) framework was used to analyze the participants' beliefs about mathematics, teaching and learning. One participant expressed an instrumentalist view of mathematics, one participant had a Platonist view of mathematics, and the remaining

four participants had a combination view of mathematics. The participants also indicated beliefs that not everyone could learn mathematics equally well, that technology is not essential to teaching mathematics to adults, and that students are responsible for their own learning despite the fact that adults face many impediments to learning mathematics. With regard to the high failure rate in College Algebra participants' beliefs about the curriculum, administration, instruction, and students were identified.

The conclusions from this study are that there may be a better curriculum for students who will not take calculus, time constraints affect both College Algebra instructors and students, teachers need additional preparation to teach College Algebra, students are not adequately prepared for College Algebra, and self-efficacy issues lead to students failing College Algebra. Each of these conclusions has implications for college administrators and/or College Algebra instructors.

INDEX WORDS: Beliefs, College Algebra, Self-efficacy

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A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial
Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2011

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DEDICATION

I dedicate this work to memory of my mother, Sue Morgan. Her sacrifices throughout her life made it possible for me to choose any path. I also dedicate my dissertation to my husband and our son. I thank my son, Jackson Morgan Hall, for his understanding and encouragement. I thank my husband, Derrell Hall, for the extra responsibility he took on so that I could work on this project.

ACKNOWLEDGEMENTS

I wish to acknowledge the many people who have helped and supported me throughout this process. First, I thank my committee members for being generous with their time and understanding about my slow progress. I thank Denise Spangler, my committee chair, for being an inspiration to me since I first met her many years ago. I thank Sybilla Beckmann for always being encouraging and for helping me believe in myself. Finally, I thank Jim Wilson for challenging me to think and to do my best.

I would also like to acknowledge and thank my participants who gave freely of their time and their thoughts. Without them and their generosity, this project would not have been completed.

I thank all of my co-workers for their patience. Special thanks go to Ken Jarrett for being flexible with my schedule and always encouraging me to do what I need to do to get done. Also, I give special thanks to Bobbi Johnstone who always listened to me and gave me advice and encouragement.

Finally, I thank my friends for their support. In particular, I thank Caroline Angelo, Stephanie Ransom, and Jeremy Ransom, for being willing to entertain my son when I needed to study. And, I also thank Catherina Chang for always being interested in my study and willing to give me advice.

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CHAPTER 1

INTRODUCTION TO THE STUDY

Introduction

My motivation for this study stemmed from the high failure rate of students in College Algebra at Athens Technical College (ATC). In the fall of 2007, 34.5% of students enrolled in College Algebra received grades of D, F, or W in the course (P. Harris, personal communication, March 10, 2008), a phenomenon that is not unique to this particular institution. This failure rate indicates that many individuals failed college algebra. Difficulty with College Algebra is common among learners in the US. For example, in 2007 the college newspaper of Florida International University reported that approximately 70% of College Algebra students withdrew or received a grade of D or F (Concha, 2007), and in the fall of 2002, 41% of College Algebra students at Austin Community College received a W or an F (Owens, 2003). The large number of students failing College Algebra at Athens Technical College is a problem for the students, the administrators, the community at large, and the instructors.

First, the high failure rate in College Algebra is a problem for the students who withdraw from or do not pass the course. Failing the course may prevent them from achieving their educational goals and thus prevent them from meeting other professional, personal, and economic goals. Failure to meet these goals may have ripple effects on other family members, particularly children. Children whose parents did not succeed in college are more likely to live in poverty and less likely to pursue higher education themselves (Baum & Payea, 2005).

Second, the high failure rate is a problem for the college administration. Failing College Algebra can lead to a student leaving the institution or failing to graduate. Funding for schools in the Technical College System of Georgia is connected to the school's retention rate and graduation rate. If a student chooses to leave school or does not graduate as a result of struggling with College Algebra, the school's funding may be diminished, and administrators will have to provide the same services with less money.

Third, the high failure rate is a problem for the community. When students drop out of ATC, the community has a less qualified workforce to attract new business. In choosing a site in North Carolina over the Athens area for its vaccine plant, Novartis cited a need for an educated and well-qualified workforce and noted that the NC universities and technical colleges could provide large numbers of biotech graduates while ATC's current program could only produce 20 per year (Aued, 2006). At the time of this study ATC was attempting to increase the number of biotech graduates. A new building was recently completed to house a larger program, but College Algebra is the required mathematics course for the biotechnology major. Thus if an adequate number of students cannot succeed in College Algebra, we will not graduate a sufficient number of students from the program. Individuals doing poorly in mathematics are also problematic for the larger community of the United States. Because we are graduating fewer students with technical degrees, more jobs are going overseas (Herman, 2004).

Another, not unrelated problem, faced by the community served by Athens Technical College is a high poverty rate. According to the Partners for a Prosperous Athens website (2008), Athens-Clarke County has the fifth highest poverty rate in the nation. Individuals who do not complete an associate's degree are likely to have lower incomes than those with an associate's degree (Baum & Payea, 2005). Thus, one can see a connection between failing or withdrawing

from College Algebra and the poverty rate in Clarke County and surrounding areas. Poverty, which results in part from less education, is a problem for a community on many levels. For example, those with less education pay less in taxes and receive more assistance from social programs such as Temporary Aid for Needy Families, Food Stamps, and Medicaid (Baum & Payea, 2005).

Finally, the high failure rate is a problem for the instructors. The job of the College Algebra instructor is to provide students with experiences and explanations that allow the students to develop a sufficient understanding of the topics. When they are unable to assist students in developing this understanding, teachers can become frustrated or perhaps risk losing their jobs.

I have experienced this problem from all four perspectives. I have served as both a College Algebra instructor and an administrator in charge of hiring part-time or adjunct instructors¹ and scheduling mathematics classes. I have watched my husband struggle with College Algebra—withdrawing from the course twice at ATC and finally transferring to a school that offered mathematical modeling instead. Finally, I am a member of the community that needs qualified workers and taxpayers. My greatest affinity, however, lies with instructors.

Background

In examining why there is such a high failure rate in College Algebra, I chose to focus this study on instructors' beliefs about mathematics, teaching, and learning. Although there is a wealth of research on algebra and teacher beliefs, much of it focuses on the K-12 environment. It is not unrealistic to assume that some of the knowledge gained from research in the K-12 environment may be applied to college level courses, but it is not clear which pieces of

¹ Technically, an adjunct instructor is a college employee who is hired to teach a course separate from other job duties and a part-time instructor is someone who is not otherwise affiliated with the college. But, most people use these terms interchangeably as will I.

knowledge are applicable because the college environment is different in three essential ways: the students are more diverse in terms of age and life experience, the instructors are differently prepared, and the curriculum, at least in Georgia, seems to have been less influenced by the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). In order to know whether results from studies done at the K-12 level are generalizable to the college level, the research would need to be repeated in that environment. This study begins to address this gap in the literature.

Rationale

There are few, if any, studies that consider the problem of the high failure rate in College Algebra from the point of view of the teachers. We need to hear from the College Algebra instructors because they are the people at the intersection of the four groups affected by the problem. Instructors interact with students, administrators, and the community at large. Although students and administrators are members of the larger community, it is not common for administrators and students to interact.

One goal of this study was to give voice to College Algebra instructors by examining their beliefs about why learners are struggling with College Algebra. In addition to giving voice to instructors, the other goal of this study was to develop hypotheses about why students struggle with College Algebra. Generation of these hypotheses promotes future research by giving researchers well-developed hypotheses to test.

Research Questions

Many College Algebra instructors have strong backgrounds in mathematics but little formal education related to teaching or learning. Although they may not have formally studied learning theory or be familiar with educational terminology, these teachers have likely developed

theories of their own regarding how their students learn and what teaching methods are most effective. In this socio-cultural study, I interviewed mathematics instructors with experience teaching College Algebra at institutions that offer associate degrees. The interviews focused on the instructors' beliefs about mathematics, teaching, and learning. I used the following research questions to guide my study:

1. What beliefs do these instructors hold about mathematics as a discipline?
2. What beliefs do these instructors hold about the teaching of mathematics?
3. What beliefs do these instructors hold about adults' learning of mathematics?
4. What do these instructors believe are the causes of the high failure rate in College Algebra?

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Introduction

This study was influenced by literature from several areas within the field of mathematics education: College Algebra, adults learning mathematics, and teacher beliefs. In this chapter, I review the relevant literature in each of these areas and use this literature to develop the theoretical framework with which I analyzed my data.

College Algebra

Although there is an emphasis on K-12 algebra in the literature, there are still many studies that address college level mathematics and College Algebra specifically. These articles fall mainly into four categories: effectiveness studies, predictive studies, bridging the gap studies, and instructor characteristics studies. I will provide a brief overview of each of these categories.

By effectiveness studies, I mean studies that involve testing the effectiveness of a particular aspect of the way College Algebra is taught. For example, Duncan and Dick (2000) examined the effectiveness of collaborative workshops in introductory college mathematics courses including College Algebra, and Adams (1997) explored “the influence of graphing calculators on a teacher’s assessment practices in a College Algebra course” (p. 481). More recently, Gallo and Odu (2009) explored the effectiveness of various ways of scheduling College Algebra courses (one day per week, two days per week, or three days per week). Although these studies contribute to our understanding of the way College Algebra is taught and learned, they do

not usually consider how these variations may work in combination to result in the success or failure of the students.

Researchers do sometimes recognize this limitation. For example, Gallo and Odu (2009) attempted to address it by examining student and teacher attributes that affected student achievement. But the attributes they considered were largely demographic (gender, age, grade level, employment status) or broadly defined (student attitudes toward mathematics, learning styles, teacher self-efficacy, and instructional style). No other specific aspects of teaching or learning College Algebra, such as the use of collaborative groups or specific types of technology, were considered.

By predictive studies, I mean studies in which the researcher attempts to develop a formula that will predict whether a student will succeed in College Algebra based on the attributes of that student. For example, Sigler (2002) and Pedersen (2004) completed these types of studies as part of their doctoral research. It is of interest that both were in fields other than mathematics education. Although these types of studies may be helpful in determining in which mathematics class a student should be placed, I believe that because they do not directly address either the teaching or the learning of mathematics, they are of limited value to someone interested in mathematics education.

Bridging the gap studies focus on the gap between high school and college mathematics courses. I include studies of developmental mathematics courses in this category because bridging the gap between high school and college mathematics is one of the purposes of developmental mathematics courses. Discussions of these studies often begin with the assumption that the high failure rate in College Algebra is due to poor preparation in high school. For example, Jacobson (2006) stated that success depends on “a good high school preparation in

algebra, a preparation that many matriculating freshmen do not have” (p. 138). Similarly, Berry (2003) asked “Students with the ink barely dry on their high school diplomas enroll in college but find themselves back in high school level (or lower) remediation courses. What has gone wrong” (p. 393)?

If poor high school preparation—be it the curriculum or the instruction—were the only factor or even the primary factor leading students to struggle in College Algebra, developmental studies courses should prepare students to take and succeed in College Algebra. There are studies that support this idea. For example, Johnson (1996) found connections between performance in a developmental mathematics course and performance in an entry-level college mathematics course. Jacobson (2006), however, reminded us that we need to look at overall retention as well as the number of College Algebra students who succeed after taking a developmental mathematics course. He stated,

If, for example, the first DM [developmental mathematics] course filters out a large number of students, so that very few become eligible for the second, the success rate for these few in the second course could be very high. This number by itself would indicate a successful DM program even though very few students get through it. (p. 139)

At his institution, for example, in the fall of 2001 only 43% of students successfully completed intermediate algebra, the course immediately preceding College Algebra.

One aspect of developmental studies courses and College Algebra courses that has been explored by several researchers is the characteristics of the instructors. Many of these instructor characteristics studies focus on the effect of instructor’s employment status on student success. This topic is essential to consider when examining the high failure rate in College Algebra because so many sections of the course are taught by adjuncts. For example, a review of the Athens Technical College fall quarter 2009 online schedule revealed that 11 of the 15 sections of College Algebra and 17 of 22 developmental level courses offered were taught by adjuncts

(Athens Technical College). Whether the employment status of the instructor has an effect and if so whether the effect is positive or negative is not clear. Penny and White (1998) found through a correlational analysis that students taught by part-time instructors in their last developmental mathematics course and by full-time instructors in College Algebra received higher grades in the developmental mathematics course and lower grades in College Algebra than students taught by full-time instructors in both courses. Burgess and Samuels (1999) found similar results. They looked at student performance in consecutive mathematics courses and concluded that students who took the first course from a part-time instructor did not perform as well in the second course as students who had taken the first course from a full-time instructor.

In a more recent study, Fike and Fike (2007) concluded that “even though the majority of community college faculty are part-time instructors, students are not adversely impacted” (p. 6). But, unlike the studies cited above, Fike and Fike looked only at performance in the developmental mathematics course and not at subsequent performance in a college level course. They acknowledge their “findings might only be applicable to developmental mathematics programs at community colleges” (p. 8). Fike and Fike did, however, find a positive relationship between student performance and education level (bachelor’s degree or advanced degree) of the instructor. Burgess and Samuels (1999) did not address the education level of the participants, but all of the participants in Penny and White’s (1998) study had advanced degrees. Although Penny and White’s results imply that full-time faculty with advanced degrees are preferable to part-time faculty with advanced degrees, we are still left with the question of whether a part-time instructor with an advanced degree is, in general, preferable to a full-time instructor with only a bachelor’s degree. This question, of course, only applies to developmental studies courses

because accreditation requirements call for instructors of college level courses to have at least a master's degree.

This leads us to an unanswered question that is at least 40 years old—what is the best academic preparation for a mathematics instructor at the two-year college? Laible (1970) suggested that “he needs to be better prepared mathematically than does his counterpart at the secondary level” and “he needs to have better preparation in motivating students and, frequently, in teaching remedial courses than does the usual college or university teacher” (p. 55). Although this claim seems reasonable, there does not appear to be research either to support or refute his claim.

Adults Learning Mathematics

There are many opinions as to what defines an adult, but most agree that age is not the primary consideration. Evans (2000), for example, emphasized that an adult can fall into a range of ages but is someone who participates in many activities including some outside the home, has a variety of social relationships, has the ability to participate in paid or voluntary work, and is socially and politically aware. For the purposes of this study, the simpler definition provided by Fitzsimons and Godden (2000) is more appropriate. They state that adults are “those persons who are of an age or status where education is post-compulsory in their particular society” (p. 14).

When discussing adults learning mathematics, many authors discuss individuals' abilities to do mathematics outside of the classroom with greater ease than many adults seem to be able to perform in the classroom. Coben (2000) described this phenomenon as invisible mathematics, which she defined as mathematics a person can do but which the person does not think of as mathematics. She explained that invisible mathematics is problematic because people do not see

themselves as being able to do mathematics, and this failure to recognize their own abilities can limit their success. There are instances of people doing invisible mathematics throughout the literature. For example, Llorente (2000) described an uneducated woman who could correctly use proportionality when making jam but could not explain and likely could not apply in another setting the mathematics she was using. Similarly, Wedege (1999) discussed her mother, a draughtsman, who regularly did applied mathematics on the job and in running her home but did not see it as such. Wedege's mother viewed herself as being poor at mathematics throughout her life. Wedege recognized this emotional aspect of her mother's learning and even went so far as to say that for adults "Emotional factors are just as important as cognitive ones in the psychological learning process" (p. 206).

Many other authors also recognize an emotional element to adults learning mathematics (Burton, 1987; Coben, 2000; Colwell, 2000; Evans, 2000; Fitzsimons & Godden, 2000; Maxwell, 1999; O'Donoghue, 2000; Safford 2000). Although some of these authors describe an extreme fear or anxiety regarding the learning and doing of mathematics (Evans, 2000; Maxwell, 1989), I believe a better construct for describing the emotional element of learning College Algebra is self-efficacy. Bandura (1977) developed this construct and defined self-efficacy as one's belief about whether he can or cannot succeed at a particular task. But, as Pajares and Miller (1994) pointed out, one must not confuse self-concept with self-efficacy. Self-concept is a broader idea than self-efficacy. Pajares and Miller noted that the question "Are you a good math student?" gets at a person's self-concept while the question "Can you solve this specific problem?" gets at a person's self-efficacy (p. 194).

Self-Efficacy Theory

Bandura (1977) identified four elements that can influence a person's self-efficacy: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. The term performance accomplishments refers to a person's past experiences with a given situation. In terms of succeeding in College Algebra, past success with a particular type of problem would lead to a stronger self-efficacy, while past failures would lead to a weaker self-efficacy regarding one's ability to solve the problem. Past performance is particularly important in College Algebra because students will have had experience with most if not all of the problem types in the course. It is also fair to refer to a person's self-efficacy with regard to a course. Many students take College Algebra multiple times. Based on past performance, a person taking the course for a second or third time likely has poor self-efficacy regarding successfully completing the course.

Vicarious experience is what we see others accomplish. Seeing others successfully complete a particular type of problem may lead individuals to believe they can solve problems of that type as well. In addition, seeing someone of similar abilities successfully complete the course could lead a person to believe he can succeed in the course as well. In contrast, an institution with a high failure rate in College Algebra is providing students with many negative vicarious experiences, leading students to believe they cannot succeed in College Algebra.

Verbal persuasion refers to what others tell us we can accomplish. For example, a teacher telling a student he is capable of solving a particular type of problem or of succeeding in College Algebra may strengthen that student's self-efficacy. Similarly, being told that one is not capable or will never pass the course can weaken one's self-efficacy.

Emotional arousal refers to the physical reaction a person has to a given situation. If someone experiences a heightened physiological arousal, anxiety, when sitting in a College Algebra classroom, solving a particular type of problem, or taking a mathematics test, the person's self-efficacy may be weakened.

Self-efficacy is important because it predicts performance, influences course and career choices, and affects the persistence one has at a task. Although Bandura did not necessarily develop this construct with mathematics education in mind, in the time since he developed it, many researchers have applied it to mathematics education.

Some authors have looked at the connection between self-efficacy and performance in mathematics classes and have found a strong connection for school age children (Pietsch, Walker, & Chapman, 2003; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004) and among college students (Hackett & Betz, 1989; Hoffman & Spataru, 2008; Pajares & Miller, 1994, 1995). Not all studies have found this connection. Walsh (2008), who studied associate degree seeking nursing students and the specific task of completing a medication mathematics test, did not find a relationship between mathematical self-efficacy and performance on the test. She did note that the "participants in this study generally possessed confidence in their ability to accurately perform basic and complex mathematics tasks" (p. 228). So, there may not have been enough variation in student's self-efficacy to see a resulting variation in performance. Pajares and Miller (1994) found that students are often over-confident in their ability to perform a mathematical task, but even given that over-confidence, self-efficacy is still an excellent predictor of performance. Obviously, self-efficacy is not the sole predictor of one's performance in a mathematics course.

Authors have also looked at the connection between self-efficacy and a student's choice to pursue a career that requires one to take mathematics courses. Betz and Hackett (1983) found that "students reporting stronger mathematics self-efficacy expectations were more likely to select science-based college majors than were students reporting weaker expectations of efficacy with regard to mathematics" (p. 342). Lent, Lopez, and Bieschke (1991) noted that the results of their study supported the results of Betz and Hackett (1983), and O'Brien, Kopala, and Martinez-Pons (1999) found similar results with high school students. In terms of this study, one could hypothesize that if a person has a low self-efficacy with regard to College Algebra, the person would be less likely to choose a major or career that requires completion of the course. As was stated in Chapter One, the fewer students we have pursuing these majors in the Athens area, the less qualified our workforce and the less attractive we are to new businesses.

Self-efficacy affects a student's motivation in a given course. In particular, students are more likely to persist in a task if they believe they can accomplish the task. Bandura (1993) stated that "Self-efficacy beliefs contribute to motivation in several ways: They determine the goals people set for themselves, how much effort they expend, how long they persevere in the face of difficulties, and their resilience to failures" (p. 131). He went on to note that "Strong perseverance usually pays off in performance accomplishments" (p. 131). In terms of College Algebra, a student cannot be successful in the course without persevering to the end of the course. Students with poor self-efficacy related to College Algebra are more likely to give up on the course when faced with a concept they have difficulty understanding.

Pajares and Miller (1994) put it well when they said,

Classroom teachers may well be impressed by the force of theory arguing that self-efficacy beliefs are important determinants of performance, but they are apt to be more interested in ways to alter these beliefs when they are inaccurate and debilitating to children. (p. 201)

Many authors have looked at methods classroom teachers can employ to improve student self-efficacy. The methods suggested center around three of Bandura's (1977) four elements that can influence a person's self-efficacy: performance accomplishments, vicarious experience, and verbal persuasion. Siegle and McCoach (2007) found that with relatively little training teachers can learn and implement strategies related to these three elements that help build student self-efficacy.

Performance accomplishments are the strongest indicator of a person's self-efficacy related to a task (Bandura 1993). Siegle and McCoach (2007) believe that students sometimes have trouble recognizing their performance accomplishments. They state that "Sometimes students are unaware of their abilities or the progress they are making" (p. 284). Both Siegle and McCoach (2007) and Margolis and McCabe (2006) suggest ways teachers can help students have and recognize performance accomplishments. Margolis and McCabe suggest teachers plan moderately challenging tasks. The tasks should not be simple for the learner but should be something the learner can accomplish. Similarly, Siegle and McCoach believe that setting specific goals will allow students to better gauge their progress and see their successes. By successfully completing specific tasks and by recognizing that specific goals have been met, the learner's self-efficacy will improve, which will in turn make the learner more likely to persist with similar tasks in the future and achieve further success.

Although not all vicarious experience occurs in the classroom or can be controlled, there are ways that teachers can create vicarious experiences through peer modeling and videos that may positively influence student self-efficacy. Both Siegle and McCoach (2007) and Margolis and McCabe (2006) suggest using peer models as a type of vicarious experience. Both note that the more similar the model is to the learner, the more likely the experience is to improve the

learner's self-efficacy. Margolis and McCabe suggest using models for both content demonstrations and learning strategy demonstrations and state that models should attribute successes and failures to controllable factors so that learners believe they also have power over succeeding or failing. In addition to straight peer modeling, Siegle and McCoach also encourage teachers to use group work as group work provides "students with an opportunity to observe a variety of peer models" (p. 305).

Rather than using peer models, Hekimoglu and Kittrell (2010) suggest showing a video, such as the documentary *The Proof* (Lynch & Singh, 1997), to provide a vicarious experience that improves student self-efficacy. *The Proof* tells the story of Andrew Wiles's long struggle to prove Fermat's Last Theorem. Although students are not likely to see Wiles as similar to themselves, Hekimoglu and Kittrell hope that seeing a professional mathematician struggle with a problem will help students see that struggling with mathematics does not mean you are bad at it and will help them understand that hard work and persistence are the keys to being successful in a mathematics class. After showing this documentary to students in College Algebra, pre-calculus, and calculus, Hekimoglu and Kittrell found that "Across all classes, most students said that seeing the documentary encouraged them to work harder in order to understand the concepts" (p. 316).

Both Siegle and McCoach (2007) and Margolis and McCabe (2006) recognize teacher feedback as a type of verbal persuasion. Both suggest teachers can influence self-efficacy by stressing recent successes and by explicitly explaining how the current tasks resemble tasks the learner has successfully completed. Both also recognize the importance of giving frequent task-specific feedback. Siegle and McCoach emphasize that general comments such as "Good job!" are not as beneficial as task-specific compliments such as "You are getting good at completing

the square.” They state that the latter type of comment “gives the student more information to cognitively appraise his or her progress” (p. 304). Margolis and McCabe support this view and explain that “When teachers focus task feedback on what struggling learners did correctly and on the steps necessary for improvement, they give learners a map for success, which often strengthens their self-efficacy” (p. 224).

Both Siegle and McCoach (2007) and Margolis and McCabe (2006) also suggest that teachers regularly encourage students to try by emphasizing that a lack of effort leads to failure, while hard work is the key to success. Margolis and McCabe suggest teachers verbally persuade students by “telling them success is likely if they make the effort, persist, and correctly use previously learned strategies” (p. 223). Margolis and McCabe emphasize that comparing a student’s current performance to his previous performance can be beneficial but warn against comparing one student to another.

Teacher Beliefs

This study is also informed by the literature on teacher beliefs. The Meriam-Webster online dictionary offers multiple definitions of “belief,” but the one that is most appropriate when discussing teacher beliefs is a “conviction of the truth of some statement or the reality of some being or phenomenon especially when based on examination of evidence.” Teachers have a conviction about what they believe mathematics is, whether they can articulate it or not. Ernest (1989) pointed out that “Teachers’ conceptions of the nature of mathematics by no means have to be consciously held views; rather they may be implicitly held philosophies” (p. 250).

Teachers’ beliefs are important because they influence teacher actions. Humans do not want to experience cognitive dissonance, so teachers will either alter their actions to coincide with their beliefs or alter their beliefs to coincide with their actions.

Although much of the research on teacher beliefs is focused on teachers at the K-12 level, there are two recent studies similar to the one I conducted. Katner (2008) explored the ways in which instructors' philosophies of mathematics shaped mathematics instruction in community colleges, and Li (2009) examined instructors' conceptions of mathematics, teaching, and learning. Although these studies are similar in nature to my study, they differ significantly with regard to the participants.

Katner (2008) limited her participants to full-time faculty. Not including adjunct faculty members in her study limits the significance of her study because many community college level courses are taught by adjuncts. For example, as described earlier, more than half of the College Algebra sections at Athens Technical College in the fall of 2009 were taught by adjuncts. Katner chose to limit her participants to full-time faculty members because she wanted to guarantee "the participants had full understanding of the institutional policies structuring their professional practices" (p. 6). Because the focus of my study is the high failure rate in College Algebra, I wanted to know if part-time instructors felt disconnected from the institution in which they were teaching, and, if so, how they thought this affected their teaching and their students' learning.

Li's (2009) participants were teaching assistants "in their first or second year of their graduate studies in mathematics. Most of them plan to earn a master [sic] degree then find a job as college mathematics instructors" (p. 5). This group would seem to correspond to pre-service teachers at the elementary and secondary level who are in the process of developing their beliefs about mathematics, teaching, and learning. With this group, the goal of the researcher is often to understand how the beliefs are developed in order to help teacher educators effectively challenge a student's existing beliefs about mathematics, teaching, and learning. I was not necessarily interested in how the beliefs were formed but rather in what they were. I was not directly

interested in how to educate future mathematics instructors but rather in why so many students fail College Algebra. It may be that College Algebra instructors need better preparation, but that would be a hypothesis that results from my study rather than initiates it. Therefore, unlike Li (2009), my participants were experienced teachers who were more likely to have firm beliefs developed over time and based on experiences as teachers in the classroom.

Although changing the participants' beliefs was not a goal of this study, I do hope I have given participants an opportunity to reflect on their views of mathematics and their experiences in teaching mathematics. In the literature on teacher beliefs, we see a consistent connection between reflection and the changing of a teacher's beliefs. The importance of reflection is sometimes discussed explicitly (Cooney, Shealy, & Arvold, 1998; Ernest, 1989; Mewborn, 1999; Richardson & Placier, 2001; Thompson, 1984) and other times implied (Cooney, 1985; Jaworski, 1989; Nathan & Koedinger, 2000). But, Mewborn (1999) warned that "Merely providing preservice teachers with opportunities to reflect and activities that encourage reflection does not guarantee that reflection will occur" (p. 317). Although she was discussing preservice teachers, I believe the statement applies to all teachers at all levels.

Although not directly based on research with college instructors, the frameworks utilized by researchers studying K-12 teacher beliefs may be applicable to college instructors (Cooney, Shealy, & Arvold, 1998; Ernest, 1989; Katner, 2008; Li, 2009; Mewborn, 1999). For example, Ernest (1989) provided a nice framework for discussing mathematics teacher's beliefs and the relationship of those beliefs to the teaching and learning of mathematics. He identified three components of the mathematics teacher's belief system that correspond directly to my research questions: the view of the nature of mathematics, the view of mathematics teaching, and the view

of mathematics learning. Ernest identified three philosophies of mathematics and tied each to a corresponding view of teaching and learning.

First, Ernest (1989) defined the instrumentalist view as one in which mathematics is seen as “an accumulation of facts, rules, and skills to be used in the pursuance of some external end” (p. 250). He asserted that this view of mathematics is most often linked to the instructor model of teaching. In this model, the teacher strictly follows a textbook or imposed curriculum and sees the intended outcome of teaching as the students’ “skills mastery with correct performance” (p. 251). A person with this point of view will also likely see learning as a student’s “compliant behaviour and mastery of skills” (p. 251).

Second, Ernest (1989) defined the Platonist view as one in which mathematics is seen as a “static but unified body or certain knowledge. Mathematics is discovered, not created” (p. 250). He posited that someone with this view of mathematics is likely to see the role of the teacher as that of explainer with the intended outcome of teaching being the students’ “conceptual understanding with unified knowledge” (p. 251). Teachers who follow this model will modify approaches found in textbooks and enrich given curricula with supplementary exercises. This teacher is inclined to see learning as the “reception of knowledge” (p. 251).

Finally, Ernest (1989) defined the problem-solving view as one in which mathematics is seen as “a dynamic, continually expanding field of human creation and invention, a cultural product” (p. 250). Teachers with this view of mathematics tend to see their role as that of facilitator with the goal of their teaching being the development of

confident problem-posing and problem-solving students. In this model, the teacher is not reliant on a particular textbook, but will often use a curriculum constructed by him or the school. This teacher will view “learning as the active construction of understanding, possibly even as autonomous problem-posing and problem-solving. (p. 252)

Ernest (1989) conjectured that these the three views of mathematics and their associated views of teaching and learning have a hierarchy with the instrumentalist view at the bottom, followed by the Platonist view, and then the problem-solving view. Ernest explained that these views are translated into classroom practices but acknowledged that a person's espoused views may not always directly influence practice. He identified two reasons for the disparity between belief and practice: social context and the level of the teacher's thought. The social context is comprised of the expectations of the other stakeholders in the classroom: students, administrators, parents, other teachers. Ernest noted that "despite having differing beliefs about mathematics and its teaching, teachers in the same school are often observed to adopt similar classroom practices" (p. 253). The level of the teacher's thought affects how conscious the teacher is of her beliefs and how reflective she is about the connection between her beliefs and her practice.

Theoretical Framework

I expanded upon Ernest's (1989) framework to develop a theoretical framework with which to analyze my data and answer my research questions. I began by suggesting a fourth view of mathematics, which I will call the combination view as it combines the Platonist view and the problem-solving view described by Ernest. This view separates mathematics from our understanding of mathematics. Mathematics exists whether there is anyone here to understand it; it is a thing unto itself not created by humans. But, we as humans create an understanding of mathematics, and our understanding is constantly evolving. I would use the words Ernest (1989) used to describe mathematics to describe our understanding of mathematics: "a process of inquiry and coming to know, not a finished product, for its results remain open to revision" (p. 250).

In my framework for analyzing my data, I used the three roles of the teacher suggested by Ernest (1989): the instructor who strictly follows the text or externally imposed scheme, the explainer who modifies the textbook or externally imposed curriculum, and the facilitator who participates in the construction of the curriculum. I did not add any additional roles to correspond with my additional view of mathematics as I hypothesized that the facilitator role would be appropriate for this view. Although I tried to draw connections between the participants' views of mathematics and their views of teaching, I also explored the limiting factors they faced in teaching. In particular, I focused on how the social context in which the person taught affected the person's ability to teach the way she thought she should. The culture in which my participants lived, taught, and learned affected their beliefs about learning, teaching, and mathematics and how they acted on these beliefs.

When analyzing the data for the research question about the teachers' beliefs about the learning of mathematics, I used the four models proposed by Ernest (1989): “1 compliant behaviour and mastery of skills model, 2 reception of knowledge model, 3 active construction of knowledge model, 4 exploration and autonomous pursuit of own interests model” (p. 251). Again, I did not add any other models to correspond with the additional view of mathematics as models three and four are appropriate. I did, however, also look at the constraints the social context may apply to learning as it did to teaching.

Combination View of Mathematics

The combination view of mathematics, which I added to Ernest's (1989) framework, comes from the development of my own view of mathematics. Crotty (2003) emphasized the distinction between ontology and epistemology. He explained that ontology is “a certain way of understanding *what is*” while epistemology is “a certain way of understanding *what it is to*

know” (p. 10). This distinction is important for me. Ontologically speaking, I am a realist, which means I believe that realities exist outside the mind. I believe that there is an absolute truth and that mathematics exists unto itself. For me, this belief is an act of faith. I do not believe that the existence of reality outside the mind can either be proven or disproven. So, I do not attempt to prove my belief.

Often realism in ontology is associated with objectivism as an epistemology. Although I consider myself a realist, I am not an objectivist. Crotty (2003) said the objectivist believes that “careful research can attain that objective truth and meaning” (pp. 5-6). I believe that we aspire to understand the absolute truth that exists, but I do not believe that we can attain a full understanding of the objective truth and meaning of reality. All we can ever know is our individual understanding of reality; we cannot know whether our understanding exactly matches reality. For this reason, the reality that exists outside our minds is irrelevant and what matters is our understanding of that reality. So, my epistemology fits more with what Crotty (2003) called constructionism, and as Crotty asserted “Realism in ontology and constructionism in epistemology turn out to be quite compatible” (p. 11).

Crotty (2003) defined constructionism as “the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context” (p. 42). He went on to say that constructionists believe “Before there were consciousnesses on earth capable of interpreting the world, the world held no meaning at all” (p. 43). But, if one believes that the world was created by a conscious being, then the world and everything in it has always had meaning. In particular, mathematics has always existed in a meaningful way. So, my epistemology does not exactly fit with constructionism. I believe that

we are constructing our understanding of the meaning and in particular the mathematical meaning that has always been there. The role of the teacher is to help students construct an understanding of mathematics.

Although each person develops his or her unique understanding of reality, the culture in which an individual lives strongly affects a person's understanding. Individuals are unlikely to develop an understanding that directly conflicts with the culture's understanding. Usually changes in cultural understanding evolve over generations. Individuals who challenge cultural beliefs are often not appreciated as great thinkers until later generations reflect back on them. For example, Galileo faced persecution for his support of the idea of a heliocentric universe during his lifetime but is now revered as one of the greatest thinkers of all time.

Theoretical Lens

In addition to explaining the framework I will use to analyze my data, it is also relevant to discuss the lens through which I processed the data. Both Crotty (2003) and Cobb (2007) discussed constructivism and how it differs from social constructionism or sociocultural theory. Crotty (2003) said constructivism “points up the unique experience of each of us. It suggests that each one's way of making sense of the world is as valid and worthy of respect as any other” and in contrast “social constructionism emphasises the hold our culture has on us: it shapes the way in which we see things (even the way in which we feel things!) and gives us a quite definite view of the world” (p. 58). This idea that constructivism and social constructivism or sociocultural theory are interested in different aspects of the same phenomenon is supported by Cobb. Cobb (2007) said that “In a very real sense, the two groups of researchers are attempting to understand different realities” (p. 22), and I agree with this statement. I see a constructivist perspective as

focusing on the individual and the constraints affecting that individual. In contrast, I see sociocultural theory as focusing on a group of people and the constraints affecting that group.

Cobb (2007) implied that research that focused on student learning or which has the purpose of designing instructional activities benefits from the use of a constructivist lens. As a teacher in the classroom, I would use this perspective. In the role of a teacher, I am trying to understand the reality of each of my students, and I would use the information gathered to inform my teaching of these particular individuals. If I were concerned with how individuals are developing mathematical ideas or my purpose was to design instructional activities, I would employ a constructivist perspective. However, because my study focused on teachers and their perspectives as members of the college culture, I believe sociocultural lens is a more appropriate perspective.

Cobb (2007) asserted that sociocultural theory is useful for studies that “take account of [the] institutional setting of teaching and learning” (p. 28). This perspective fits well with my goals for the study. I was not trying to change what is happening in the classroom, but rather I was trying to understand, from the teachers’ perspectives, what constraints were placed on them that affect what happens in the classroom. I see four distinct cultures that affect the College Algebra classroom: the culture of mathematics, the culture of the instructors, the culture of the college, and the culture of the students. Of the stakeholders in the issue of the College Algebra failure rate, only the College Algebra instructors directly participate in each of these cultures. I believe what happens in the classroom is affected by the teacher’s understanding of and participation in the each of these cultures.

Sociocultural theory provided an appropriate theoretical perspective for my study because the teachers were participants in the established culture of the colleges in which they

taught. Their teaching cannot be separated from the constraints imposed on them by students, administrators, etc. Cobb (2007) stated

Teachers' instructional practices are profoundly influenced by the institutional constraints that they attempt to satisfy, the formal and informal sources of assistance on which they draw, and the materials and resources that they use in classroom practice... Analyses that document these affordances and constraints can inform the development of designs for supporting teachers' learning. In particular, they orient researchers and teacher educators to consider whether their collaborations with teachers should involve concerted attempts to bring about change in the institutional settings in which the teachers have developed and revised their instructional practices. (p. 25)

CHAPTER 3

METHODOLOGY

According to Burton (2002), one's methodology should not be an explanation of how data were collected, but rather an explanation of why data were collected in a particular way. Thus, this section will address not only the methods employed in the study, but also the rationale for the choice of methods, the limitations imposed by those choices, and the assumptions inherent in the choices.

Setting

This study was not conducted in a single setting, but each of the participants was associated with an open-admission institution in Georgia that offers developmental studies courses and College Algebra. Three of the affiliated institutions were two-year technical colleges. The fourth institution was a former junior college that continued to offer associate degrees in addition to granting bachelor's degrees.

Participants

This study focused on the beliefs of individuals who teach or have taught College Algebra, so the main selection criterion was experience teaching College Algebra. The six participants in this study were chosen using a network selection process. deMarrais (2004) explained that in this process, the researcher locates participants who meet the selection criteria and then those participants suggest other individuals who meet the selection criteria.

Although my study was inspired by the high failure rate in College Algebra at Athens Technical College (ATC), I did not limit my participants to ATC instructors. Including

instructors from other institutions was necessary for two reasons. First, choosing participants affiliated with multiple institutions allowed me to consider the culture of the college as a variable to be investigated. Second, limiting the study to ATC instructors would have taken away from the participants' anonymity, which could have inhibited what they were willing to say.

Because my interest was not in how these individuals developed their beliefs but rather in what their beliefs were, I did not limit myself to instructors who were currently teaching College Algebra. Instead, I sought participants who had taught for many years and who had enough experience with teaching mathematics to have well formed beliefs about mathematics, teaching, and learning. This is not to say that these individuals' beliefs about these topics cannot and will not change but that their beliefs are based on what has happened, not on what they expect to happen. All of my participants had at least 10 years teaching experience, and all but one had at least five years of experience teaching College Algebra. In contrast to someone with 10 or more years of teaching experience, someone who is in her first or second year of teaching is more likely to still be forming her beliefs about mathematics, teaching, and learning.

In addition to my participants' years of experience, they also represented a variety of educational backgrounds and had experience in a variety of settings. It was important to include people with degrees only in mathematics and people with degrees in mathematics education so that I could consider whether a difference in educational background correlated with a difference in beliefs about mathematics, teaching, learning, and the high failure rate in College Algebra. Three of the six participants had only degrees in mathematics. One of the other three had only degrees in mathematics education, and the remaining two participants had degrees in both mathematics and mathematics education. The participants had taught in a variety of educational settings, which allowed me to consider whether experience teaching at different levels correlates

with differences in beliefs. Only two of the six participants had taught exclusively at the college level. The remaining four had at least one year of experience teaching at the middle or high school level. The one participant with less than five years of experience teaching College Algebra had the widest variety of teaching experience. She had taught everything from elementary school up through graduate level courses for teachers. The study also included two participants with administrative experience, which allowed for some insight into the intersection of the culture of the instructor and the administration.

It was also important to include individuals with experience as adjunct instructors. College Algebra is a course often taught by adjuncts. For example, in the fall of 2009, 73% of College Algebra sections at ATC were taught by adjuncts (Athens Technical College). Because of their less central role in the culture of the college, instructors with experience teaching as adjuncts may be affected by different constraints and have different beliefs about teaching, learning, and the causes of the high failure rate in College Algebra. At the time of the study, two of the six participants were working as adjunct faculty. Both of these individuals had previously been full-time faculty. In addition, one of the participants who was teaching full-time had extensive experience working as an adjunct at multiple institutions.

Data Collection

The primary method of data collection for this study was interviews with the participants. The initial interview protocols were developed using ideas from the literature on teacher beliefs and the literature on College Algebra. The similes regarding mathematics, teaching, and learning used in Interview Protocol #1 (Appendix 2) and Interview Protocol #2 (Appendix 3) were based on those used by Cooney, Shealy, and Arvold (1998). Prior to beginning formal data collection, I piloted my interview protocols with someone who met the criteria for being a participant in my

study. Based on this pilot, I removed some questions from the interview protocol and used them to create a questionnaire for participants to complete prior to the first interview. The purpose of the questionnaire (Appendix 1) was to collect background information such as education and work history. Asking these questions in this format rather than as part of the first interview reduced the amount of time required for the first interview.

Following the questionnaire, three interviews were conducted with each participant. The duration of the interviews varied greatly based on the talkativeness of the participant, but most were in the thirty-minute to one-hour range. The purpose of the first interview (Appendix 2) was to explore the interviewee's view of mathematics. The second interview (Appendix 3) focused on teaching and learning of mathematics. It was important to discuss teaching and learning in the same interview because these topics are often intertwined. The third interview (Appendix 4) allowed for member checking of the first two interviews and specifically addressed the topic of the high failure rate in College Algebra.

Following my analysis of the third interview, I sent each participant an email (Appendix 5) with five themes I identified across all participants related to the high failure rate in College Algebra and asked them to rank the themes in order of importance. Participants were allowed to give multiple themes the same rank or to leave off a theme they did not think was relevant. In addition, they were encouraged to comment on why they ranked the items in that order. This email allowed for additional member-checking of the third interview. Member-checking was an essential method to use because of my assumption that my participants are my peers and are capable of understanding and reflecting on their own belief systems. In addition, allowing participants to comment on my interpretations of their words added validity to my study.

Studies on teacher beliefs often include classroom observations, but this study did not. One reason for this choice is that this study was intended to focus on the instructors and not on the classroom culture. Another reason for this choice was that making an effort to check that the instructors' stated beliefs were supported by their actions could have been insulting to my participants and changed the tone of my research. The most important assumption I made with regard to my study was that my participants care and think about both their teaching and their students' learning. My intention was not to validate their stated beliefs but to give voice to them.

Researcher Bias

In a qualitative study, it is essential for the researcher to identify and address personal biases. Prior to beginning the participant interviews, I participated in a bracketing interview. deMarrais (2004) defined a bracketing interview as one in which the researcher is "interviewed by another researcher often using the same question he or she plans to use in his or her study" (p. 58). A bracketing interview is an important method for this study because while I was the researcher, I also meet the criteria to be a participant. Because this was a sociocultural study, I needed to recognize myself as a member of the cultures I was studying. deMarrais (2004) suggested that conducting a bracketing interview would allow me to understand the assumptions and beliefs I brought to the study. It was important for me to recognize my own beliefs with regard to mathematics, teaching, learning, and College Algebra so I could distinguish my beliefs from those of my participants.

Data Analysis

I began analyzing my data during the data collection process. This preliminary analysis involved listening to the recordings of the interviews multiple times and then summarizing each

participant's beliefs about mathematics, teaching, and learning. These summaries were presented to each participant for member checking in order to allow me to triangulate my data.

Following the completion of all three interviews, the interviews were transcribed by a third party and returned to me. Upon receiving the transcripts from the third party, I listened to the interviews while reading the transcripts to check for correctness and completeness. While listening to the interviews, I began an initial association of themes with each of the research questions (Appendix 6). For example, when discussing the use of computers in the classroom, it did not seem the participants saw them as an integral part of teaching mathematics. Instead, they primarily discussed using the computer as a content delivery system or as a testing tool. Thus, for the question *What beliefs do these instructors hold about the teaching of mathematics?*, I identified the theme *technology is not essential to the teaching of mathematics*. Similarly, participants often referred to the usefulness of mathematics as being a reason for students to study mathematics at the college level. So, for the question *What beliefs do these instructors hold about mathematics as a discipline?*, I associated the theme *mathematics is important for people to understand because it is useful; not everyone appreciates its usefulness*. Although this theme may seem to incorporate two separate ideas, I grouped them together because the ideas should be analyzed and discussed together. I used similar grouping for other ideas that were closely tied together and should be analyzed and discussed together. For example, another theme associated with *What beliefs do these instructors hold about mathematics as a discipline?* is *mathematics is beautiful; not everyone appreciates its beauty*.

With the theme *technology is not essential to the teaching of mathematics*, it seemed appropriate to identify sub-themes regarding why technology is not essential. Two such sub-themes were *technology is primarily a method for delivering content* and *technology can hinder*

learning. Similarly, when considering the theme *adults face many impediments to learning mathematics in college* under the question *What beliefs do these instructors hold about adults' learning of mathematics?*, it seemed important to identify sub-themes related to the specific impediments they may face: emotional baggage, lack of study skills, life responsibilities, too much reliance on tutors and tutorials. Each of these could have been a theme unto itself instead of a sub-theme, but these impediments should be discussed and analyzed together.

The process for identifying themes for the fourth research question, *What do these instructors believe are the causes of the high failure rate in College Algebra?*, was slightly different. I began by identifying four broad themes or categories from the data that can have an impact on College Algebra: student issues, curriculum issues, administrative issues, and teacher issues. Then as I listened to the interviews and identified sub-themes, I placed them under the correct theme. For example, the participants frequently referred to not having sufficient time to cover all of the College Algebra topics as in-depth as they would like. These comments resulted in the sub-theme *too much material for time allowed* under the theme curriculum issues. Similarly, participants referred to College Algebra being used by the administration as a filter or a way of distinguishing weaker students from stronger students. This topic was identified as the sub-theme *use of College Algebra as a weed out course* under the *administrative issues* theme.

Similar themes were associated with more than one question. For example, *Not everyone can understand mathematics at the same level* is a theme under *What beliefs do these instructors hold about mathematics as a discipline?* and *not all people can learn mathematics equally well* is a theme under *What beliefs do these instructors hold about adults' learning of mathematics?* Although having such similar themes may seem redundant, it is essential to a thorough analysis of the data. Not only must these ideas be analyzed separately with regard to each research

question, but a thorough analysis of the data may require discussing how beliefs in one area affect beliefs in another.

Following the development of the themes, I went through each printed transcript to identify where each theme was discussed by each participant. Although this process was essential in order to analyze my data and produce my results, it also served to help me determine which themes were most relevant and to create my final data collection tool. In order to member check interview number three, I identified five potential reasons for the high failure rate in College Algebra and sent them listed alphabetically to the participants to rank. This process, in addition to the member checking in interview three, allowed me to triangulate my data.

The five reasons included in the email were chosen based on an initial analysis of the fourth research question: *What do these instructors believe are the causes of the high failure rate in College Algebra?* I included one sub-theme from three of the four themes (curriculum issues, administrative issues, and teacher issues) and two from the fourth issue (student issues). Two sub-themes were chosen from *student issues* because this theme was the most commonly discussed. From this theme, I chose the two most commonly discussed sub-themes: *lack of sufficient studying* and *lack of belief that they can succeed in College Algebra*. For the remaining themes, I chose the sub-theme that was discussed by all six participants: *too much material for time allowed*, *student placement in College Algebra*, and *students are not adequately prepared*. These data were analyzed by giving each rank a numerical value: five points for a ranking of number one down to one point for a ranking of number five. The purpose of this analysis was solely to support the analysis of the qualitative data.

The final analysis of the data involved synthesizing what the participants said related to each research question and then comparing and contrasting the beliefs of the individual participants to identify any common beliefs. Common beliefs about why students do not succeed in College Algebra can be turned into hypotheses that can be tested with further research.

Limitations

As a qualitative study, this research is limited in the results it can produce. A qualitative study cannot be used to show cause and effect. So, based on this study, no conclusions may be drawn about why so many people struggle with College Algebra. At best, this research can generate hypotheses for further research.

This study was also limited by the assumption that the participants were telling the truth. Intentionally, no methods were included that could assess whether the participants' actions support their stated beliefs. Although I have no reason to believe that anyone was not telling me what he honestly believed, I must acknowledge it is possible.

Finally, this study is limited by its setting and small sample size. This study only included instructors associated with open-admission institutions in Georgia. We cannot assume that results from this study are generalizable to other settings. For example, we cannot assume instructors from other geographic regions would have the same beliefs about mathematics or would identify the same issues regarding the high failure rate in College Algebra.

CHAPTER 4

FINDINGS

Introduction

This chapter is divided into two sections. In the first section, I present results and analysis related to my first three research questions: What beliefs do these instructors hold about mathematics as a discipline?, What beliefs do these instructors hold about the teaching of mathematics?, and What beliefs do these instructors hold about adults' learning of mathematics? In the second section, I present results and analysis related to my fourth research question: What do these instructors believe are the causes of the high failure rate in College Algebra?

Section I: Beliefs About Mathematics, Teaching, and Learning

First, I provide a brief synopsis of each participant's beliefs about mathematics as a discipline, the teaching of mathematics, and adults' learning of mathematics. Following the presentation of these results, I provide an analysis of the participants' beliefs about these topics. I have chosen to provide the results and analysis for these three topics together because they are so intertwined. It is difficult to discuss one without alluding to the other two, so analyzing them separately would lead to many redundancies.

These results are presented using Ernest's (1989) framework as described in Chapter Two. Recall, Ernest defined three views of the philosophical nature of mathematics with corresponding views of teaching and learning. An instrumentalist sees mathematics as rules that can be used to pursue an end. He likely employs an instructor model of teaching, meaning he closely follows an externally imposed curriculum and he equates learning with the mastery of

skills. A Platonist views mathematics as a body of knowledge to be discovered. She usually employs an explainer model of teaching, meaning she augments externally imposed curricula and expects students to go beyond the simple mastery of skills. The Platonist sees students as receivers of knowledge rather than creators of knowledge. The problem-solver sees mathematics as an ever-expanding human creation and would be expected to teach using the facilitator model, meaning he is not dependent on a particular textbook and may develop his own curriculum to meet external objectives. The problem-solver sees learning as the active creation of understanding and may expect students to be able to autonomously pose and solve problems. In addition to these three views, I suggested a fourth view of mathematics that combines the Platonist and the problem-solving views. Someone with the combination view believes mathematics exists unto itself—it is knowledge to be discovered—but sees our understanding of the mathematics that exists as an ever-expanding human creation. Someone with a combination view could be expected to use the facilitator model of teaching and to desire students to actively create their own understanding.

Ernest (1989) acknowledged a teacher with a particular view of mathematics may not always use the associated teaching model. He noted that teachers may not always be aware of the connection between their beliefs and their practice and that the teacher's social context (students, administrators, and other teachers) may influence the model of teaching used.

Adam's Beliefs

Adam had a master's degree in mathematics and had taught at the college level for over 17 years. He taught courses ranging from developmental studies courses through Calculus II. So, his students were primarily those who intended to major in a subject other than mathematics. He

had no formal background in mathematics education but did read mathematics education journals.

Using my modified version of Ernest's (1989) framework, Adam had a combination view of mathematics. He believed mathematics exists unto itself but that humans create ways to appreciate and use it. Adam had a very broad view of mathematics and saw it as both beautiful and useful. He did not see mathematics as being limited to computations or the classroom. In response to the analogy asking which of the following is most like mathematics, he chose art "because of its broad-based nature and sometimes undefinability and that's what we encounter in math" (interview, March 19, 2010). Another example of his broad view of mathematics was his recognition of the mathematics used in activities such as packing a truck, doing yard work, and making a group decision. He believed mathematics is present in "anything that involves a problem that needs to be solved" (interview, March 19, 2010).

As is to be expected with someone who has a combination view of mathematics, Adam followed the facilitator model of teaching. He was an extremely reflective teacher and regularly modified his teaching methods and activities in an effort to improve student learning. He stated that

The real goal is, what should the learning objectives be that are centered around the traditional College Algebra material that fosters critical thinking. Independence, confidence, comfort. As opposed to the rote learning, in one ear, out the other, gone in five minutes types of objectives. (interview, March 19, 2010)

His rejection of the online homework program that came with the textbook is further evidence that he is a facilitator. He stated he did not use it because it was too tied to the textbook's construction of the course, and what he wanted to do was a little different.

Because of his view that mathematics is problem-solving, he believed he must teach in a way that enables his students to create their own understanding and become problem solvers. When asked what kinds of instructional activities are beneficial, he responded, “The bottom line is getting them to do more and me less. But it is a lot of work on my part to do less. It takes more preparation” (interview, August 20, 2010).

Adam’s beliefs and practices seemed to be in agreement. His teaching methods did not appear to have been strongly affected by the social context in which he taught. Although he regularly modified his teaching methods in an effort to improve learning, he did not let his students’ difficulties with the material lower his expectations of what they needed to learn. Similarly, although he respected his administrators and ensured the assigned objectives were covered, he would often radically alter the way College Algebra was taught. For example, he did not rely on the text assigned to the course and would teach topics in a different order than other teachers.

Beth’s Beliefs

Beth had a master’s degree in mathematics and taught at the college level for 18 years. She taught courses ranging from developmental studies through business calculus, and her students were primarily pursuing majors other than mathematics. She had no formal background in mathematics education but had familiarized herself with the NCTM standards.

Beth expressed an instrumentalist view of mathematics when discussing the mathematics she taught. She saw mathematics as a very skill-based discipline and believed practice is the key to learning mathematics. In response to the analogy asking which of the following is most like mathematics, she chose both sports and music. Her reasoning for both of these choices was that

in mathematics, sports, and music, success depends on the individual's willingness to take responsibility for his own learning and to practice until understanding is achieved.

As expected with her instrumentalist view of mathematics, Beth utilized the instructor model of teaching. Of herself as a teacher, she said

I'm very stepwise, you know. Don't skip a step. Keep your steps in order and follow the method. I know that, that of all the things my students would probably comment on was that I would go on the board I was extremely organized. ... I wasn't one to just say well you can figure out the rest. (interview, September 2, 2010)

In keeping with an instrumentalist view of mathematics and the instructor model of teaching, she viewed learning as the mastery of skills as evidenced by her emphasis on the connection between practice and learning. For example, she stated that with practice everyone can learn to play the violin at a proficient level and even described art as a skill to be mastered: "If you draw a straight line for ten days, you'll draw better and better straight lines" (interview, September 2, 2010).

Beth's views may have been influenced by the social context of my study. In our interviews, she was very focused on College Algebra and that level of student. If our discussions had centered on a different level of mathematics student, I think she may have expressed different views. When discussing which activity is most like learning mathematics, she made a distinction between lower level courses such as College Algebra and other courses. She compared learning lower level mathematics to formulaic tasks such as building a house, following a recipe, and working on an assembly line. In contrast, she saw a more creative aspect to higher-level courses and compared learning in those courses to working a jigsaw puzzle.

Beth's views on mathematics, teaching, and learning were also influenced by her own experiences as a mathematics student. Multiple times she referred to her own mathematical limitations. For example, in the first interview she said, "I don't think I'm a gifted mathematician. I don't feel like I'm a mathematician, like my husband is also a math professor

and he has a fluency with math that, you know, doesn't come to me quite as quickly" (interview, September 2, 2010). Because she did not see her role as a student to be to create new mathematics, I do not think she saw it as a goal for her students to create mathematics but rather to utilize mathematics developed by others.

Although I do believe her experiences as a student influenced her belief system, Beth was willing to push back against the social context in which she was teaching. In particular, she was very adamant that teachers, administrators, and the society at large not lower expectations in mathematics courses. In a discussion of student struggles with College Algebra, she said "It's not a popular belief or stance, but not everybody's meant to go to college" (interview, October 14, 2010).

Carl's Beliefs

Carl had a master's degree in mathematics and a Ph.D. in mathematics education. He had taught at the college level for more than 40 years and had one year of experience teaching high school. He taught courses ranging from developmental studies through courses such as complex variables and vector analysis. Although he had taught some courses past the calculus level, most of his students were individuals planning to major in subjects other than mathematics.

Carl had a Platonist view of mathematics. Although he did acknowledge a creative, artistic element to mathematics, he focused on the utilitarian aspects of the discipline. When discussing the nature of mathematics, he compared it to a language on more than one occasion. He saw mathematics as a way for humans to describe phenomena they observe or discover. I think this view of mathematics was influenced by his view of himself as a mathematician. I do not think he saw himself as someone who creates mathematics, as he said "people that are really

good at it, very good at it, not myself, but people that really can do mathematics make an art out of it almost” (interview, February 18, 2010).

It is difficult to pinpoint whether Carl used the instructor model or the explainer model as a teacher. On the one hand, he strictly followed the state curriculum and the assigned textbook as someone using the instructor model would do. He did this primarily because he saw it as his job to cover the required topics. Several times, he mentioned time as a limiting factor in teaching College Algebra. So, he may have felt he did not have time to modify and enrich the given curriculum. On the other hand, he referred to deriving formulas for students. This choice fits better with the explainer model of teaching as it indicated a desire for students to go beyond the mastery of a skill and to develop conceptual understanding of the mathematics they are utilizing. Although he was pleased when students could master mathematical skills, there was evidence that he saw true learning as an understanding of how to apply these skills.

Emma's Beliefs

Emma had a master's degree in mathematics and had taught at the college level for over eight years and had one year of experience teaching high school mathematics. At the college level, she taught courses ranging from developmental studies through pre-calculus. So, her students were primarily those who intended to major in a subject other than mathematics. She took a couple of education courses as part of her master's degree, but the courses were not specific to mathematics. Hence, she had no formal background in mathematics education but did have some familiarity with the Georgia Performance Standards (the state curriculum for K-12 students).

In Emma, I saw elements of a Platonist view of mathematics as well as a combination view. From her students' perspective, Emma saw mathematics through a Platonist lens. For

them, mathematics provided skills they need. And as a teacher, she used the explainer model. She saw her responsibility as the teacher to provide students with information, and then it was the students' responsibility to practice and study until they understood. She mainly engaged in the traditional lecture format but also saw the benefits of allowing her students to work on problems together. Her goal was for her students to go beyond the mastery of skills in order to apply what they learned to novel situations, but I did not see evidence she expected them to construct knowledge beyond what was presented in class or to be the autonomous problem-posers and problem-solvers Ernest (1989) described.

From her own perspective, Emma had a combination view of mathematics. She believed mathematics exists unto itself and said, "It's here whether we quantify and write it down and all that stuff or not" (interview, September 29, 2010). In addition, from her own perspective, Emma saw mathematics as having a beauty worth appreciating regardless of its usefulness. This combination of usefulness and beauty was seen in her response to the analogy asking which of the following is most like mathematics. She chose music because

there is a language to music just like there's a language to math. You'd have to be able to read the notes and interpret what you see just like you have to be able to read mathematical statements, interpret what they mean. And there's also a little bit of artistic nuance to mathematics. And obviously there's artistic nuances to music. (interview, August 31, 2010)

She also repeatedly equated mathematics with problem solving. For example, when discussing a job she had, which, from the outside appeared to involve little mathematics, she said "There were little algorithms that you were constantly doing in your head, constantly logic[ing] out how to go about doing the case" (interview, August 31, 2010). She went on to emphasize that she truly believed mathematics "helps people to analyze problems and be more effective in solving a huge host of problems" (interview, August 31, 2010).

The dichotomy in Emma's views, I believe, resulted from the social context of her students. Although she firmly believed that with practice everyone could master mathematics to a certain level, she also believed that for other people the understanding would come more easily. For example, when comparing learning mathematics to learning to play the piano, she suggested there will be prodigies but also be people who are tone deaf. I think her expectations for her students were based on her view of their abilities. Given a class of prodigies, her goal may have been for them to become independent problem-posers and problem-solvers. I also think given the right class conditions, she would have incorporated a facilitator model of teaching more often. Of her attempts to use manipulatives in the classroom, she described the potential benefits, but found that ultimately, "it was more trouble than it was worth" (interview, September 16, 2010).

Fran's Beliefs

Fran had a master's degree and a Ph.D. in mathematics education. She did not have a degree in mathematics but did have more than 18 hours of graduate level mathematics courses, including doctoral level courses. She had taught mathematics at all levels from elementary school through graduate school. At the college level, she taught developmental studies and College Algebra. At the graduate level, she taught mathematics for elementary and middle school teachers. Although her students at the college level were likely not pursuing mathematics related degrees, she worked formally with mathematics teachers who presumably had a strong interest in mathematics.

Fran had a combination view of mathematics. She believed mathematics exists whether anyone understands or recognizes it. She thought it is in a sense discovered, but that each individual has to construct an understanding of it in his own brain. She believed mathematics is

important because it is useful. Despite this utilitarian description of mathematics, I would not classify her as having an instrumentalist or Platonist view of mathematics because she believed each person could create mathematical understanding for himself rather than being limited to memorizing and applying rules given by other people.

Fran's preferred model of teaching was the facilitator model. When discussing teaching elementary school, for example, she focused on finding the right tasks and getting the right discussions started so that her students could learn from one another. In contrast, she used the instructor model when teaching developmental studies and College Algebra. She said she "felt like a sinner for doing direct teaching" (interview, March 16, 2010). Similarly, when as part of the member checking in the third interview I suggested that her goal for her students was for them to pass the test in College Algebra, she responded that it was true but "it's horrible hearing you say that" (interview, April 13, 2010).

There were several factors in Fran's social context at the technical college that led her to use the explainer model of teaching even though she was disappointed in herself for doing so. First, she felt limited by having only nine weeks to teach the College Algebra curriculum and cited this as a reason she did not include "a whole lot of class discussions or group work or investigations" (interview, March 16, 2010). The issue of time was accentuated by the type of students she taught. She talked about feeling more like a social worker than a mathematics teacher because of the time she had to spend encouraging her students and accommodating their personal problems. Finally, she felt limited by the College Algebra curriculum itself. She did not see the College Algebra material as useful to her students in the long run. About College Algebra, she explained, "It is hard for me to get enthusiastic about it. It's hard for me to develop learning activities for students" (interview, April 13, 2010).

Gail's Beliefs

Gail had a master's degree in mathematics, a specialist degree in mathematics education, and a Ph.D. in educational leadership. In her eleven years teaching at the college level, she had taught courses ranging from developmental studies through calculus. In addition, she had two years of experience teaching middle school mathematics and several years of experience as a college administrator.

Gail had a combination view of mathematics. She believed mathematics exists separately from the human existence and that we construct an understanding of it. Of mathematics, she said "It's really been our journey to try to fit within what is already there" (interview, October 4, 2010). She saw an inherent beauty in mathematics but believed its primary importance came from its usefulness. In her view, the usefulness of mathematics was not limited to a person's ability to do computations but included the logic skills that are needed to solve problems. Her experience as an administrator strengthened her belief that mathematics is tied to problem solving skills. She noted her program directors were "totally adamant" that College Algebra is the course that develops the critical thinking and problem solving skills students will need on the job.

Despite her combination view of mathematics, Gail primarily used an explainer model in her teaching. She described her methods as a "combination of demonstration and allowing them to practice" (interview, April 21, 2010). She cited the time constraints of the quarter system as the reason she did not use more involved activities requiring students to deepen their understanding of the mathematics. She was optimistic that a change to semesters would allow instructors to use more problem-solving or problem-posing types of activities.

In addition to time constraints, I think her teaching methods were limited by the social context of her students. Because her students struggled with mathematics, I think she was pleased when they could reach the level of being able to understand the mathematics presented to them and did not expect them to create it for themselves. She made several references to mathematicians having unreasonable expectations for lower level students. When asked what training someone needs to teach College Algebra, she emphasized that an understanding of the mathematics is not sufficient. She believed instructors need to recognize that their students may struggle and that the instructors need to learn to deliver the material in multiple ways to reach a variety of learners.

Analysis of Beliefs About Mathematics, Teaching, and Learning

In analyzing the data, I identified several themes regarding the participants' beliefs about mathematics, teaching and learning. First, they believed not everyone can learn mathematics equally well. This belief about the learning of mathematics was related to their beliefs about how mathematics should be taught and what the responsibilities of the teacher are. Second, the participants did not see technology as essential to teaching mathematics to adults. This belief may be connected to their belief that student-teacher interaction is essential to learning mathematics. Finally, the participants agreed that students are responsible for their own learning despite the fact that adults face many impediments to learning mathematics.

Not Everyone Can Learn Mathematics Equally Well

Although four of the six participants had a combination view of mathematics, only one of those four regularly employed the facilitator model of teaching. The common reasons for the other three using an explainer model instead were time and issues with students. In fact, all six participants seemed to be frustrated with either their students' ability or willingness to learn. This

frustration led all of them to accept, at least in the College Algebra course, the mastery of skills or perhaps the reception of knowledge as sufficient learning. None discussed assessments that would require students to display an active construction of understanding or to pose/solve non-standard problems. All stated that their College Algebra tests were similar to the homework given and expressed a belief that it would not be fair to do otherwise in this course. The following comment from Gail illustrated the lowering of the expectation from one level of understanding to another:

But I try to make sure I am assessing what they've been exposed to. So, I try not to, you know, assess at a more combining level, which I think is a hard thing not to do because we think, "Well, they've seen this, they've seen this, and so now it's just a combination," but you know. And that was a learning experience too because I think at first I was just, in my mind, "Well, they have seen it and it's true." But they haven't seen it like that. And so, again, going back to that language thing where if you've just been doing vocabulary, you can't jump from vocabulary and then on a test say, "Make a sentence," if you haven't talked about putting those things together. And so I try to make sure that the assessment is assessing at an appropriate level that the instruction has been and try to keep those things kind of parallel. (interview, April 21, 2010)

Even Adam, who was the most ardent about facilitating rather than explaining in the classroom, and Beth, who was the most ardent about not watering down the content level, acknowledged that in College Algebra the questions on the assessments were very similar to homework questions.

The participants' frustrations with their students' performance resulted in a shared belief that not everyone can learn mathematics equally well. All six participants expressed this belief at one time or another. This recognition that many students struggle in mathematics led the participants to believe that the role of the College Algebra teacher was not limited to someone who can explain mathematics or who can facilitate activities that encourage people to learn. Teachers must also inspire their students to persevere. Adam, Beth, and Gail compared teaching mathematics to being a coach because as Gail said, "sometimes there's encouragement needed"

(interview, April 21, 2010). In a similar vein, Fran and Emma compared teaching mathematics to being a social worker because of the variety of problems students face. Fran also felt like a social worker because “so many of them were afraid of math that I had to literally help them one by one overcome whatever the fear was” (interview, March 16, 2010). Instead of coach or social worker, Carl thought teaching mathematics was like being a lawyer because he had to convince his students the material was worth learning.

Technology is Not Essential to Teaching Mathematics to Adults

Another belief held in common by the participants was that technology is not essential for teaching mathematics to adults. In other words, if the technology they used went away, none of them would have had to change the way they taught. As Beth said “You could be the most fabulous College Algebra teacher if you just had chalk and a chalkboard” (interview, September 21, 2010). This belief may have stemmed from a view that technology was just another way to deliver content. In our discussions about technology, the participants focused on creating lectures using programs such as PowerPoint (presentation software), assigning homework using online sites that accompany the textbook, and assessing students by using testing software. Although a few people mentioned using technology to graph equations more quickly, no one mentioned using technology to truly explore a concept.

Some of the participants saw positive reasons for using technology to deliver content and provide tests. For example, Gail liked the fact she could provide the PowerPoint notes to her students because it meant they could listen rather than trying to take notes. Emma, Carl, and Fran all liked certain features of the online homework. In particular, they saw advantages to students getting instant feedback and in having the computer grade the homework.

For the most part, however, participants found the use of technology hindered rather than improved teaching and learning. For example, several participants, including the same three participants who saw advantages, saw limitations in using the online homework. Adam, Carl and Fran expressed concern students would become too dependent on the help button that gave hints or showed them how to do the problem or they would experience frustration when a correct answer was marked wrong because it was not typed in correctly. Emma found that when she started using the online homework program, students did not ask as many questions in class about the homework. She found this to be a negative consequence because she had less interaction with her students and was less aware of what they did and did not understand on a daily basis.

The loss of student interaction Emma described may be the reason the participants did not see technology as essential to teaching mathematics. All of the participants believed interaction with their students was essential to teaching mathematics. When technology is used for content delivery, it can become a barrier between the teacher and student instead of being a tool to prompt discussion and illustrate ideas. Emma and Carl alluded to this limitation of technology when discussing having lecture notes prepared ahead of time using something like PowerPoint. Emma did not like using PowerPoint lectures because she thought they were less interactive than writing on the board. She felt that “It’s very easy if you’re at the board to just erase and write back up something else or change the numbers if you want to kind of look at it from a different direction.” Similarly, Carl thought it was important for him to work problems on the board rather than have them previously prepared so his students could see him make mistakes.

Another reason the participants may not have seen technology as essential to teaching mathematics to adults is the constraints put on them by time and the understanding level of their

students. Fran and Gail, for example, both had experience working with programs like Geometer's Sketch Pad (GSP) to create exploratory lessons, but neither thought there would be time to incorporate such lessons into a technical college quarter. In explaining why he did not use technology to engage students in explorations, Adam cited lack of numerical literacy of students in the lower level college courses. He said that instead of using a graphing calculator to allow students to explore graphing, he would "rather get them to do an exploration on paper and develop some number literacy" (interview, August 20, 2010).

Students are Responsible for Their Own Learning

The participants were also in agreement that students are responsible for their own learning. By this statement, I mean that it is not sufficient for students to come to class and listen to what the teacher says. The student must practice on his own until the material is learned.

When asked which activity is most like succeeding at College Algebra, each participant chose either running a marathon or playing the piano. Those activities were chosen because they require practice and perseverance. For example, Fran said,

If you're preparing for a marathon, it's not the type of thing that you can go out there today and run 8 miles and then not do anything else for a week and half and then try to go out and run 8 miles. It's the type of thing where you have to be consistent and persistent in preparing for it. (interview, March 16, 2010)

Similarly, Carl chose playing the piano because "It's all practicing over and over again" (interview, April 15, 2010).

The participants recognized their adult students faced many impediments to learning mathematics at the college level. These impediments included the emotional baggage they brought with them as well as family and work responsibilities. The emotional aspects of adults learning mathematics are well documented in the literature as well (Burton, 1987; Coben, 2000;

Colwell, 2000; Evans, 2000; Fitzsimons & Godden, 2000; Maxwell, 1999; O'Donoghue, 2000; Safford, 2000).

Despite their recognition of these difficulties, the participants did not think they could or should take responsibility for the students' learning. Beth, for example, was particularly vocal on this topic. She even noted that the use of review sheets could take responsibility from the student by identifying what should be studied. She felt that part of preparing for the test was identifying the topics that needed to be studied. Upon figuring out that students were "counting on that review sheet to be their sole ticket to passing the test," she stopped providing them (interview, September 21, 2010).

Section II: Beliefs About the High Failure Rate in College Algebra

In analyzing the data regarding the participants' beliefs about the high failure rate in College Algebra, I identified four general areas of concern: curriculum issues, administrative issues, teacher issues, and student issues. In this section, I present the results and analysis for each of these topics. Rather than summarizing each participants' beliefs about this topic individually, I discuss the themes and how the participants' beliefs relate to those themes.

Curriculum Issues

The participants identified several curriculum issues that could be affecting the failure rate in College Algebra: there is too much material in the College Algebra curriculum for the time allowed, the material covered in a College Algebra course may not be the mathematics these students need, and the College Algebra course may be the place where students are required to shift from elementary to advanced mathematical thinking.

Several participants, Carl, Beth, Emma, Fran, and Gail, suggested the amount of material in the College Algebra course is difficult for a student to digest in the typical nine or ten week

technical college quarter. For example, Beth, who taught under both the quarter and the semester systems, felt the semester system allowed students more time get work done. She noted that under the quarter system, students normally had only 24 hours to complete their homework. She also noted that the semester system allowed students more time to “digest it all and think on it” (interview, October 14, 2010). Gail made a similar statement:

The thing about semesters that’s really, as far as the math standpoint, I don’t think it will necessarily do a whole lot more, but it just gives the students time to really process, and that’s really the challenge being on the quarter system that they’re three weeks behind you in terms of their processing. (interview, April 21, 2010)

Carl and Emma also supported the idea that semesters might be better for students.

In contrast, Adam, who taught College Algebra under both the quarter and semester systems, expressed his belief that the semester system is not better for teaching College Algebra. He noted that although the contact hours are the same, the number of minutes per session is not. Under the quarter system, classes traditionally met for 50 minutes while under the semester system a section that meets only twice per week meets for 75 minutes. Adam felt the two systems were not equivalent. He was unsure why it made such a difference but suggested it could be related to the students’ inability to pay attention for the full 75 minutes. He also believed the semester system required more stamina from students, not just because they had to focus on the subject for 16 weeks instead of 10, but also because they needed to be prepared to take 75 minute tests instead of 50 minute tests. He asked his students “Have you practiced sitting down and doing math and nothing but math for 75 minutes? No. You’ve got to take a 75 minute, it’s gonna be a 75 minute test. You’ve got to have that stamina” (interview, October 8, 2010). Adam’s belief that longer class sessions are less effective is supported by the research of Gallo and Odu (2009). They conducted an effectiveness study to look at whether students were more successful in College Algebra classes that met one, two, or three days per week. After controlling for

student and teacher attributes, they found that students in classes meeting only once a week did not score as well on tests.

In addition to the discussions about quarters versus semesters, some of the participants also felt some material could be deleted from the current College Algebra curriculum, allowing more time to cover the remaining topics. For example, Carl and Gail both suggested the material on conic sections could be removed and the integrity of the course remain.

Several participants, Adam, Fran, and Carl, believed the curriculum could be entirely changed, perhaps even becoming something different than College Algebra. Adam asserted that if students were only going to take one math course in college, it should not be College Algebra but rather a course focusing on the mathematics of decision-making. He felt understanding topics such as fair division and Arrow's impossibility theorem would be more beneficial to students than understanding the traditional College Algebra curriculum. Similarly, Fran believed her students would not use College Algebra in their lives beyond college and stated that a problem solving class "would be useful because people need to learn how to problem solve in the everyday world" (interview, April 13, 2010). Carl also felt a more practical course might be more appropriate for some students. For example, nursing students might be better prepared for their jobs having taken a math-based drug and solutions course.

In contrast, Beth and Emma felt the College Algebra course was important for people getting a college degree. Beth believed the integrity of a college degree required students to have a rigorous mathematics background and thought students should have "at least College Algebra, if not calculus, and statistics" to obtain a bachelor's degree (interview, September 2, 2010). She worried that some of the courses that have been created to replace College Algebra had been watered down to the point of not being college level mathematics. Beth and Emma both thought

that not requiring College Algebra could limit the students' future choices as they would not be able to choose a major requiring calculus.

Gail, as the participant with administrative experience, took a more pragmatic approach to the question of whether College Algebra is the right mathematics for her students. She noted that colleges are trying to serve a variety of students and that College Algebra works for a variety of majors, unlike a course that covered topics specific to a particular major or career. She did investigate the question with her program directors and people from the various industries those programs serve. She found that for the most part the program directors and industry representatives believed the current College Algebra curriculum was appropriate for their students. Those that did not changed the requirement.

Several participants, Beth, Adam, Gail, and Fran, thought students might struggle in College Algebra because of the advanced mathematical thinking required in the course. The College Algebra curriculum represented a significant shift from classes that came before it; College Algebra is the course where students are required to go from elementary mathematical thinking to advanced mathematical thinking. Gail stated that the beginning part of College Algebra was elementary but it becomes advanced "And that's where I think you start to see the issues with students" (interview, February 10, 2010). Similarly, Adam noted that "there's an intrinsic difficulty with the material. It's an abstraction" (interview, August 20, 2010). Beth did not necessarily see the material in College Algebra as advanced but did think College Algebra was "far and above intermediate or the learning support levels" (interview, September 2, 2010).

Administrative Issues

The participants identified three administrative issues that could be affecting the high failure rate in College Algebra: students are not properly placed in the course, the course is

intended to differentiate weaker students from stronger students, and large numbers of adjunct or part-time faculty are employed to teach College Algebra.

Some of the participants felt that students, particularly those straight out of high school, were not properly placed in College Algebra and should have been in a developmental studies course instead. This belief fit with the predictive studies in the literature that attempted to develop a formula to predict which students will succeed in College Algebra. Those studies considered multiple variables such as race, gender, and GPA, but the participants in this study focused primarily on COMPASS² scores. Many institutions used the COMPASS exam to place new students as well as to test developmental studies students for readiness to take credit mathematics courses. Beth, Gail, and Adam did not believe the test always did a good job of placing students in the right course. Gail thought that because the COMPASS is a multiple-choice test, it often overstated a student's mathematical ability. Adam noted that at his institution, students who score 40 or higher on the COMPASS exam were allowed to take College Algebra, but an in-house researcher had discovered that success in the course was better correlated with a score of 55 or higher.

In contrast, Fran had great faith in the COMPASS examination. At her institution, students could also place into College Algebra based on college entrance examination scores (such as the Scholastic Aptitude Test, or SAT). Fran found students who were placed using their SAT scores were not as well prepared as those placed using their scores on the COMPASS. She thought the COMPASS did a particularly good job of testing whether a student coming out of developmental studies was prepared for College Algebra. She stated, "The COMPASS examination was an excellent gatekeeper. If they passed it, they were capable of College

² COMPASS is a standardized test produced by American College Testing (ACT) and used by many colleges to determine in which mathematics course to place a student.

Algebra” (interview, March 16, 2010). Emma also believed the COMPASS examination was an effective placement tool. At her institution, the requirement to take the COMPASS examination to go from developmental studies to College Algebra had been removed, but she had found the requirement helpful and thought it should be reinstated. The differing attitudes about the COMPASS exam could be due to differing cut-offs for placement in College Algebra at different institutions. As the research at Adam’s institution indicated, the problem may not be with the test but in how the scores are used.

Some of the participants also believed administrators saw one of the purposes of College Algebra to be to differentiate between strong and weak students. When asked what the purpose of studying mathematics at the post-secondary level is, Carl, Fran, and Adam all stated it was used as a filter or “weed out” course. As an example, Carl noted that the nursing program at his institution had 400 applications for 30 spots and implied that a large number of the applicants would not pass College Algebra and would be weeded out of the application process. The three people who believed the College Algebra curriculum could be completely replaced are the same three people who commented on the College Algebra course being used as a filter. Believing that the purpose of College Algebra is to serve as a gatekeeper course could influence one’s belief that the mathematics in the course is not the mathematics students need to learn and vice versa. These beliefs could also affect how one teaches the course. Fran even stated the primary purpose of College Algebra being a gate-keeping course was “probably why I spent more time teaching perseverance because most of my students didn’t need College Algebra to do what they wanted to do in life. They just had to have it to get their degree” (interview, April 13, 2010).

The final administrative issue addressed by the participants was the use of adjunct or part-time instructors to teach College Algebra. Emma, Adam, Carl, and Gail were not opposed to

the hiring of part-time faculty and believed they provided high quality instruction and could be as effective as full-time faculty. But, in order to perform well, they all believed that part-time faculty needed to be well managed. For example, Gail noted part-time faculty needed to be paid well so that they could focus on teaching rather than having multiple jobs. Both Adam and Emma talked about the importance of communicating with the part-time faculty. Adam felt it was important to incorporate part-time faculty into the discussions about curriculum and pedagogy that full-time faculty have, and Emma suggested it was important for the adjunct coordinator to ensure part-time faculty were following the syllabus and moving at an appropriate pace.

These participants did acknowledge some negative factors in using adjuncts. For example, Carl, who was working as a part-time instructor at the time of the interview, noted he did not have an office in which to meet students. He stated that when he taught full-time he interacted with many students outside of class but that it was difficult to do so as an adjunct. Fran also mentioned that part-time faculty members were not as available to students outside of class. Emma raised an issue about the quality of part-time instructors. As an adjunct coordinator she had worked with many wonderful instructors, but she recognized the pool of qualified (master's degree and 18 hours of graduate level mathematics) mathematics instructors was limited. On occasion, she worked with people who were good mathematicians but not great teachers.

In contrast to the other participants, Fran had strong negative opinions about using adjuncts to teach developmental studies and College Algebra. She described a unique situation in which the adjuncts at her school were not well managed. At her institution, part-time faculty members were only required to complete 60% of the course syllabus. She said that at her school adjuncts would often cancel class or let students go early. This disparity between full and part-

time faculty caused her frustration for a couple of reasons. For one, it allowed students in a course taught by an adjunct to more easily get an A than students in her course, which is especially problematic when you consider the fact that these students could be competing for the same spot in a program of study. Secondly, students who did not complete all of the required material would come to the next course ill-prepared.

Like the participants, the literature addressing whether an instructor's employment status affects student performance is divided. Some studies show students perform better in classes taught by full-time faculty (Burgess & Samuels, 1999; Penny & White, 1998). In contrast, Fike and Fike (2007) concluded students were not negatively affected by being taught by part-time faculty. It may be that the issue is not the employment status but rather how the institution manages part-time faculty. Certainly, in the case of Fran, the administration's radically different expectations for full and part-time faculty resulted in students having very different learning experiences based on their instructor's employment status.

Teacher Issues

The participants identified two issues associated with mathematics teachers that could be affecting the high failure rate in College Algebra: students are not adequately prepared and teachers are not adequately prepared to teach College Algebra. *Students are not adequately prepared* may sound like a student issue, but I have identified it as a teacher issue because to enter a College Algebra course, the student must have successfully completed a prerequisite course—meaning a teacher has passed someone who should not have been passed.

Many researchers have identified poor high school preparation as a problem and examined the gap between high school and college mathematics (Berry, 2003; Jacobson, 2006; Johnson, 1996). When asked to rank five reasons for the high failure rate in College Algebra,

Carl ranked inadequate preparation as number one. Emma and Gail ranked it number two. In fact, all of my participants asserted many College Algebra students were not adequately prepared for the course. For example, Adam and Carl observed many students could not do arithmetic. Similarly, Emma and Beth found students had difficulty solving even basic equations, and Emma also noted students' inability to factor. Beth, Fran, and Carl specifically believed the reason some students were not adequately prepared was because they had poor instruction in prerequisite courses in high school or college.

The poor instruction may not have resulted from having teachers who could not adequately teach the material. Fran noted sometimes teachers got caught in a review cycle where because students came to them unprepared, they spent extra time reviewing with students, which, in turn, meant students left their courses not having covered all of the required material and thus unprepared for the next course.

Emma suggested the problem might lie with teachers' and administrators' low expectations for students. She noted that in her experience as a high school teacher she felt pressured to pass students who had not mastered the material. Beth also believed instructors at the college level had low expectations. She noted many instructors enabled their students with practice tests and review sheets, presumably because they did not think the students were capable of preparing for a test without them. She believed that instructors taking responsibility for student learning this way was detrimental to the students. She stated "If you have you have a student who successfully works through the developmental studies course by a professor who really makes them responsible for the content of those courses, they'll be ready" (interview, September 21, 2010).

Fran suggested not all developmental studies and College Algebra instructors are adequately prepared to teach. She noted the requirements to be qualified to teach College Algebra focused on the instructor's knowledge of mathematics rather than on the instructor's knowledge of pedagogy. She believed teachers with a background in education might be better suited to teaching College Algebra than mathematicians. There is research on the connection between mathematics instructors at the college level and student performance, but it focuses on factors such as the instructors' educational level and employment status rather than on the types of courses the instructors took. For example, Fike and Fike (2007) found a correlation between instructors' education level and student performance; students performed better in classes taught by instructors with advanced degrees.

Adam, who had no education coursework, agreed mathematical knowledge was not sufficient to be a good teacher. He thought instructors could benefit from discussions about teaching and learning and was concerned that a large percentage of instructors did not engage in thinking about how best to teach the material. He suggested that teachers, especially new teachers, could benefit from a structured staff development program that would introduce them to pedagogical ideas such as active learning.

Student Issues

The participants identified many issues related to students that could be affecting the high failure rate in College Algebra: the increasing number of people going to college, interference from family and work responsibilities, students' lack of understanding how to study, students' lack of motivation to study, students' refusal to take responsibility for their own learning, and students' lack of belief that they can succeed in College Algebra.

Adam, Beth, and Carl made interesting observations about the changing cultural expectations regarding education. They seemed to imply one reason so many students fail College Algebra is that in recent times so many more people are expected to take the course. Adam noted that today we expect everyone to be literate whereas 100 years ago this was not the case. In mathematics, he saw a shift from our society wanting everyone to be able to do arithmetic to an expectation that all people should be critical thinkers, which means more people will need to go to college. Beth was concerned about the push for more people to become college graduates. She feared that because so many students fail College Algebra that standards would be lessened in order to produce more graduates. Although she knew it was not a popular stance, she believed not everyone was meant to go to college and that what it means to have a degree should not be changed in order to enable more people to graduate. Carl suggested that what Beth feared was already happening. For example, he described a 100-year-old eighth-grade textbook and noted that “College graduates in mathematics would have trouble working the problems in this book. But that’s then and this is now. And then we educated very few people and now we educate a lot” (interview, April 15, 2010).

Another result of more people going to college and particularly more people going to technical and community colleges could be that more college students have family and job responsibilities. All of the participants expressed concern about the level of responsibilities their students had outside of school. Adam and Beth both noted their students had many more work and family obligations outside of school than each of them did in college. When Adam and Beth were undergraduates, school was their primary responsibility. Carl, Emma, Fran, and Gail all believed these outside responsibilities affected their students’ performance in the classroom. For example, Fran noted family and work obligations sometimes kept her students from attending

class or doing homework. And, as an administrator, Gail found that about one-third of students who dropped College Algebra did so because of family or work commitments.

In addition to the demands placed on students' time by work and family, these students also faced economic demands. Both Fran and Gail explicitly stated that money was an issue for their students. These money concerns affected both the students' ability to come to class and what happened in the classroom once they got there. Fran, Beth, and Emma all mentioned a lack of childcare as an impediment to students coming to class. Gail noted sometimes students could not afford to buy their books at the beginning of the quarter, and Fran stated one reason she did not use graphing calculators was that they were too expensive for her students.

Although the participants did recognize their students had many very real and serious problems, they did not necessarily see it as part of their jobs to directly address these problems. Emma, for example, was wary of becoming a social worker to her students but did try to point them to available resources. Similarly, Beth was very careful to maintain boundaries and felt that it was a dangerous position for teachers to get into if they became too involved with their students' personal lives.

As an administrator, Gail was able to develop services to help students with some of their less severe non-academic problems. She described a program at her institution designed to influence the aspects of student life that have an impact on academics. One purpose of this program was to help students understand how to study. In particular, Gail explained that students need help understanding how to cope with distractions when they study. She noted students would claim to have studied for three hours, but really they just had their books open for that length of time. Distractions from spouses, kids, dogs, etc. kept them from focusing. Other

participants agreed that many students struggle in College Algebra because they do not know how to study and would likely approve of this program's emphasis on developing study skills.

Adam found his students had difficulty taking good notes and did not appreciate the importance of understanding vocabulary. He attempted to develop activities that would help them. For example, he gave quizzes requiring students to read through the book to help them with note taking and began including test questions requiring students to state definitions to emphasize the importance of vocabulary. Adam, Beth, Carl, and Fran believed that one reason students struggled on tests was that they did not understand how to prepare. They felt students were too dependent on homework aids. Adam noted some students never “engage in that weaning off process to establish true comfort and confidence” (interview, August 20, 2010). Fran thought some of the study aids rewarded students for looking for patterns to complete the homework rather than genuinely learning the material.

Carl suggested that students might be using these aids because they did not want to take responsibility for their own learning. He said “They go to tutoring and I think the tutor does too much work for them. And they never work a problem themselves” (interview, October 21, 2010). Emma also believed students did not take sufficient responsibility for their own learning. She felt high schools were “not preparing them for the responsibility that they’re gonna need to take for their own learning once they get to the college level” (interview, September 29, 2010).

The participants suggested that one way students not knowing how to study and not taking responsibility for their own learning manifested itself was in students not spending sufficient time preparing for tests. Adam and Emma believed the fact that students did not spend sufficient time studying College Algebra was the number one reason for the high failure rate in College Algebra. Carl ranked this reason number one along with students not being adequately

prepared. Beth believed her students did not understand that studying mathematics involved an extensive amount of time spent practicing. She noted that as a student herself she would spend 15 to 20 hours studying for one test; she did not believe her students did the same. Similarly, Carl lamented the fact that his students did not “do anything ‘til the very last minute literally” (interview, February 18, 2010). Carl also suggested the lack of studying might be the result of a lack of motivation.

Emma, Fran, and Gail agreed a lack of motivation played a role in students’ struggles with College Algebra. For example, Emma believed when it comes to the percentage of students failing College Algebra, “The larger numbers are people who don’t care” (interview, September 16, 2010). Similarly, Fran stated, “College Algebra wise it was completely effort” (interview, March 16, 2010). She suggested that one reason people might not be motivated to put in the required effort was that they did not believe they could succeed in the course. She said,

It’s the type of thing where you have to be consistent and you have to be persistent in preparing for it. And that is what I always kept telling my students in College Algebra. First of all, you got to get over the I can’t. (interview, March 16, 2010)

In the literature, poor study skills and lack of motivation are sometimes linked to a student’s poor self-efficacy (Bandura, 1993). And, many studies have found a connection between student self-efficacy and student performance in mathematics for college students (Hackett & Betz, 1989; Hoffman & Spataru, 2008; Pajares & Miller, 1994, 1995). Although the participants in this study did not use the term self-efficacy, they would likely agree the link between self-efficacy and performance applies to their students as well.

When asked to rank five reasons for the high failure rate in College Algebra, Gail and Fran ranked “Students do not believe they can succeed in College Algebra” number one and Adam and Carl ranked it number two. If a lack of persistence or a lack of time spent studying is

considered a result of poor self-efficacy, then five of the participants ranked self-efficacy as the primary reason students are failing College Algebra. The sixth participant did not respond to my request for a ranking.

Although the participants did not use his vocabulary, they did discuss each of the four elements Bandura (1977) stated could influence a person's self-efficacy. Bandura (1993) stated that performance accomplishments, or a person's past experiences with a task, are the strongest indicators of a person's self-efficacy related to a task. Based on comments from my participants, this appears to be true for students' self-efficacy related to passing College Algebra. My participants believed that students' past experiences in mathematics classes influenced their beliefs about whether they could succeed in College Algebra. For example, Adam found

When you get the students that are in College Algebra in college, not only are they in this situation, but it comes with all this psychological baggage, this history of 'not only have I seen it X number of times before, I never liked it and I never did well in it.' And so this isn't going to be any different. ... First you have to be able to convince them that there is a paradigm and it might be mutable, it might be changeable, so it's just such a loaded situation from the beginning. (interview, August 20, 2010)

By this comment, I think he meant that students must recognize their own model or paradigm for how they will perform in a College Algebra and then recognize this model is mutable or capable of being changed in order to change it and perform differently in the course. Until students believe their experience with algebra will be different, it will not be. Similarly, Fran believed "And then they hear that word algebra, and because they had such horrible experiences in high school, they walk in the door saying 'I can't do this'" (interview, February 16, 2010).

Gail noted students could perform mathematical tasks in other contexts that they could not perform in the mathematics classroom. She gave an example of a drafting student who could not perform a particular task in algebra. When she pointed out it was the same task he had done

in the drafting laboratory, he replied that it was not. Upon explaining what he had done there, she knew it was the same, but he remained unconvinced. She said,

I just chalk it up to some sort of bad experience or the fact that they've already convinced themselves that they can't do math. So once they step through that door, you know, they're just...it turns off and they can't help themselves. (interview, February 10, 2010)

Bandura (1977) also stated that vicarious experiences, or what we see others do, influence a person's self-efficacy. Some of the participants implied an understanding of this concept. Fran talked about students not doing well in college courses because their parents did not go to college. In other words, these students lacked vicarious experience with regard to college tasks. Adam described a program at his institution in which students who had previously been successful in a course were hired to sit in on a course and be positive role-models. He noted that "It's much easier to believe a student about what it takes to be successful than it is the teacher" (interview, August 20, 2010). Such a program could be an excellent way to give students positive vicarious experiences. Beth also tried to create a vicarious experience for her students with her own experience. She would tell her students about her own struggles in mathematics in an effort to persuade them they could also learn the material.

Verbal persuasion, what someone else says you can accomplish, is another way a person's self-efficacy can be affected (Bandura, 1977). Again, the participants did not overtly discuss the effect of verbal persuasion on student performance, but they did imply it. Adam, Gail, and Beth all compared being a mathematics teacher to being a coach. Gail noted that she was like a coach because "sometimes there's encouragement needed" (interview, April 21, 2010). Similarly, Adam talked about needing to inspire his students by doing a lot of "hand-holding." Fran and Emma both described being a mathematics teacher as being similar to a social

worker. Fran talked specifically about helping her students overcome their fears, and Emma referred to their need for encouragement.

The final element Bandura (1977) identified as influencing self-efficacy is emotional arousal, which is the physical reaction a person has to a situation. Several participants, Adam, Beth, Fran, and Gail, described students with test anxiety—a physical reaction to the testing situation that prevents students from performing well. For example, Gail believed her students had a fear of mathematics that she could recognize. She noted “Part of what happens when they get to the test is those anxiety and those other psychological factors come into play where it’s too quiet and they hear every little thing” (interview, October 4, 2010). Although, they recognized that some students do truly experience test anxiety, Adam and Beth thought the term was over used. They thought that perhaps test anxiety is actually lack of preparation.

Summary of Findings

With regard to my participants’ beliefs about mathematics as a discipline, I found that one participant had an instrumentalist view of mathematics and that one had a Platonist view. These two participants’ beliefs about teaching and learning aligned well with their views of mathematics. The remaining four participants had a combination view of mathematics, but their beliefs about teaching and learning did not align as well with this view. Of these four, only one regularly used a facilitator model of teaching in College Algebra. For the other three individuals with a combination view, their beliefs about teaching and learning were limited by time, administrative decisions, their beliefs about their students’ capabilities, and their beliefs about the College Algebra curriculum.

The participants identified reasons related to the curriculum, the administration, the teachers, and the students for the high failure rate in College Algebra. Although beliefs about all

four of these areas were identified, the participants seemed to believe student issues most strongly affected the failure rate in College Algebra. In particular, they implied that students' poor self-efficacy most strongly affected the students' inability to succeed in College Algebra.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

This study was motivated by the high failure rate in College Algebra, which is a problem for the students who fail the course, the instructors who teach the course, the administrators of the institutions that offer the course, and the communities those institutions serve. I sought to give voice to instructors because few, if any, studies have considered this problem from the point of view of the instructor and because instructors represent the intersection of the four groups affected by the problem. This study was guided by the following research questions:

1. What beliefs do these instructors hold about mathematics as a discipline?
2. What beliefs do these instructors hold about the teaching of mathematics?
3. What beliefs do these instructors hold about adults' learning of mathematics?
4. What do these instructors believe are the causes of the high failure rate in College Algebra?

The literature on College Algebra, adults learning mathematics, and teacher beliefs informed this study. The literature on College Algebra falls into four categories: effectiveness studies, predictive studies, bridging the gap studies, and instructor characteristics studies. Effectiveness studies focus on the effectiveness of a particular teaching method or other aspect of teaching College Algebra. Predictive studies aim to predict whether, based on certain characteristics, a student will succeed in College Algebra. Bridging the gap studies focus on the gap between high school and college mathematics and are often predicated on the assumption

that the high failure rate in College Algebra is due to poor high school preparation. Studies of developmental mathematics courses are included in this category because the purpose of these courses is to bridge the gap between high school and college mathematics. Instructor characteristic studies look at the effect certain characteristics, such as employment status, have on student performance.

The literature on adults learning mathematics often alludes to the emotional or psychological aspects of learning mathematics (Burton, 1987; Coben, 2000; Colwell, 2000; Evans, 2000; Fitzsimons & Godden, 2000; Llorente, 2000; Maxwell, 1989; O'Donoghue, 2000; Safford, 2000; Wedege, 1999). One construct for describing the emotional element of succeeding in College Algebra is self-efficacy. This construct was defined by Bandura (1977) as a person's belief about whether he can or cannot succeed at a particular task. Self-efficacy should not be confused with self-concept. Pajares and Miller (1994) explained that self-concept is one's belief about his ability to do mathematics in general while self-efficacy is one's belief about his ability to perform specific tasks. They warned against confusing self-efficacy with self-concept, but it is fair to talk about self-efficacy with regard to a particular course. Self-efficacy has been strongly correlated with student performance (Hackett & Betz, 1989; Hoffman & Spataru, 2008; Pajares & Miller, 1994, 1995; Pietsch, Walker, & Chapman, 2003; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). And, many authors have explored ways to improve students' self-efficacy (Hekimoglu & Kittrell, 2010; Margolis & McCabe, 2006; Siegle & McCoach, 2007).

Teachers' beliefs are important because they influence their actions. A modified version of the framework suggested by Ernest (1989) was used to analyze the beliefs of the participants in this study. Ernest suggested three views of the nature of mathematics (instrumentalist, Platonist, and problem-solving) with corresponding views of teaching and learning. To these

three, I added the combination view, which incorporates both the Platonist and problem-solving views and is associated with the problem-solving view of teaching and learning. Ernest suggested these views are translated into classroom practices but acknowledged that a person's actions are not solely determined by his beliefs. Actions are also influenced by a person's social context and level of thought.

The teachers in this study were all affiliated with open-admission institutions in Georgia and each had at least 10 years of experience teaching and had taught College Algebra multiple times. Mature instructors were intentionally chosen because I wanted participants with fully formed and firmly held beliefs about mathematics, teaching, and learning. I was not interested in how their beliefs developed but in what they were at the given time. The participants represented a variety of educational backgrounds and work experiences. Each participant completed a background questionnaire and three interviews. During the third interview, participants were given a brief summary of their views on mathematics, teaching, and learning in order to member-check the initial analysis. A second member-check was conducted after the third interview when participants were given a chance to rank five reasons for the high failure rate in College Algebra. These reasons were chosen based on an analysis of the interviews, and participants were allowed to provide different reasons or to omit any of the given reasons.

I used the modified version of Ernest's (1989) framework to analyze my participants' beliefs about mathematics, teaching and learning. I found that only one participant expressed an instrumentalist view of mathematics. At least in terms of College Algebra, she saw mathematics as "an accumulation of facts, rules, and skills to be used in the pursuance of some external end." (Ernest, 1989, p. 250) As is to be expected with this view of mathematics, she used the instructor

model of teaching, meaning she strictly followed the externally imposed curriculum and saw learning as a mastery of skills.

Similarly, only one participant had a Platonist view of mathematics. He viewed mathematics as a “static but unified body or certain knowledge. Mathematics is discovered, not created” (Ernest, 1989, p. 250). Many of his teaching methods fit with an instructor model of teaching, but his belief that it was important for students to see formulas derived fits better with an explainer model. He was pleased when students mastered skills but saw learning as an ability to apply these skills.

The remaining four participants had a combination view of mathematics, but only one employed a facilitator model of teaching in College Algebra. Another preferred a facilitator model of teaching, in general, but employed an explainer model of teaching in College Algebra. In College Algebra, she felt limited in her teaching by the administration, the curriculum, and the students. Two other participants also employed the explainer model of teaching and seemed to prefer it. Although they acknowledged the benefits of activities that allow students to construct their own understanding, they did not see such activities as essential and felt limited by time in trying to use them. For one of these participants, learning was associated with students developing their own understanding of the material and being able to apply this understanding to solve and pose problems. He was frustrated because his students were not able to do this. In contrast, the other three participants were satisfied when their students went beyond the simple mastery of skills to a level where they could apply these skills to novel situations.

In addition to using Ernest’s (1989) framework, I analyzed the data by identifying themes regarding the participants’ beliefs about mathematics, teaching and learning. First, they believed not everyone could learn mathematics equally well. This belief about the nature of mathematics

and people's ability to learn it was related to their beliefs about how mathematics should be taught and the responsibilities of the teacher. Second, the participants did not see technology as essential to teaching mathematics to adults. This belief may be connected to their belief that student-teacher interaction is essential to learning mathematics as some of the participants thought technology hindered their direct interaction with students. Finally, the participants agreed that students are responsible for their own learning despite the fact that adults face many impediments to learning mathematics.

With regard to the fourth research question about the high failure rate in College Algebra, I identified four broad themes with sub-themes for each. First, curriculum issues include the following: there is too much material in the College Algebra curriculum for the time allowed, the material covered in a College Algebra course may not be the mathematics these students need, and the College Algebra course may be the place where students are required to shift from elementary to advanced mathematical thinking. Second, administrative issues that could be affecting the high failure rate in College Algebra are that students are not properly placed in the course, that the course is intended to differentiate weaker students from stronger students, and that a large number of adjunct or part-time faculty teach College Algebra. Next, issues associated with mathematics teachers are that students are not adequately prepared for College Algebra and that teachers are not adequately prepared to teach College Algebra. Finally, issues related to students include the following: the increasing number of people going to college, interference from family and work responsibilities, lack of understanding how to study, lack of motivation to study, students' refusal to take responsibility for their own learning, and students' lack of belief they can succeed in College Algebra. Several of the student issues taken together are examples of self-efficacy.

Conclusions and Implications

The results of this study lead me to five major conclusions: 1) There may be a better curriculum for students who will not take calculus. 2) Time constraints affect both College Algebra instructors and students. 3) Teachers need additional preparation to teach College Algebra. 4) Students are not adequately prepared for College Algebra. 5) Self-efficacy issues are the main reason students fail College Algebra. Each of these conclusions has implications for college administrators and/or College Algebra instructors.

A Better Curriculum

The content in a traditional College Algebra course is designed to prepare students to take subsequent mathematics courses such as trigonometry, precalculus, and calculus, and thus the content focuses heavily on algebraic procedures that are needed for these more advanced courses. But many students are required to take College Algebra who do not intend to and are not required to take additional mathematics courses. Although not all of my participants thought a different curriculum would be appropriate, those who did felt very strongly that a different curriculum would be better for students who will not take calculus.

Adam was perhaps most vocal in this belief. For example, in response to the email asking him to rank the reasons for the high failure rate in College Algebra, he wrote this in as an additional reason. Fran was also adamant that the mathematics in the College Algebra course was not useful to her students. She cited this as the reason she saw her role as the teacher in the course to be to help students pass more than to help them gain mathematical understanding. The primary concerns regarding changing the curriculum were a fear that the course would not be as rigorous and that students would not be able to as easily change to a major or career that required calculus. To the latter of these concerns, Adam responded

That's hooley, what they mean is they would have to take another course. They would have to pay extra dollars. They'd have to pay the time to then go back and do the formal College Algebra, pre-calc sequence to prepare for calculus. But mightn't they be more successful? (interview, October 8, 2010)

The main implication of the conclusion that there may be a better curriculum for students who will not take calculus is that colleges should consider whether College Algebra is the correct course for students to take. This consideration appears to be taking place. For example, Gail, in her role as an administrator talked to her program directors and advisory committees about whether students in particular majors really needed College Algebra. Similarly, Athens Technical College recently stopped requiring nursing students to take College Algebra and began letting these students take mathematical modeling. Although mathematical modeling is commonly used to replace College Algebra, there may be better choices for the mathematics someone not reaching the level of calculus should take. For example, Adam suggested a course that focused on topics such as fair division and Arrow's impossibility theorem. Also, Beth emphasized the importance of understanding statistics in the modern world.

Time Constraints

All six participants cited time as a constraint on the success rate in College Algebra. Time was a consideration both in the amount of time given to cover the topics and also in the way the course is scheduled. In terms of the amount of time relative to the amount of material to be covered, time affected the way the instructors taught. Time limitations often resulted in direct teaching being the preferred method. For example, Carl stated his primary limitation in using technology was time. Similarly, Fran and Gail would have liked to incorporate more student-centered activities into their teaching but did not feel they had time to do so. Both Fran and Gail noted a quarter is a relatively short amount of time to thoroughly cover all of the material. Although a quarter and a semester have the same number of contact hours, how those contact

hours are scheduled affects learning. Traditionally, but not always, classes meet for five 50-minute sessions per week under the quarter system. In the semester system, it is common for courses to meet for two 75-minute sessions instead. As Adam said,

the difference is a 50 minute class versus a 75 minute class, and the whole idea is that it's the same number of contact hours, but the packaging is completely different, and man does that, really thinking about connections and cohesiveness, man does make a difference. (interview, August 20, 2010)

Most of the instructors taught under the quarter system and believed the semester system would be more advantageous to students. Beth, Emma, and Gail, for example, thought 15-week semesters would allow more time outside of class for students to process and understand the information covered in class than 10-week quarters. Although semesters seem to offer advantages, Adam and Emma raised concerns about the longer class times associated with sections meeting twice per week under a semester system. Both thought long class sessions made it harder for students to pay attention during the entire class. Adam suggested that what could be covered in two 75 minute sessions was not equivalent to what could be covered in three 50 minute sessions. Based on these comments, the ideal scheduling for College Algebra may be a course that meets three times per week (50 minutes per session) under the semester system. Such a schedule would allow students to focus for the entire classroom session and to have sufficient time outside of class to process and understand the material.

As the technical colleges change from quarters to semesters, the conclusion that time constraints may affect instructors and students has obvious implications for scheduling courses. Administrators may want to refrain from scheduling College Algebra courses to meet only once or twice a week. As course scheduling is often constrained by room availability, administrators may want to think creatively when scheduling College Algebra. For example, a classroom-web hybrid course could be effective. In such a scenario, a College Algebra course could meet five

times a week—three times in the classroom and twice online. Such a course might offer students the advantages of both the quarter and the semester systems.

Teachers Need Additional Preparation

In addition to teaching methods being limited by time, they may also be limited by the instructor's preparation to teach the course. In order to teach the course, The Commission on Colleges of the Southern Association of Colleges and Schools (an accrediting agency) requires instructors to have a master's degree and 18 hours of graduate level mathematics. There is no requirement to have any pedagogical or andragogical³ preparation. Several participants believed that having some understanding of teaching and learning theory or pedagogy would be helpful to instructors. Beth explained that mathematical knowledge was not sufficient to teach College Algebra and noted that "We both know there are people out there with Ph.D.s who can't teach at all" (interview, September 21, 2010) But, she also warned there were people with backgrounds in mathematics education who were not exemplary teachers.

The need for additional preparation has implications for staff development. As an administrator, Gail tried to help faculty develop an understanding of topics such as learning styles. Adam thought it was important for faculty, both full and part-time to have discussions about pedagogy. He suggested it would be beneficial for administrators to schedule more time for these discussions to occur. Emma lamented that the education courses she took were not specific to mathematics and suggested that content-specific training would be most beneficial. Administrators may want to consider offering staff development programs that are specific to the mathematics taught at their institutions.

³ Andragogy is synonymous with pedagogy but refers to adults rather than children.

Students Are Not Adequately Prepared

In addition to better preparing College Algebra instructors, students also need better preparation. The participants in this study believed many of their students were not adequately prepared for College Algebra. The causes for this inadequate preparation were three-fold: students may have passed courses in high school or college without understanding the material well enough to succeed in the next class, students may be placed in College Algebra when they really need to be in developmental studies, and students may not be prepared to be responsible for their own learning.

With regard to student having passed pre-requisite courses without sufficient understanding of the material, Emma noted students who squeaked by with a 70 in the pre-requisite course struggled in College Algebra. Although she lamented the fact these students were moving on before they were ready, she recognized that when she was assigned to teach a developmental studies course, she may have passed people who were not ready to take the next course. She stated,

If you're going to put me in the developmental studies class, I am going to try to pass everybody I reasonably can. I'm not going to give a grade away, but I'm gonna go above and beyond; I'm gonna try to get that student to pass if at all possible. (interview, September 16, 2010)

The participants also thought students were often placed in College Algebra when they should have been placed in developmental studies and thought the commonly used placement test did a poor job of properly placing students. Only Fran thought it did a good job. In contrast, she believed college admissions scores were a poor predictor of success in College Algebra.

In addition to not being mathematically prepared or not being properly placed, students often were also not prepared for the level of responsibility required in a College Algebra course. In discussing the difference between high school and college, Emma noted that in high school

there is a lot of hand holding, but once you get to college “It’s like, ‘Here’s your homework, here’s your test days, you’re pretty much responsible for it, I’ll remind you in class,’ but that’s pretty much it. That’s a big change” (interview, September 16, 2010).

There are implications from the conclusion that students are not adequately prepared for College Algebra for both administrators and instructors. Administrators should examine placement procedures to determine what combination of course experiences and test scores lead to success in College Algebra. Adam indicated his institution had gathered data and attempted to answer this question for its students. Administrators might also attempt to educate students about the different level of responsibility they will have to assume in college. Many institutions have an “orientation to college” type course that they require developmental studies students to take. Something similar, but shorter in duration, might be appropriate for all entering students.

For instructors, the main implication is really a question: What should it mean when a student passes your course? Should it mean that the student is prepared for the next course? If this is the case, what changes will you need to make to ensure that someone passing your class is prepared for the next course? Will you need to try new teaching methods or make your testing more rigorous so that students must demonstrate mastery of the concepts? If instead we accept that passing a prerequisite course may not mean the student is prepared for College Algebra, what responsibilities do the College Algebra instructors have to address this gap?

Self-Efficacy Issues

Self-efficacy, one’s belief about whether he can or cannot succeed at a task, is tied to student preparedness among other things. Because past performance affects self-efficacy, having struggled with certain topics in a pre-requisite course may lead to poor self-efficacy related to those topics in College Algebra. Interestingly, my participants saw issues related to poor self-

efficacy in College Algebra as the primary reason students struggle in the course. When given the opportunity to rank possible reasons for the high failure rate in College Algebra, the five participants who responded ranked the following two reasons the highest: students do not spend sufficient time studying and students do not believe they can succeed in College Algebra.

On the surface, it may not be clear that students not spending sufficient time studying could be tied to poor self-efficacy. One might assume students do not spend much time studying because they are lazy, distracted, or unmotivated. Although this may be the case for some students, other students may be giving up on homework problems because they do not think they are capable of solving the problems. In other words, poor self-efficacy related to the homework problems stops them from persevering, and without perseverance they will not succeed. Bandura (1993) made this connection between self-efficacy and motivation. He specifically noted self-efficacy affects the amount of effort a person will expend on a task and how likely the person is to persevere in the face of failure at a task.

It is not surprising that College Algebra students would not believe they can succeed in College Algebra or in other words that they have low self-efficacy with regard to the mathematical tasks in the course. Normally, College Algebra students would have seen the material in the course multiple times in previous courses. If these students had always been successful, they likely would be starting college by taking calculus or another higher-level course. Thus, we can hypothesize these students lack the performance accomplishments that lead to positive self-efficacy.

The implication of the conclusion that student self-efficacy is the main reason students struggle in College Algebra is that instructors and administrators must find ways to improve it. The literature on self-efficacy offers many relatively simple suggestions for how instructors can

positively influence self-efficacy. For example, both Siegle and McCoach (2007) and Margolis and McCabe (2006) suggest ways teachers can help students have and recognize performance accomplishments, provide appropriate vicarious experiences, and give effective verbal persuasion.

Future Research

Based on this study there are multiple future studies that could be conducted. First, the data and conclusions from this study could be further examined. One extension could be to do classroom observations of the participants in order to make links between their stated beliefs and their actions in the classroom. In addition, existing data could be further analyzed and more data collected as needed in order to examine how the participants developed their beliefs. Did they see things the same way as a novice teacher as they see them as a mature teacher?

Second, the results of this study are limited to the beliefs of a small group of instructors in a limited geographical area and in a particular type of institution (open-admission colleges). In order to see whether these results are generalizable, this study would need to be conducted multiple times using instructors from various locations and different types of institutions.

Third, research should be conducted to investigate what type of mathematics students should study instead of College Algebra. Some questions to explore include: Are the existing mathematical modeling courses the best alternative? What topics should students be learning? What skills should students be developing? One way to approach these questions would be to study technical college graduates in their major courses, clinical placements, or job settings and conduct a task analysis to determine what types of mathematical decisions they regularly make. Because their use of mathematics is not limited to the workplace, these same individuals could be studied in their home environments to see what mathematical skills would benefit them in

their personal lives as well. For example, many participants in this study assumed students' primary use of mathematics outside the classroom was in making financial decisions. A task analysis study could test this hypothesis.

A fourth study that could follow up this research would be one looking at the scheduling of College Algebra in an effort to determine whether how often a class meets or for how long a class meets has an effect on student success in the course. For example, it is not uncommon to have sections that meet once a week, three times a week, or online. A properly designed study could investigate whether student performance is related to how often the course meets. If a relationship existed, one could consider whether other factors affected this relationship. For example, it would not be surprising to find that more students who work full-time choose classes meeting once a week and that this fact is involved in the relationship between student performance and how often the course meets.

A final area of research that could build on this study is an exploration of student's self-efficacy. The participants in this study thought that many students do not think they can succeed in College Algebra and that this belief becomes a self-fulfilling prophecy. A study exploring the self-efficacy of College Algebra students could help us determine whether this hypothesis is true. In this situation, a mixed methods study might be most appropriate. The students' self-efficacy beliefs could be explored qualitatively and then the correlation of those beliefs to performance in College Algebra could be examined quantitatively.

Parting Comments

Conducting this study has been beneficial to me as both a researcher and an instructor. As a researcher conducting my first autonomous work, I have learned much about which techniques are effective and which are not. For example, I found the use of member checking to be very

helpful in completing my analysis, but I would do it slightly differently next time. If I were to conduct this study again, I would do a much more in depth analysis before conducting the member-checking portion of my study. As a novice researcher I was unaware of how deep I would eventually go into my data.

As an instructor, I have been introduced to the concept of self-efficacy, and now that I am aware of it, I see it everywhere. I see how it affects me, my family, and the people with whom I currently work. I am grateful for the opportunity to have learned so much and am eager to return to the classroom to apply it.

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APPENDIX 1
QUESTIONNAIRE

Name: _____

- I. Educational Background
- a. Where did you go to high school?
 - 1. What was your favorite math class?
 - 2. What was your least favorite math class?
 - 3. Did you take any AP math courses? (please list)
 - 4. Did you take any college level courses?
 - b. Where did you go to college?
 - 1. What was your major?
 - 2. What was the first math course you took?
 - 3. What was your favorite math class?
 - 4. What was your least favorite math class?
 - 5. Other than math, which subjects did you most enjoy?
 - 6. Other than math, which subjects did you least enjoy?
 - c. Where did you go to graduate school?
 - 1. What degrees did you receive? (please list)
 - 2. What was your favorite math course?
 - 3. What was your least favorite math course?
 - d. Were there any people or events that motivated you to study or teach mathematics?
 - e. Do you have any formal education with regards to teaching mathematics?
 - 1. Did you find the courses helpful when you began teaching?
 - 2. Did your courses focus on teaching children or adults?
 - 3. Have you ever studied the NCTM standards?
- II. Teaching History
- a. How long have you been teaching mathematics?
 - 1. Where have you taught mathematics?
 - 2. Please list the mathematics courses you have taught.

- b. How long have you been teaching College Algebra?
 - 1. At what institutions have you taught College Algebra?
 - 2. Have you taught any developmental studies courses?
- c. Have you had any jobs that did not involve teaching mathematics?
 - 1. What did you like about those jobs?
 - 2. What did you dislike about those jobs?

APPENDIX 2

INTERVIEW PROTOCOL #1

1. Refer to the background information collected prior to the interview and ask the interviewee why the various courses were favorites or least favorites.
2. Refer to the background information collected prior to the interview and ask the interviewee about the people and/or events that motivated study of mathematics.
3. Refer to the background information and ask the interviewee about jobs other than teaching mathematics.

- a. What did you like/dislike about this job?
- b. Did you use mathematics in it? How?

4. Mathematics is most like:

language
religion
art
sports

botany
music
philosophy
grammar
Other _____

Which simile best describes mathematics? Why?

5. What is “elementary” mathematical thinking as opposed to “advanced” mathematical thinking?
 - a. Which type of thinking does College Algebra involve?
6. What is the purpose of studying mathematics at the post-secondary level?
 - a. What is the purpose of students taking College Algebra?

- b. What mathematics should someone earning an associate's degree know?
 - c. What types of mathematics do adults need to understand?
 - d. What kinds of mathematics do you think your students can do in the "real world"?
Does it differ from what they can do in the classroom?
7. In what ways do your students think differently about mathematics than you do?
8. How do you think your former College Algebra students utilize what they learned in your course?
9. What is your favorite mathematics course to teach? Why?
10. Which courses do you least like to teach? Why?

APPENDIX 3

INTERVIEW PROTOCOL #2

1. A mathematics teacher is like a:

news broadcaster	entertainer
Doctor	orchestra conductor
Gardener	coach
Missionary	social worker
	Other _____

Which simile best describes mathematics teaching? Why?

2. Learning mathematics is like:

working on an assembly line	watching a movie
cooking with a recipe	picking fruit from a tree
working a jigsaw puzzle	conducting an experiment
building a house	creating a clay sculpture
	Other _____

Which simile best describes learning mathematics? Why?

3. Succeeding in College Algebra is most like succeeding at:

a marathon	playing the piano
a triathlon	English composition
losing weight	acting
saving for retirement	developing a vaccine
	Other _____

Which simile best describes succeeding in College Algebra? Why?

4. Do many students fail College Algebra at your institution?

- a. Why do you think so many fail/succeed?
- b. Are the right students taking College Algebra?

5. Do many students fail **your** College Algebra course?

- a. Why do you think so many fail/succeed?
6. Are there other courses at your institution with similar failure rates?
 - a. What similarities/differences do these courses have with College Algebra?
7. Are most students adequately prepared for College Algebra?
 - a. Are students coming out of developmental studies courses better prepared than students who do not require remediation?
8. What preparation does one need to teach College Algebra?
 - a. What mathematical knowledge does someone need in order to teach College Algebra effectively?
 - b. What pedagogical knowledge does someone need in order to teach College Algebra effectively?
9. What types of instructional activities are most beneficial when teaching College Algebra?
 - a. Can you describe for me a lesson that you think went really well?
 - b. What methods work best when teaching adults? Do these methods work as well with children?
 - c. What types of technology do you use in your teaching?
 - i. What are the limiting factors with regards to using more technology in your teaching?
 - ii. Are there any effective uses of the internet in teaching mathematics?
10. What kinds of questions do you ask on tests?
 - a. Are these questions similar to homework questions?
 - b. Is it enough for College Algebra students to be able to solve problems similar to examples in class or in the book or should they be able to solve non-standard problems?
 - c. Do you think it is fair to have a test question that is not similar to something students have seen on test or in class?
 - d. Can you give me an example of a test question that really tells you a lot about a student's understanding of a topic?
 - e. Can you give me an example of an easy test question? Can you give me an example of a difficult test question?
 - f. Do you ever ask students to explain their reasoning or to generate examples on a test?
11. Do you ever have students that struggle on tests but seem to understand the material on the homework and in class? If so, why do you think this happens?

- a. How do you know when students understand what you have taught?
- b. Do you think someone who took College Algebra two years ago could pass the final today?

APPENDIX 4

INTERVIEW PROTOCOL #3

1. Allow participants to review previously gathered data. Is there anything you would like to change or further explain?
2. MIRACLE QUESTION: Is there something you feel you could do differently that would improve the rate of student success in College Algebra? What is preventing you from implementing these ideas—lack of time, lack of knowledge, lack of money, lack of support?
3. What types of students do you most enjoy teaching? What attributes in a student do you find most challenging?
4. What types of non-academic needs do your students have? Should teachers be addressing those?
5. How does a mathematics class at the post-secondary level differ from one at a high school level? How should high school/post secondary courses be the same? Different? How do adult learners differ from child learners? What is an adult?

6. Are you familiar with the new Georgia Performance Standards or any of the curriculums based on the NCTM standards such as *Investigations* or *Making Connections*? If so, would those types of curriculums be effective with College Algebra students? Why/why not?

APPENDIX 5

EMAIL MEMBER CHECK

I hope you had a happy holiday. I have begun analyzing the data from my interviews and have identified several themes regarding the reason for the high failure rate in College Algebra. Below is a listing of some commonly discussed themes. I would appreciate it if you could take a few minutes to rank these for me in order of relevance. If you do not think one of the themes listed is relevant to the failure rate in College Algebra, leave it off the list. If you think two items are equally relevant, you may give them the same rank. Also, feel free to provide comments on your ranking.

- a. Students are not adequately prepared for College Algebra.
- b. Students are not appropriately placed in College Algebra.
- c. Students do not believe they can succeed in College Algebra.
- d. Students do not spend sufficient time studying in College Algebra.
- e. There is too much material to cover in the time allowed.

Thank you for all of your assistance.

Margaret

APPENDIX 6

INITIAL ANALYSIS THEMES

1. What beliefs do these instructors hold about mathematics as a discipline?

- A. It is important for people to understand because it is useful; not everyone appreciates its usefulness.
- B. Mathematics exists outside the human experience, but humans construct an understanding of it.
- C. Mathematics is beautiful; not everyone appreciates its beauty.
- D. Not everyone can understand mathematics at the same level.
- E. Doing mathematics is doing problem solving/improves thinking.
- F. Mathematics is an essential form of communication between humans.

2. What beliefs do these instructors hold about the teaching of mathematics?

- A. The role of a teacher is not limited to being a content expert; Teachers must also inspire students.
 - i. mathematics teachers can be intimidating
 - ii. teachers facilitate, but are not responsible for, learning
 - iii. a good teacher can motivate students to want to learn
- B. The traditional lecture format (direct teaching) is the best way to teach mathematics.
- C. Interaction with students is essential to teaching.
 - i. student attitudes determine whether teaching a particular course is pleasurable
- D. Technology is not essential to the teaching of mathematics.

- i. technology is primarily a method for delivering content
- ii. technology can hinder learning

E. An instructor should have a solid background in mathematics and an interest in teaching

3. What beliefs do these instructors hold about adults' learning of mathematics?

A. Not all people can learn mathematics equally well.

- i. few people retain what they learn over time

B. Students are responsible for their own learning

- i. practice is essential for learning mathematics

C. Adults face many impediments to learning mathematics in college

- i. emotional baggage
- ii. lack of study skills
- iii. life responsibilities
- iv. too much reliance on tutors and tutorials

D. People need to have a strong foundation with concrete skills (arithmetic skills, factoring, solving equations, etc.) in order to learn more abstract mathematics.

4. What do these instructors believe are the causes of the high failure rate in College Algebra?

A. Student issues

- i. lack of motivation
- ii. lack of understanding how to study
- iii. interference from outside problems (family, work, etc.)
- iv. refusal to take responsibility for their own learning
- v. lack of belief that they can succeed in mathematics

vi. more people are going to college

B. Curriculum issue

i. too much material for time allowed

ii. some material could be deleted (not necessary)

iii. may not be the math these students need

iv. shift from elementary to advanced mathematical thinking

v. students who do not take college algebra limit their future choices

C. Administrative issues

i. student placement in college algebra

ii. use of college algebra as a weed out course

iii. overuse of part-time faculty

D. Teacher issues

i. students are not adequately prepared

ii. teacher preparation

iii. teachers have low expectations of students