ADULT STUDENT LEARNING BEHAVIORS IN A ROADBLOCK MATHEMATICS COURSE

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ROADBLOCK MATHEMATICS COURSE

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ABSTRACT

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Adult students are a growing population on college campuses. Adult students have lower graduation rates and longer times to graduation than traditional-age students. The ability to pass a college level mathematics course is a key factor in the graduation rates of all students. Past research has identified developmental mathematics, college algebra, and calculus as courses that have impeded students in realizing their educational goals. The purpose of this study was two-fold. First, through an analysis of transcripts of a cohort of students at Texas State University-San Marcos, the mathematics course that served as the greatest roadblock to the original educational goals of adult students was identified. Second, using a social constructivist framework, the behaviors of four adult students

enrolled in the identified course were examined in hopes of understanding what made the course difficult for adult students. The results of the transcript analysis pointed to Math 1319-Mathematics for Business and Economics 1 as the course that served as the greatest roadblock for adult students in the cohort. In the second, qualitative portion of this study, the adult students who struggled in the roadblock mathematics course had limited participation in classroom activities. Factors that inhibited participation included fear of embarrassment, the fast pace of the classroom discussion, and the perceived lack of adequate responses from the instructor to questions posed in class. An important indicator of adult student success in Math 1319 was the quality of the high school mathematics background of the adult students. Even though several adult students progressed successfully through the developmental mathematics program before enrolling in Math 1319, several continued to struggle and believed that they did not possess the same mathematics knowledge as their younger classmates. Continuing academic support for adult students in college level mathematics courses may be needed to ensure the success of adult students in reaching their educational goals.

CHAPTER 1

INTRODUCTION

Students over the age of 25 are one of the fastest growing demographic groups on college campuses today (Van der Werf, 2009). In 2008, over a third of students at degree-granting institutions in the United States were 25 or older; this is expected to increase to over 40% by 2017 (National Center for Education Statistics [NCES], 2009). Adult undergraduates are contributing to the growing population of nontraditional students that now account for 89% of students in postsecondary education today and include commuter students, students that work fulltime, as well as adult students (Choy, 2002). As early as 1999, 46% of undergraduates in the United States had delayed entry into college for over a year after leaving high school (Bozick & DeLuca, 2005). These adult students enter college with unique characteristics that distinguish them from traditional-age students. Adult students often enroll in college with less academic preparation than traditional-age students (Calcagno, Crosta, Bailey, & Jenkins, 2007; Horn, Cataldi, & Sikora, 2005; Kasworm & Pike, 1994; Kasworm, Polson, & Fishback, 2002). Adult students are more likely to work over 30 hours per week, have dependent children, and commute to campus than younger students (Choy, 2002; Horn et al., 2005; Kasworm & Pike, 1994; Kasworm et al., 2002; Sandmann, 2010). Many adult students are first generation college-goers (Horn et al., 2005; Kasworm et al., 2002) and most adults who delay entry into college come from families with little economic support

(Bozick & DeLuca, 2005). Because of their complicated lives, adult students have little time to participate in campus activities (Donaldson & Graham, 1999; Graham, Donaldson, Kasworm, & Dirkx, 2000; Kasworm, 2008). All these factors put adult students at risk for not completing their college degrees (Adelman, 2006; Astin, 1999; Tinto, 1987). Understanding the characteristics and unique needs of this growing population of college students is important in order to provide them opportunities to succeed in their educational goals.

Adult undergraduates face barriers to their educational goals that distinguish them from traditional-age students. These include life-situation and dispositional barriers as well as academic barriers (Cross, 1981; Spellman, 2007). Because of their family and work obligations, adult students have limited time for their academic studies (Bourgeois, Duke, Guyot, & Merrill, 1999; Kasworm, 2008). In addition, adult students often cite finance-related or work-related reasons for leaving school (Bradburn, 2002; Schatzel, Callahan, Scott, & Davis, 2011). Often, women experience acute conflict between their domestic and academic roles. Many women are forced to withdraw from school because of family commitments and lack of adequate childcare (McGivney, 2004, Schatzel et al., 2011). Because of their many responsibilities, many adult students are only able to attend college part-time which lengthens the time needed to complete an educational program (Pusser et al., 2007; Sandmann, 2010).

Dispositional barriers that adult students face include the insecurity and doubts many adult students hold about their acceptance as students and their ability to perform as undergraduates (Cross, 1981; Kasworm, 2006). Another challenge for adult students is the social isolation many adult students experience on the college campus (Kasworm, 2006; Spellman, 2007). Because of their complex lives, adult students have limited time to spend on campus. In contrast to residential students who live on campus, adult students often do not have the opportunity to join campus social organizations, study groups, attend instructors' office hours, or take advantage of student support services. The classroom is the main focus of their educational experience (Donaldson, & Graham, 1999; Faust & Courtenay, 2002; Graham et al., 2000). Unfortunately, for new adult students who have been away from any academic setting for an extended period of time, it may be difficult to make sense of the "new and sometimes confusing culture of actions, words, and evaluative systems" found in the college classroom (Kasworm, 2003, p. 89). In addition, the majority of adult students fail to form relationships with their classmates which might serve to alleviate their feelings of isolation (Kasworm, 2006; Lundberg, 2003).

Adult students often enroll in college with uneven academic preparation. Adult students are more likely to have received a nontraditional secondary credential (Calcagno et al., 2007; Horn et al., 2005; Maralani, 2011) and often have lower high school grade point averages (GPAs) and lower scores on standardized tests than traditional-age students (Bozick & DeLuca, 2005; Kasworm & Pike, 1994; Kasworm et al., 2002). In contrast to this, adult students often score higher than traditional-age students on college placement tests in English and verbal skills (Calcagno et al., 2007; Kasworm et al., 2002). Mathematics is a particular area in which many entering adult students have less preparation than traditional-age students (Adelman, 2006; Calcagno et al., 2007; Horn et al., 2005; Kasworm et al., 2002; Kasworm & Pike, 1994). In addition to adult students scoring lower on mathematics placement exams (Calcagno et al., 2007; Kasworm et al., 2002), a quarter of students with delayed entry into college have completed only high school mathematics courses rated as non-academic (Horn et al., 2005).

In spite of these challenges, many adult students are successful in college (Donaldson & Graham, 1999; Kasworm & Pike, 1994). One reason for this is the high level of motivation` many adult students exhibit (Ross-Gordon, 2003). For adult students, completing a college degree often has been a long term goal. Adults view their experience in college as a "purposeful choice for a new and different future, a future of hope and possibilities" (Kasworm, 2008, p. 27). Adult students have practical goals for their education and see enrollment in college as a gateway to a better life (Compton, Cox, & Laanan, 2006; Pusser et al., 2007). A second reason for their success is the life experiences adult students bring to the classroom. These experiences form a framework which enables adult students to process and assimilate new information and situations (Compton et al., 2006; Donaldson & Graham, 1999). In addition, adults' life experiences can foster a determination to overcome obstacles in their lives (Carmichael & Taylor, 2005). Adult students are more likely to report a high level of satisfaction with their studies than younger students (Kasworm et al., 2002). Adult students who persist in their studies often have college GPAs comparable to traditional-age students (Graham et al., 2000; Kasworm & Pike, 1994).

In spite of being highly motivated and earning high grades in college courses, adult students complete their educational programs at a lower rate than younger students (Bozick & DeLuca, 2005; Bradburn, 2002; Calcagno et al., 2007; Choy, 2002; Horn et al, 2005; McGivney, 2004; Milesi, 2010; Schatzel et al., 2011; Taniguchi & Kaufman, 2005). While this may be due in part to non-academic factors, many researchers have demonstrated that high school preparation, particularly in mathematics, plays a major role in students earning their bachelor's degree (Adelman, 1999, 2006; Trusty & Niles, 2003).

Because of poor high school preparation and the lapse of time since being in an academic setting, mathematics is an area of particular concern for adult undergraduates (Calcagno et al., 2007; Horn et al, 2005). Research in adult students learning mathematics has given an ambiguous portrait of how adult students compare to traditional-age student in college mathematics classrooms. Adult students reported low levels of confidence to do mathematics in some studies (Civil, 2003; Leonelli, 1999; Peters & Kortecamp, 2010), but high levels in others (Elliott, 1990; Lehmann, 1987). Especially in lower levels of college mathematics, adult students reported the need to overcome negative attitudes and a lack of confidence in order to succeed in their mathematics courses (Civil, 2003; Lawrence, 1988; Leonelli, 1999). Studies comparing mathematics anxiety in adult and traditional-age students resulted in conflicting findings (Ulrich, 1988; Zopp, 1999). While adult students may bring negative attitudes and beliefs about mathematics to the classroom which may affect their learning (Lawrence, 1988; Nonesuch, 2006), adult students have been shown to be able to make grades comparable to traditional-age students in two studies that compared adult and traditional-age students in freshman-level mathematics courses (Elliott, 1990; Gupta, Harris, Carrier, & Caron, 2006).

Statement of the Problem

Because of the unique challenges adult undergraduates face, many adult students fail to achieve their educational goals. "Understanding the factors affecting the decision to drop out and recognizing differential completion rates for younger and older students is crucial for institutions and policy makers" (Calcagno et al., 2007, p. 219). Many researchers agree that adult students complete their educational programs at lower rates than younger, traditional students (Bozick & DeLuca, 2005; Calcagno et al., 2007; Choy, 2002; Horn et al, 2005; McGivney, 2004; Milesi, 2010; Schatzel et al., 2011; Taniguchi

& Kaufman, 2005). Calcagno, Crosta, Bailey, and Jenkins' (2007) research on completion rates at community colleges in Florida is particularly important for this study. A revealing aspect of Calcagno et al.'s research was that if the effect of pre-college mathematics achievement was taken into account, adult students shifted from being less likely to complete their educational programs to being significantly more likely to graduate than traditional-age students. This result emphasized the importance of mathematics as a factor in the success of adult students. Calcagno et al. concluded that adult students in community colleges graduate at lower rates than traditional-age students, not because of their age, but because of adults' needs to refresh their mathematics skills.

Several models have been proposed to understand student persistence in higher education. Tinto (1987) proposed a model based on students' integration into the academic and social systems of the postsecondary institution. Astin (1999) proposed that the amount of time and energy spent on campus and academic activities influenced student development and retention. Because of the limited time adult students have on campus and the social isolation many adults experience, both of these models predict high rates of attrition for adult students. While the attrition rate for adults is higher than for traditional students (Bozick & DeLuca, 2005; Calcagno et al., 2007; Choy, 2002; Horn et al., 2005; McGivney, 2004; Milesi, 2010; Taniguchi & Kaufman, 2005), many adult students are successful in attaining their college degrees (Kasworm & Pike, 1994; Donaldson & Graham, 1999). Bean and Metzner (1985) developed a model that focused on nontraditional—older, part-time, and commuter—students who cannot spend much time on campus. Bean and Metzner's model included the effects of a student's background, academic experiences in college, and external, environmental factors to explain nontraditional students' persistence in college. Focusing specifically on adult students, Donaldson and Graham (1999) developed a model for college outcomes for adults. This model was similar to Bean and Metzner's and incorporated the effects of prior life experiences, psychosocial and value orientations such as motivation and self-confidence, the different roles adult have in the multiple communities they live in, and the college classroom as the primary site of social interaction on campus. The two models that focus on nontraditional and adult students emphasize the importance of past life and academic experiences adult students bring to their college experience as well as the importance of the college classroom in influencing adult students' experiences in higher education. Because of the negative past experiences and attitudes many adult students have about mathematics, what happens in the mathematics classroom may have a great impact on the adult students' academic outcomes and indirectly influence the success of adult students attaining their educational goals.

This research focuses on the role of mathematics in adult students' success in attaining their educational goals in a 4-year university. Because mathematics plays a pivotal role in the success of adult students, there may be a particular mathematics course that acts as a roadblock to adult students' persistence in college. If this course were identified, measures could be taken to give adult students adequate support in this course. Success in gateway courses (those that are prerequisites for other, required courses), or roadblock courses (those that have been shown to block students' progress in college), plays a significant role in attaining a degree for traditional-age students (Adelman, 2006). This may also be true for adult students. This study proposed to first identify the mathematics course that presented the greatest challenge for a cohort of adult students in

4-year university, and second, to examine learning behaviors adult students exhibit in this course to help explain why this course acts as a roadblock to adults' success.

There are many factors that contribute to students' success in mathematics courses. Among these are the level of knowledge a student brings to the course; emotions, beliefs, and attitudes a student holds about mathematics; and the student behaviors employed in the course. This study is limited to understanding adult student success in a particular mathematics course. Because mathematics courses require prerequisite coursework or test scores before a student can enroll, all students in the targeted course should have a similar range of knowledge at the beginning of the course. Although emotions, beliefs, and attitudes about mathematics affect student success in mathematics courses (Nolting, 2007; Saxon, Levine-Brown, & Boylan, 2008), the direct impact of these factors on student success is "not simple, linear and unidirectional; rather it is complex and convoluted" (Grootenboer & Hemmings, 2007, p. 3). Because student learning behaviors can be tied directly to the success of students in college courses (Boaler, 1998; Lundberg, 2003; Michael, 2006; Rau & Heyl, 1990), and because learning behaviors are observable and confirmable, these will form the focus of this research. Prior knowledge and non-academic factors will be examined only in light of their influence on learning behaviors.

Donaldson and Graham's (1999) model of college outcomes for adults stressed the importance of the college classroom as the main site of learning for adult students. Donaldson and Graham recognized that adult students use the classroom differently than traditional-age students. While traditional-age students have the opportunity to augment their classroom experiences with outside learning assistance, adult students' learning is focused in the classroom. While these researchers assumed that knowledge is individually constructed, they also assumed that learning occurs as adults participate in the social learning community of the classroom. Donaldson and Graham's model was influenced by the social constructivist theories of learning. In mathematics, this theory was developed through the work of Bishop (1985), Bauersfeld (1988), and Cobb (2000).

The examination of learning behaviors to understand adult student success in a mathematics course draws heavily on the social constructivist theory in mathematics education (Cobb, 2000). Social constructivist theory, rather than viewing learning as an individual endeavor, focuses on the "acquisition of intellectual skills through social interaction" (Palincsar, 1998, p. 347). "Dialogue becomes the vehicle by which ideas are considered, shared, and developed" (Pritchard, 2009, p. 24). The ways adult students participate in the dialogue of the mathematics classroom influence their learning and success in the course. This study focuses on the learning behaviors of adult students in a roadblock mathematics classroom in order to uncover factors that make this course difficult for adult students.

In recent years, the National Council for Teachers of Mathematics has placed great emphasis on active learning (Callahan, 2008). Adults particularly benefit from active learning experiences and student-directed learning (Knowles, Holton, & Swanson, 2005; Nonesuch, 2006; Ross-Gordon, 2003). In mathematics courses, this is implemented by encouraging students' participation in class with whole class discussion and small group activities (Callahan, 2008). Understanding how and why adult students participate or don't participate in class discussions and activities will shed light on why the identified roadblock mathematics course acts as a barrier for adult students. Factors that affect students' level of participation in the classroom are known to include fear of being evaluated by peers (Neer & Kircher, 1989), lack of preparation for class (Howard, Short, & Clark, 1996) and, particularly for adults, the perception of the usefulness of the material presented in class (Kasworm, 2003; Knowles et al., 2005). Other factors that might affect adult students' participation include the isolation many adults feel in the classroom (Kasworm, 2006), adults' poor foundation in mathematics (Calcagno et al., 2007; Horn et al., 2005; Kasworm et al., 2002), and the insecurity many adult students experience when first entering college (Bourgeois et al., 1999; Kasworm, 2008).

Mathematics can negatively affect graduation rates for adult students (Calcagno et al., 2007). Because adult students' college experience is largely limited to the classroom, this places great importance on what happens in the mathematics classroom. Understanding which mathematics courses pose particular challenges for adult students and understanding the factors that influence adult's active participation in these mathematics courses is vital in supporting the success of adult students.

Scant research exists on adult undergraduate students. In a recent search of general education journals read by audiences interested in undergraduate education, only 1.27% of the 3,219 articles reviewed focused on adult students (Donaldson & Townsend, 2007). Of these, few focused on adult students in mathematics and how mathematics courses may affect educational goals. Another report described data and research on adult learners as "inconsistent and spotty" (Paulson & Boeke, 2006, p. v). This study will extend research on adult undergraduates in three ways. First, Calcagno et al. (2007) investigated the success of adult students at community colleges by analyzing transcripts, and determined that mathematics played a pivotal role in their success. Although both McGivney (2004) and Taniguchi and Kaufman (2005) examined adult student success in 4-year institutions, they focused on family, work, and other life situations and did not attempt to tie students' success to specific coursework. This study will extend Calcagno et al.'s research by analyzing transcripts of students at a 4-year university to determine the role that mathematics plays in the success of adult students in attaining their educational goals and identifying the mathematics course that poses the greatest roadblock for adult students. Second, roadblock mathematics courses have been identified for several student populations including underprepared students (Bryk & Treisman, 2010; Burton, 1987) and science and engineering students (Suresh, 2006; Treisman, 1992). No attempt has been made to identify a roadblock mathematics course for adult students who may have unique needs and challenges in mathematics. This study will address this void. Finally, past research on adult students' learning behaviors in college classrooms have produced conflicting results. This study will narrow the focus of past research to adult student learning behaviors (participation in classroom discussion and activities, homework and study strategies, and meetings with faculty or other students outside of class) in a roadblock mathematics course in order to understand adult learning behaviors and the factors that influence their level of participation in class.

Purpose of the Study

The purpose of this research is twofold. The first goal is to identify a roadblock mathematics course that poses particular difficulties for adult students in a 4-year university. The second goal is to examine the learning behaviors of adult students which may affect success in this course. By identifying this course, policies can be put in place to ensure adult students in this course get adequate support. By examining adult learning behaviors in this course instructors can be aware of how to encourage adult students to fully participate in their learning experiences.

Significance of the Study

This study is significant for three audiences—policy makers, mathematics educators, and adult students themselves. For policy makers, identifying a roadblock mathematics course for adult students will inform policy makers about the needs of adult students and the need for student support services for this course. Success in roadblock, or gateway, courses have significant influence on student success in earning a college degree. Identifying and monitoring adult student enrollment and success in these courses can allow administrators to track adult students' momentum through the educational process (Adelman, 2006). Students' learning behaviors can be tied to student success in college courses (Bell, Grossen, & Perret-Clermont, 1985; Boaler, 1998; Johnson, Johnson, & Smith, 1998; Michael, 2006; Rau & Heyl, 1990). Examining adult student behaviors in roadblock mathematics courses will aid in understanding why this particular course is a roadblock for adult students. Policy makers can weigh factors such as class size, class meeting times, and class durations to determine whether changes need to be made to this identified roadblock course in order to support active learning principles.

Reasons adult students give for their level of their participation will inform educators how to encourage adult students to participate more fully in the classroom. For adult students, the college classroom is the focal point of learning in college (Donaldson & Graham, 1999; Graham et al., 2000). The relationships formed in the classroom with faculty and other students make up the some of the most powerful influences of adult students' college experiences (Graham et al., 2000). Instructors who understand this and make efforts to foster relationships will enhance the learning experience of adult students and may influence their decisions to persist with their education (Faust & Courtenay, 2002; Neer & Kircher, 1989; Ross-Gordon, 2003). The results of this study highlight specific mathematics courses that are particularly difficult for adult students. Knowing which courses may pose particular problems for adult students will alert instructors for the need to monitor their adult students' progress in these courses.

Finally, adult students themselves, when presented with other adult students' experiences, may be encouraged to participate in the college classroom at higher levels. Adult students often feel isolated on campus (Kasworm, 2003, 2006; McGivney, 2004; Spellman, 2007) and enter college unsure of their academic abilities and their role as a student (Bourgeois et al., 1999; Kasworm et al., 2002). Reading about the experiences of other adult students and how these students negotiated and participated in a particularly difficult course might alleviate their insecurity and enhance adult students' college experiences.

Definition of Terms

Definitions of several terms used throughout this dissertation are provided here to provide the reader a clearer meaning of the terms as used in this document.

Adult student. The term *adult student* is used in this study to describe undergraduate students who are 25 years old and older and are working towards their first baccalaureate degree (Graham et al., 2000; Kasworm & Pike, 1994; McGivney, 2004).

Roadblock course. The term *roadblock course* is defined as a course that, because a student has difficulty earning a passing grade in the course, delays graduation or influences the student to either change his major to one not requiring the course or to drop out of college altogether. The terms *roadblock course*, *barrier course*, and *gatekeeper course* are used interchangeably in this study.

Learning behaviors. The term *learning behaviors* refers to the observable behaviors students use in and outside of the classroom. Because this study uses a social constructivist framework, the learning behaviors focused on in this study include participation in classroom discussions, participation in classroom activities, attending the instructor's office hours, and receiving learning assistance from either school sponsored student support services, private tutors, or classmates.

Affective factors. Affective factors are those "relating to, arising from, or influencing feelings or emotions" (Merriam-Webster, n.d.).

Belief. Belief is the "conviction of the truth of some statement or the reality of some being or phenomenon especially when based on examination of evidence" (Merriam-Webster, n.d.).

Mathematics anxiety. Mathematics anxiety "is a person's negative affective reaction to situations involving numbers, math and mathematics calculations" that interferes with performance on mathematics tasks (Ashcraft & Moore, 2009, p. 197).

Mathematics self-efficacy. Self-efficacy is defined as a person's beliefs of his capabilities of performing a task (Bandura, 1994). Self-efficacy influences "how people feel, think, motivate themselves, and behave" (Bandura, 1994, p. 71). Mathematics self-efficacy pertains to a person's beliefs about his capabilities of performing a mathematics task.

Developmental mathematics. Previously called preparatory, compensatory, or remedial; developmental mathematics courses address both the academic and non-cognitive factors such as "locus of control, attitudes toward learning, self-concept, autonomy, ability to seek help, and a host of other influences having nothing to do with students' intellect or academic skill" (Boylan & Saxon, 1998, p. 7) in the teaching of mathematics to prepare students for college-level mathematics. In this research, developmental mathematics refers specifically to the non-credit preparatory course for college algebra designed for students "who have graduated from high school with no more than the minimum mathematics requirements or for students who have been away from mathematics for a number of years" (Texas State University-San Marcos, 2012a).

Entry-level mathematics course. In this study, the term *entry-level mathematics course* refers to the first mathematics course a student attempts after enrollment in postsecondary education. These courses are typically taken in the freshman year. There may be several courses at a university that meet this requirement including developmental mathematics, college algebra, finite mathematics, mathematics for business majors, and others that satisfy the university's general education requirements.

Self-directed learning. Self-directed learning includes student input in identifying goals, resources, implementations, and methods of evaluation in the classroom (Ross-Gordon, 2003).

Engagement. Engagement with learning is "undertaking actions and activities, mental or physical, which center on the facts, the concepts or the skills in in question" (Pritchard, 2009, p. 29).

Research Questions

The research questions for this study are:

1. For a cohort of adult undergraduates pursuing their first baccalaureate degree at a four-year university, what mathematics course serves as the greatest roadblock to the successful completion of their originally declared major?
2. What learning behaviors do adult students use in the roadblock mathematics course and how do these differ from traditional-age students? What factors influence the learning behaviors? What influence do adult students' behaviors have on their success in the roadblock mathematics course?

Delimitations of Study

This study focuses on only a few limited aspects of adult persistence in postsecondary education and only limited aspects of student success in a roadblock mathematics course. While both theoretical and empirical studies focusing on adult attrition emphasize the role of financial difficulties, family obligations, and work obligations as major influences in the decisions for adults to withdraw from college (Bean & Metzner, 1985; Donaldson & Graham, 1999; McGivney, 2004; Schatzel et al., 2011; Spellman, 2007; Taniguchi & Kaufman, 2005), academic factors have a significant influence on student attrition (Adelman, 1999, 2006; Bradburn, 2002). This study considers only the academic factors and in particular, the role of mathematics, in the persistence of adult students.

Student success in mathematics courses are influenced by affective factors (Nolting, 2007; Saxon et al., 2008) and past experiences in mathematics (Burton, 1987; Civil, 2003; Diamond, 2001; Safford, 2002). A student's active participation in classroom discussions and classroom activities in the mathematics classroom also have an impact on success (Boaler, 1998; Johnson et al., 1998; Michael, 2006). Because the college classroom is the focal point of learning for adult undergraduates (Donaldson & Graham, 1999; Graham et al., 2000; Kasworm, 2003), this study focuses on the learning behaviors adult students exhibit in the mathematics classroom in order to understand why this course may present particular difficulties for adult students and considers affective characteristics and past experiences only as they influence current learning behaviors.

Third, although community colleges have a larger percentage of adult students than 4-year institutions (Choy, 2002), the population of adult students in 4-year institutions is growing (NCES, 2009). This study focuses on adult undergraduates in a 4-year institution to better understand this growing population.

CHAPTER 2

LITERATURE REVIEW

The purpose of this study is two-fold. The first goal is to identify a mathematics course that acts as a roadblock for adult undergraduates pursuing their first baccalaureate degree in a 4-year university. The second goal is to examine the learning behaviors of adult students in that course. In this chapter, past research is presented that forms the background for this study. The literature review is divided into two main sections. This first section gives background material for the first research question: At a 4-year university, what mathematics course serves as the greatest roadblock to the successful completion of adult students' degree programs? The second section addresses the second research question: What learning behaviors do adult students exhibit in a roadblock mathematics course?

Part 1: Adult Student Attrition and the Role of Mathematics

While adult undergraduates in 4-year institutions exhibit high levels of motivation (Ross-Gordon, 2003; Kasworm, 2008), experience satisfaction with their learning experiences (Bourgeois et al., 1999; Civil, 2003; Kasworm et al., 2002), and often have at least as high college GPAs as traditional-age students (Kasworm & Pike, 1994), they have lower rates of program completion than traditional-age students (Calcagno et al., 2007; Choy, 2002; Horn et al., 2005; McGivney, 2004; Schatzel et al., 2011; Taniguchi & Kaufman, 2005). Understanding the factors that influence adult undergraduate attrition and especially the role of college mathematics courses in contributing to adult attrition is the focus of this part of this study. This section of the literature review includes research on adult students in 4-year postsecondary institutions, adult students learning mathematics, the impact of mathematics on adult persistence in college, roadblock mathematics courses that have been identified for the general undergraduate population, and concludes with a theoretical framework for understanding adult student attrition.

Adult students in 4-year postsecondary institutions. Between one third to one half of undergraduate students in the United States are over 25 years of age. In 4-year public institutions of higher learning, about 37% of undergraduates are adult learners (NCES, 2009). At Texas State University-San Marcos, the site of this study, 18% of undergraduates are 25 years of age or older (Texas State University-San Marcos, 2012b).

Research on adult undergraduates has been complicated by the varied definitions for the term *adult student* (Bourgeois et al., 1999; Galligan & Taylor, 2008; Lundberg, 2003; Paulson & Boeke, 2006). Some researchers identify adult students by chronological age but use varying lower limits of 21, 25, or 30 in their definitions (Compton et al., 2006; Justice & Dornan, 2001; Kasworm & Pike, 1994; Kasworm et al., 2002; McGivney, 2004; Sandmann, 2010; Slotnick, Pelton, Fuller, & Tabor, 1993). Some researchers define adult students by identifying life experiences reflecting past major full-time responsibilities in careers, family roles, or military training (Bourgeois et al., 1999). Others include adult students along with other nontraditional students (Bean & Metzner, 1985; Choy, 2002) or with students with delayed entry into postsecondary education (Bozick & DeLuca, 2005; Horn et al., 2005; Maralani, 2011; Milesi, 2010). Nontraditional students are identified by life situations. The definition of nontraditional also differs when used by different researchers. Bean and Metzner (1985) defined nontraditional students as being older, part-time students, or commuter students. Choy

(2002) extended this definition to include students who have dependents other than spouses, have delayed entry into higher education, who work more than 35 hours per week, or did not earn a high school diploma. Compton, Cox, and Laanan (2006) opposed the grouping of adult students with other nontraditional students because of the unique characteristics adult students have that other nontraditional students do not share. These characteristics include that adult students are more likely to be pursuing a vocational certificate or degree, that adult students have focused goals for their education, and that adult students view themselves primarily as workers and not students. For this study, the term *adult student* is defined only by the age of the student and does not infer other characteristics. While the adult student population is diverse, distinguishing students who are 25 years and older “presents a practical way to separate and define a group of students who have greater maturity, more complex life experiences, as well as more significant heterogeneity and complexity than those who are younger” (Kasworm et al., 2002, p. 3). Additionally, because this study involves transcript analysis which does not include family and work information, identifying adult students by age seems practical.

Students over 25 years of age have different needs, different learning preferences, and face different challenges than their younger classmates. This section of the literature review includes a brief overview of research in adult learning, research on adult students’ persistence in postsecondary education, examples of some of the unique challenges faced by adult learners, and finally research on unique issues involving teaching adult students.

An overview of research in adult education. Adult students first became an area of research in the early 1920’s with an interest in the effect of age on problem solving, memory, and intelligence. It became apparent that adult learners differed from children in complex ways (Merriam, 2001). In 1968, Knowles proposed the term *andragogy* to describe the techniques most useful for teaching adult students. As opposed to pedagogy, which refers to the art and science of teaching children, andragogy addresses the unique needs and characteristics of adult learners. Whereas teachers of children have absolute control over what is taught and how to teach, teachers of adults, who are often volunteer learners, must be sensitive to the needs of their students (Knowles et al., 2005). Knowles developed a model to understand adult learning based on the several assumptions. First, adults learn better when the relevance of what they are being taught is clear. Adult students prefer to see an immediate application of the materials to their lives outside of school. Second, adults have a psychological need to be self-directed in their learning. Adults prefer to participate in decisions about content and assessment. Third, adults, because of their varied life experiences, bring to the classroom rich, complex backgrounds which can be important resources in classroom discussions. These life experiences can also hinder learning as adults may also bring with them narrow points of view and prejudges that have been built up over their lives. The final assumption is that while children respond to outside motivators such as parental approval or good grades, adults are more affected by internal motivation. Adults are motivated to learn by the desire for increased job satisfaction, self-esteem, and a better quality of life (Kasworm et al., 2002; McGivney, 2004). These assumptions lead to the use of different techniques when teaching adults than when teaching children.

Interest in adult students in higher education increased greatly after World War II when the GI Bill allowed a large number of adult students access to universities. For the first time in the United States, university campuses were open to a more diverse, adult population (DiRamio, Ackerman, & Mitchell, 2008; Quinnan, 1997). From that time, college campuses have changed from a fairly homogeneous student body to include an increase of nontraditional students, including adults (Bozick & DeLuca, 2005; Choy, 2002; Milesi, 2010). The increase in adult students has resulted in research in the unique challenges adults face in a multigenerational university setting.

There is also an increasing interest in adult undergraduates as the demands of the nation's workforce require an ever higher level of education. According to a report by the Lumina Foundation, in 2007, there were 54 million workers in the United States that lacked a college degree (Pusser et al., 2007). Helping America's adult learners reach their educational potential would substantially benefit individuals, families, communities, and the national economy. Obtaining a college degree remains one of the gateways to a better economic future for individuals from lower socioeconomic backgrounds. In Texas alone, there are over three million adults over the age of 25 who have some college credit but hold no postsecondary degree (Texas Higher Education Coordinating Board, 2011).

Challenges unique to adult undergraduates. While adult students are a diverse population (Pusser et al., 2007; Smith, 2010), they share challenges that distinguish them from traditional-age students. Cross (1981) and Spellman (2007) categorized these challenges as situational, institutional, and dispositional. Adults often face academic challenges as well. These challenges may hinder adult students' progression through their educational program.

Adult students in 4-year universities have life situation challenges that put them at risk for not completing their college degrees. They are more likely to be married and have dependent children and to work more than 30 hours a week than traditional-age students. Fifty-six percent of adult students are married and 21% of female adult undergraduates are single parents (Kasworm et al., 2002). Because adult students have family and work obligations, many attend college part-time (Sandmann, 2010). Sixtynine percent of adult students attend school part-time while only 27% of traditional-age students attend part-time (Kasworm et al., 2002). Seventy-eight percent of adult students are employed full-time (Kasworm et al., 2002). One of the most stressful issues for adult students is the financial cost of college, as money must be diverted from family use to pay for college (Kasworm et al., 2002). Forty percent of adult learners earn less than $25,000 per year (Sandmann, 2010). Time and financial issues weigh heavily in adult students' decisions for continuing their education (Sandmann, 2010). Although life situation challenges pose weighty barriers for adult students, these issues cannot totally explain the higher attrition rate for adult students (Bozick & DeLuca, 2005).

Adult students also face academic preparation challenges. While incoming adult students often score higher than traditional-age students on placement exams in English and verbal skills, they score significantly lower in mathematics (Calcagno et al., 2007; Kasworm et al., 2002). The high school academic experiences of adult students and traditional-age students differ greatly. Adult students generally have a lower high school GPA and a lower rank in their high school class than traditional-age students (Kasworm et al., 2002). Adult students are more likely than younger students to have a nontraditional high school certificate rather than a formal diploma (Calcagno et al., 2007; Kasworm et al., 2002) and come from high schools with lower academic credentials (Horn et al., 2005). The weaker high school academic program many adult college students experience may influence their graduation rates as the intensity of a student's high school preparation is a major factor in whether that student earns a bachelor's degree (Adelman, 1999, 2006).

Adult students are particularly deficient in their high school mathematics preparation. Of students who delayed entry into college, one fourth completed only high school mathematics courses that were rated as non-academic—those named remedial or business mathematics. In contrast, only 7% of students who immediately entered college after high school took only mathematics courses rated as non-academic. In addition, 70% of immediate enrollers completed an advanced high school mathematics course—beyond Algebra 2, compared to only 15% of delayed enrollers (Horn et al., 2005). In one study, adult students rated their mathematics abilities significantly lower than traditional age students (Slotnick, et al., 1993). High school mathematics course-taking is important because of research that demonstrated that finishing at least one unit of an intensive high school mathematics course more than doubles a student's likelihood of completing a college degree (Adelman, 1999, 2006; Trusty & Niles, 2003).

The lower levels of the high school mathematics of adult students may be reflective of changing requirements for high school graduation. In Texas, these changes have resulted in students taking higher levels of mathematics in order to graduate (Texas Education Agency, 2011b). For students entering high school in 1994, the minimum requirement in mathematics was three credits including Algebra 1. In 2001, three credits in mathematics were still required, but these had to include both Algebra 1 and Geometry. Presently, while the minimum requirements remain the same, students and their parents must get special permission to take only the minimum requirements. All other students must complete four credits of mathematics including Algebra 1, Geometry, and Algebra 2.

In addition, in Texas, all students must pass a standardized exam in order to graduate from high school. These exams have become more rigorous since they were first introduced in 1986 (Texas Education Agency, 2011a). In 1986, an acceptable score on the Texas Assessment of Minimal Skills (TEAMS) was required for high school graduation. In 1990, the emphasis was changed from minimal skills to academic skills in the Texas Assessment of Academic Skills (TAAS). In 2003, the Texas Assessment of Knowledge and Skills (TAKS) became the exit exam for high school. This exam was more comprehensive and students were required to pass exams in each of the four subject areas tested, including mathematics. Currently, in an effort to increase the college readiness of high school graduates, end of course (EOC) exams have been instituted. High school students graduating under the recommended program must pass EOC exams in Algebra 1, Geometry, and Algebra 2.

These increasingly more rigorous requirements for high school graduation lead to adult students being less prepared than younger students. Students who graduated ten to fifteen years prior to their entry into college had much different high school academic experiences than their younger classmates. While most traditional-age students have at least been exposed to algebra 2 concepts, such as logarithms and matrices, for many older students, these are entirely new topics. This gap in their mathematics background puts adult students at a disadvantage in mathematics courses.

In addition to life situation and academic challenges, many adults face emotional and attitudinal challenges upon entering college life (Spellman, 2007). Although most adults express confidence in their ability to eventually succeed, many face insecurity and doubts as they negotiate the procedures of the institution, the time commitments and demands of course work, and the ego demands of classroom assessment (Bourgeois et al., 1999; Kasworm, 2008). After not being in an academic setting for many years, some adults are intimidated by the classroom environment (Spellman, 2007). In a qualitative study that focused on 23 adult undergraduates, many adult students believed they were "invisible" and undervalued in the classroom (Kasworm, 2006). As one junior-year adult student stated, “At times, I feel like a phantom, yet I also feel like I have to continue” (Kasworm, 2010, p. 148). Many adult students believe they need to prove themselves worthy of being in the selective, elite environment of a university. To become an “accepted” student, they work hard to become self-sufficient and are persistent in their studies (Kasworm, 2006). The need to appear self-sufficient may affect how adult students use academic support services such as tutoring centers and instructors’ office hours.

From a social viewpoint, many adults feel isolated from their younger peers (Spellman, 2007). Adult students rarely form personal friendships with their classmates (Kasworm, 2006). Adult students often have family and career obligations which compete for their time to attend campus activities. Many adults are unable to attend group study sessions with classmates (Kasworm, 2008). Adult students perceive themselves as different from traditional-age students and many view younger students as immature (Kasworm, 2006). As one adult undergraduate stated, “I take this a lot more seriously than does a younger student” (Slotnick et al., 1993, p. 50).

While adult students face definite challenges, some researchers believe that the maturity and life experiences that adult students possess make them more capable of learning than traditional-age students. Adult students are able to use their prior experiences to process new ideas and situations (Donaldson & Graham, 1999; Compton et al., 2006). Additionally, a common thread in research focusing on adult undergraduates is the high level of motivation adult students exhibit. Because their enrollment in college was a purposeful decision which often involved financial sacrifices, adult students often are more motivated than younger students (McGivney, 2004). Many times, completing college has been a long term goal. Many adults view their experience in college as a deliberate choice to improve their lives (Kasworm, 2008). Faculty often perceives adult students as being more responsible, self-directed, and motivated than traditional-age students (Ross-Gordon, 2003). Although some research points to evidence that adult students and traditional-age students have the same levels of motivations (Justice & Dornan, 2001), most researchers agree that adult students in general are highly motivated to succeed.

The studies above demonstrate that adult students have challenges that distinguish them from traditional-age students. While adult students often exhibit higher levels of motivation and often are confident of their eventual success in college, they face barriers such as initial insecurity, inadequate academic preparation, financial constraints, and family issues that keep them from earning their degrees.

Adult student persistence in postsecondary education. Early models of student persistence in postsecondary education emphasized the importance of social integration and time and energy spent in campus activities (Astin, 1999; Tinto, 1987). These models, which are discussed in more detail later in this paper, were developed for traditional students who enrolled directly after high school graduation, lived on campus, and were financially dependent on their parents. These models were inappropriate for adult students who had little time or inclination to spend on campus social events (Bean & Metzner, 1985; Donaldson & Graham, 1999; Graham & Gisi, 2000). New models were constructed to frame research on adult students that incorporated life situations, academic performance, and adults' beliefs about the utility of a college education (Bean & Metzner, 1985; Donaldson & Graham, 1999). Research on adult undergraduate persistence demonstrates the viability of these later models.

For all college students, the attrition rate is high. In a longitudinal study following students who were in the eighth grade in 1988, Adelman (2006) found that of students who started at 4-year institutions, only about 65% attained a bachelor's degree within six years of initial enrollment. The greatest attrition from postsecondary education occurred within the first year of initial enrollment (Bradburn, 2002; Choy, 2002). The academic intensity of a student's high school program was the best predictor of degree completion (Adelman, 1999, 2006). The highest level of high school mathematics was a key factor in attaining a college diploma. Students who had credit for Algebra 2 more than doubled their odds for attaining a bachelor's degree within eight years of initial enrollment (Adelman, 2006; Trusty & Niles, 2003). College mathematics courses also were important in predicting college graduation. Of students who graduated within eight years of enrollment, 70% had credit for a college level mathematics course by the end of their second year of enrollment (Adelman, 2006). This research demonstrates the importance of both high school and college mathematics courses in attaining a college degree. Other factors that contributed to withdrawal from school were the excessive dropping of courses and failure to obtain credit for "gateway" courses such as American literature, general chemistry, and introductory mathematics courses. Factors that positively influenced persistence were earning high grades and earning 20 credit hours by the end of the first year.

Adult undergraduates have greater rates of attrition from postsecondary education than traditional-age students (Bozick & DeLuca, 2005; Calcagno et al., 2007; Choy, 2002; Horn et al., 2005; McGivney, 2004; Milesi, 2010; Schatzel et al., 2011; Taniguchi & Kaufman, 2005). Of nontraditional students who first enrolled in 4-year institutions in 1995, only 51% were still enrolled after three years. After five years, only 31% had earned their bachelor's degree compared to 54% of traditional students (Choy, 2002). Twenty-one percent of all 25 to 34 year olds in the United States have enrolled in college at some point and have left without finishing their educational programs (Schatzel et al., 2011).

Adult students have characteristics that put them at risk for not completing their educational programs. These include inadequate academic preparation, the need to care for families, and the need to work. Many adult students cite family and work responsibilities as the major reason for not continuing their education (McGivney, 2004; Schatzel et al., 2011; Spellman, 2007). While female adult students are more likely to cite financial concerns, work schedules, and the difficulty in finding adequate childcare for leaving school, male adult students are likely to cite academic reasons (Schatzel et al., 2011). Adults often enroll in college unsure of their academic abilities. They exhibit "wavering courage and diminished belief in themselves" (Kasworm et al., 2002, p. 28). Academic progress may be influenced by past, negative academic experiences (Spellman, 2007). While less than 4% of nontraditional students cite academic problems as their reason to leave school (Bradburn, 2002), first year college GPA is a leading predictor of persistence in college for all students (Adelman, 2006, Bradburn, 2002). Because of academic, financial, and affective factors, 30% of adults students revisit the decision to continue in school each semester (Kasworm et al., 2002).

Effective practices in teaching adult students. Adult students have more complex and varied backgrounds than their traditional-age counterparts (Kasworm, 2003; Pusser et al., 2007). They have life experiences and prior knowledge and skills that they bring to the classroom. The life experiences adult students bring with them into the classroom influence their learning. While some research found no difference between adults' and traditional-age students' preferences for instructional style (Slotnick et al., 1993), other researchers emphasized teaching practices that enhanced adult student learning (Galbraith & Jones, 2006; Graham et al., 2000; Kasworm, 2003; Kasworm et al., 2002).

Consistent with the model of adult learning proposed by Knowles, Holton, and Swanson (2005), Kasworm (2003) found that adult students were more engaged with the material of a course when the content of the course was relevant to the adults' practical needs in their present or future lives. Kasworm interviewed 90 adult undergraduates from six institutions who met her criteria of being at least 30 year old, in good academic standing, currently enrolled in a baccalaureate program or in a college transfer program at a community college, and had completed at least 15 hours of academic, college-level coursework. The students reported different levels of engagement with the knowledge presented in class based on how relevant they saw the knowledge to their present or future needs. Most of the adult students felt that learning new material was enhanced by instructors who integrated adult-identified prior knowledge into the course content. Most valuable learning took place when the content was congruent to their adult life roles. Adults appreciated a literal connection between the classroom and the adult students' world (Galbraith & Jones, 2006; Graham et al., 2000; Kasworm et al., 2002). This is consistent with Knowles model of adult learning in that adults' motivation for learning comes from needs in the adult's life. Because the topics included in a typical mathematics course are often difficult to tie to practical needs in a student's life, adult students may not be as engaged in the mathematics classroom as in other courses. This lack of engagement with the material in the course may affect their classroom behaviors in the course.

Learner-centered teaching that includes peer collaboration and active discussion seems to be particularly beneficial for adult students (Jacobs & Hundley, 2010; Ross-Gordon, 2003). Collaborative classroom learning activities that involve active participation in the classroom especially promote adult student learning (Galbraith & Jones, 2006; Smith, 2010). Participating in educational discussion with peers and having high quality interactions with faculty are strong predictors of adult success in college (Lundberg, 2003). Providing adult students with opportunities to exercise self-direction in the identification of learning goals, selection of learning strategies and modes of assessment also enhance adult students' learning (Ross-Gordon, 2003). Instructors should recognize and foster relationships between academic learning and learning in the larger world in addition to encouraging adult students to be active participants in the classroom.

Adult students learning mathematics. Little research has been done on adults' learning of mathematics beyond the adult basic education level, which provide education for adults whose inability to speak, read, or write English pose barriers to employment and meeting their adult responsibilities (Mezirow, Darkenwald, & Knox, 1975), and the developmental mathematics level, which prepares students for college level mathematics courses. Although the present research includes mathematics courses at the college level, these lower level studies provide insight into the emotions and attitudes adult students hold about mathematics and the instructional methods that seem to be beneficial to adult students. This section of the literature review includes research on the attitudes adult students hold about mathematics and research on the pedagogical practices that work best to facilitate the learning of mathematics by adult students. This research reinforces the importance of active learning and group discussion in the classroom for adults' effective mathematics learning.

The impact of emotions, attitudes, and beliefs. A student's emotions, attitudes, and beliefs about mathematics impact his learning (McLeod, 1994). Goldin (2003) characterized emotions as rapidly changing and ranging from mild to very intense feelings; attitudes as moderately stable with a balance of affective and cognitive characteristics; and beliefs as stable and highly cognitive. Each of these influences how students learn mathematics.

"Math, far from being soulless, logical, and cold, is a subject fraught with emotions. The emotions do not come from the numbers, but from the people working with the numbers" (Nonesuch, 2006, p. 8). Mathematics anxiety is one of the leading emotional factors impeding mathematics learning. Mathematics anxiety "is a person's negative affective reaction to situations involving numbers, math and mathematics calculations" that interferes with performance on mathematical tasks (Ashcraft & Moore, 2009, p. 197). Mathematics anxiety is widespread and can be a barrier to success in mathematics courses (Battista, 1999). Adults who are new to the college experience may have "rusty" mathematics skills and may be particularly prone to mathematics anxiety (Zopp, 1999). Conversely, some research has found that the level of mathematics anxiety is not connected to age and adult undergraduates have the same levels of mathematics anxiety as younger students (Ulrich, 1988). Mathematics anxiety in adult students has been shown to be relieved by giving students the opportunity to become acquainted with their instructor and classmates (Galbraith & Jones, 2006). This adds to the importance of interaction in the classroom for adult students.

Attitudes about mathematics are often as important as mathematical knowledge in the success of students (Nolting, 2007). Students who first enter college a significant time after high school may bring with them negative attitudes towards mathematics which affects both their learning and participation in class. The attitudes adults hold concerning mathematics are closely tied to their understanding of mathematics which has been built up through their previous experiences (Duffin & Simpson, 2000). For many adult students, these past mathematics experiences are negative (Lawrence, 1988). Adult students who enroll in mathematics courses are "often scared and angry, confused and humiliated, unconfident and passive, people, in fact, who hate and fear math" (Nonesuch, 2006, p. 8). Adult students have reported fear of failure, frustration with mathematics, and embarrassment as some of the factors that affect their persistence in developmental mathematics courses (Meader, 2000).

Self-efficacy is defined as a person's beliefs in his capabilities of performing a task (Bandura, 1994). Self-efficacy influences "how people feel, think, motivate themselves, and behave" (Bandura, 1994, p. 71). A person with a strong sense of efficacy sets high goals for himself and perceives hard tasks as surmountable, enjoyable challenges. In contrast, a person with low self-efficacy avoids difficult tasks and views them as unattainable. In mathematics, self-efficacy is a major factor in success in mathematics courses (McLeod, 1994). There is evidence that the effect of low levels of self-efficacy is greater for adult students than younger students (Carmichael & Taylor, 2005). There are conflicting results when comparing mathematics self-efficacy between adult and traditional-age students. In one study, older students reported a lower level of mathematics self-efficacy than traditional-age students (Peters & Kortecamp, 2010). In another study, students who experienced a longer lapse of time since their last mathematics course reported lower levels of mathematics self-efficacy than students who had studied mathematics more recently (Carmichael & Taylor, 2005). In a third study, adult students were found to have a higher level of confidence in doing mathematical tasks than traditional-age students (Elliot, 1986).

Some adult students express the belief that they are incapable of ever understanding mathematics (Wedege & Evans, 2006). Many adults believe that they have missed a vital element of mathematics in their early education and they will never be able to retrieve it (Lawrence, 1988). According to Bourdieu's concept of habitus, the longer a person holds a belief, the more durable it becomes, and it is eventually incorporated into their cultural identity (Swain, Baker, Holder, Newmarch, & Coben, 2005). This belief can be particularly stable in adult students who have held this belief for many years and may contribute to avoidance of mathematics courses and affect engagement in mathematics classrooms and thus affect learning. Often this belief that mathematical knowledge is unattainable is sustained even after adult students are successful in mathematics courses (Lawrence, 1988; Wedege & Evans, 2006).

The conflicting findings in the research cited above may be tied to two factors. First, the great diversity among adult students and the variety of life experiences they bring to their education may affect their beliefs, attitudes, and emotions about mathematics. Adults who voluntarily return to school generally have more positive attitudes towards mathematics, while adults who feel forced to return to school because of a job loss or change in family status exhibit more negative attitudes towards mathematics and have lower confidence in their ability to learn mathematics (Schloglmann, 2006). Second, while many new adult students are insecure about their ability to meet the academic challenges of college (Bourgeois et al, 1999; Kasworm, 2008), as adult students have successful experiences, their confidence and attitudes towards mathematics become more positive (Miller-Reilly, 2002; Safford, 2002). Although each of these factors impact adult students' success in mathematics courses, the role they play is complex and nonlinear (Grootenboer & Hemmings, 2007). Because observable learning behaviors can be verified and have been directly tied to student success in the classroom, this study focuses on adult students' learning behaviors and considers these other factors only in light of their impact on adults' behaviors.

Adults' success in entry-level mathematics courses. An entry-level mathematics course is defined not by the content or difficulty of the course, but by where it appears in the sequence of mathematics courses a student is required to take to complete his educational program. An entry-level course is the first mathematics course a student attempts after enrollment in postsecondary education. It is typically taken in the freshman year. In spite of the challenges adult students face in mathematics, there is empirical evidence that demonstrates that adult students can succeed at the same level as traditional-age students in entry-level mathematics courses. Elliott (1990) compared the mathematics achievement of adult students in a mixed-age basic (developmental) algebra course. In this study, there was little difference between the grades of adult and traditional-age students. Elliot concluded that older students can have the same level of success in mathematics as traditional-age students. Carmichael and Taylor (2005) found that although older students reported lower levels of self-confidence in doing mathematics than younger students in a developmental mathematics course, there was no difference in the final grades. In a similar study set in a college-level algebra course, adult students made as many high grades as traditional-age students (Gupta et al., 2006). These studies seem to demonstrate that in spite of entering college with less mathematical preparedness than traditional-age students, adult students can achieve at the same level as traditional students, at least at the lower levels of mathematics. Carmichael and Taylor (2005) concluded, “Older students who lack confidence and indeed adequate prior knowledge and skills, may have gained through life’s experiences a determination (as opposed to confidence) to overcome these and succeed” (p. 718). In contrast to these studies, Calcagno et al. (2007) found that because of their rusty mathematics skills, adult students had lower rates of degree completion than traditional-age students.

Effective teaching practices in mathematics courses for adults. The same principles that guide teaching adult students in general apply to teaching adult students mathematics (Lawrence, 1988). Although few empirical studies have been done to determine the type of teaching methods that work best for adult students learning mathematics, there is a consensus among researchers that active, student-centered activities that are perceived to be practical and relevant are beneficial for adults (Galbraith & Jones, 2006; Lawrence, 1988; Nonesuch, 2006). These activities are characterized by active construction of knowledge, learning in a group situation, and active dialogue among students and between students and the instructor (Michael, 2006). Most of the research in this area is based on the personal classroom experiences of the researchers. In a class for mothers of low-income high school students, the instructor found that establishing connections between adults’ life knowledge and academic knowledge promoted the learning of mathematics (Civil, 2003). The teaching in this class included group discussions about mathematics. The students reported satisfaction with working in groups in which they were able to engage in intellectual conversation with other adults. In an intergenerational developmental mathematics course, adult students were motivated by the use of practical problems that tied mathematics to real-world contexts (Miller-Reilly, 2002). In a developmental mathematics course specifically designed for adult students, the students especially appreciated the interaction among the students and between students and the instructor (Safford, 2002). In a mixed-age mathematics classroom designed to incorporate principles from andragogy, both adult students and traditional-age students in the class had better grades than adult and traditional-age students in a lecture based class taught by the same instructor (Hornor, 2001). Galbraith and Jones (2006) illustrated successful techniques in teaching adults in a developmental mathematics course by emphasizing setting a classroom climate conducive to learning by allowing students to become acquainted with the instructor and their classmates, by emphasizing the importance of clearly informing adult students about the expectations of the instructor and the requirements of the course, and finally, by emphasizing the need to integrate the concepts of mathematics to the students' personal lives. Galbraith and Jones believed this was best accomplished by encouraging the students to network both during and outside of class and by using small group learning. These findings support the conclusion of Nonesuch (2006) that activities that engage adult students in active learning promote the learning of mathematics.

All of these studies emphasize the importance of verbal interaction for adults learning mathematics. Unfortunately, many adult students in mathematics report a preference for a traditional teacher-centered classroom. Adult students in a developmental mathematics course preferred a lecture style classroom although students in learner-centered classes had higher grades and reported higher levels of satisfaction with the course (Miglietti & Strange, 1998). Students in an adult basic education mathematics class requested that the instructor only provide the students with the rules they needed to memorize to pass the General Education Development (GED) exam

(Leonelli, 1999). Additionally, many older students reported a reluctance to participate in group learning activities because of fear of exposing their ignorance (Nonesuch, 2006; Slotnick et al., 1993). The factors that influence adult students' participation in college mathematics classrooms need to be identified and examined in order to facilitate the success of adult undergraduate students.

The impact of mathematics on the success of adult students. Mathematics plays a pivotal role in the success of adult students. Calcagno et al. (2007) used transcript analysis to determine the factors that influenced students to drop out of their educational programs at community colleges in Florida. The researchers were particularly interested in the difference in educational program completion rates between adult and younger students. Calcagno et al.'s study served as a model for the first part of the present study.

In conducting their study, Calcagno et al. first reviewed research that found that academic and social engagement with the learning institution, having a strong high school academic background, having a family tradition of college education, and attending college full-time were all positive indicators of college completion. However, the researchers felt the application of these findings to adult students might not be appropriate. Calcagno et al. hypothesized that factors that influenced the persistence of adult students were different from those affecting traditional-age students.

Calcagno et al. used the longitudinal data available in the unit records transcripts of over 42,000 first-time Florida college students enrolled in a college credit course at one of 28 Florida community colleges in the fall of 1998 to analyze the likelihood of completing an educational program in any one semester for adult and traditional-age students. The researchers limited their definition of adult students to those first-time students who were 25 or older and their definition of traditional-age first-time students to those between the ages of 17 and 20. The purpose of this limitation was to confine the definition of traditional students to those who enrolled in community college immediately after high school. Both groups of students were followed for 17 semesters (fall, spring, and summer each counting as one semester).

In the preliminary comparison of these two student groups, Calcagno et al. found that students in the older group were more likely to have received a nontraditional secondary credential. The verbal placement test scores of the older students were on average 29 points higher than the younger students. In contrast to this, the math placement scores were about 87 points lower than the traditional-age students. In addition, adult students were more likely to be enrolled part-time in each of the 17 semesters studied. Over the 17 semesters, 30% of the younger group completed their educational programs, while only 19% of the adult group was successful.

After this preliminary analysis, Calcagno et al. controlled for variables including gender, race, secondary credential, full-time status, verbal and math test scores, and enrollment in remedial courses. The important finding for this present study was that when controlling for mathematics placement test scores, adult students shifted from being less likely to graduate than traditional-age students to more likely to graduate. Calcagno et al. concluded that community college adult students complete their educational programs at a lower rate than traditional-age students not because of their age, but because of their low level of incoming mathematics ability. This study highlighted the importance of mathematics in the success of adult students. Although the conclusion of this research was based on the incoming mathematics skills of adult students, there likely were mathematics courses that these students found particularly difficult that discouraged them from completing their educational program. Extending this research to the 4-year university and identifying mathematics courses that are particularly difficult for adult students will provide information valuable to assist adult students in reaching their educational goals.

Known roadblock mathematics courses. "Course work in mathematics has traditionally been a gateway to technological literacy and to higher education" (Schoenfeld, 2002, p. 13). Proficiency in mathematics can give students the opportunity for upward social mobility (Damlamian & Straber, 2009). Unfortunately, while mathematics can serve as a gateway to education, mathematics courses often serve as roadblocks to education. "Rather than a gateway to a college education and a better life, mathematics has become an unyielding gatekeeper" (Bryk, in Carnegie Foundation for the Advancement of Teaching, 2010, para. 3). For this study, the term *roadblock course* is defined as a course that, because a student has difficulty earning a passing grade in the course, delays graduation or influences a student to either change his major to one not requiring the roadblock course or to drop out of college altogether. Terms other researchers use for these courses include *gatekeeper courses*, *gateway courses*, or *barrier courses* (Suresh, 2006). For science majors these courses are often introductory science and mathematics courses; for other students, these are often general educational requirements including general mathematics courses. Failing to do well in these courses may result in a change of major, a withdrawal from school, or may discourage students by deflating self-confidence (Eagan & Jaeger, 2008). Mathematics courses that have been identified as roadblock courses include developmental mathematics courses, that prepare students for college level mathematics (Bryk & Treisman, 2010; Burton, 1987; Carnegie Foundation for the Advancement of Teaching, 2010), college algebra, which is usually the lowest level credit bearing mathematics course (Reyes, 2010; Small, 2010), and calculus (Cipra, 1988; Gerhardt, Vogel, & Wu, 2006; Suresh, 2006; Treisman, 1992; Walsh, 1987).

For students enrolling in college unprepared for college level mathematics, developmental mathematics courses can serve as roadblocks to graduation (Bryk & Treisman, 2010; Burton, 1987). "Remedial math [a term used in lieu of the more encompassing term *developmental math*] has become an insurmountable barrier for many students, ending their aspirations for higher education" (Bryk & Treisman, 2010, p. B19). Reasons given for the failure of students in these courses include the number of courses in the developmental sequence which can be discouraging for students, the perception by students that the material presented in these courses is not needed for their lives after college, and the lack of adequate academic support in the form of tutoring, goal-setting, and mentoring (Bryk & Treisman, 2010). Another factor is the finding that freshman students in developmental mathematics had lower confidence in their ability to do mathematics than freshman students in other mathematics courses (Hall & Ponton, 2005). In addition, many adults enrolled in developmental mathematics courses bring with them negative attitudes and beliefs about mathematics (Duffin & Simpson, 2000; Meader, 2000). Because success in mathematics often has as much to do with attitudes and beliefs about mathematics than about actual mathematics ability (Nolting, 2007), developmental mathematics courses may present a serious challenge for unprepared adult students.

College algebra has the largest student enrollment of any credit bearing mathematics course (Small, 2010). College algebra "blocks academic opportunities and plans for approximately 200,000 students per semester" (Small, 2010, p. 1). Many college students identify this as one of the toughest courses they take as undergraduates (Reyes, 2010). Although high school preparation, student attitudes, and the fast pace of the course contribute to the fail/drop/withdrawal rate of up to 60%, the mismatch between the content of the course and the needs of the enrolled students is the predominate reason given for student failure in this course (Herriott & Dunbar, 2009; Small, 2010).

Calculus is a third course that has been identified as a roadblock mathematics course (Cipra, 1988; Gerhardt et. al., 2006; Suresh, 2006; Treisman, 1992; Walsh, 1987). In many institutions, as many as 50% of students enrolled in calculus fail to make a passing grade in the course (Cipra, 1988; Walsh, 1987). Especially for science and engineering majors, calculus may be viewed by faculty and students as a “weed out” course taken early in the college career to allow only the highest performing students to continue in a science or engineering field. The factors that influence success in calculus include student perceptions of faculty behaviors, high school academic experience, student perceptions of academic support, and student behaviors such as study habits, coping strategies, and interaction with faculty outside the classroom (Suresh, 2006). Other factors include the perceived relevance of calculus to later career needs and the strong analytic skills needed to succeed in the course (Gerhardt et al., 2006) as well as unmanageable class sizes, outmoded emphasis on rote and repetition, and unmotivated faculty (Cipra, 1988). Treisman (1992), after recognizing that a large percentage of minority students were unsuccessful in calculus, examined the study habits of successful and unsuccessful students. He found that students that studied and did homework individually had much lower success than students who formed study groups that acted as both academic and social support.

Systematic research to identify roadblock mathematics courses has not been attempted (Suresh, 2006). Each of the above courses shares two characteristics. First, these courses are often taken in the first few semesters of college. Part of the challenge of these courses may be that students are still acclimating to the college culture. This may be true especially for adult students who often enter college unsure about their academic abilities (Bourgeois et al, 1999; Kasworm, 2008). Second, student success in each of the courses has been tied to high school academic preparation. This may pose problems for adult students as they are likely to have a lower level of high school mathematics preparation than traditional-age students.

Having a sense of connection with peers and faculty within roadblock mathematics courses substantially impacts student persistence (Eagan & Jaeger, 2008). In addition, pedagogical practices that emphasize communication skills and small group activities have been successful in increasing success in these courses (Small, 2010). Thus, how students behave in roadblock mathematics courses may affect success in the course. Examining and understanding adult students' learning behaviors in a roadblock mathematics course may illuminate why the course acts as a barrier to degree completion for adult students.

Understanding adult student persistence—a theoretical framework. Research has found that adult undergraduates have lower rates of college graduation than traditional-age students (Calcagno et al., 2007; Choy, 2002; Horn et al., 2005; McGivney, 2004; Schatzel et al., 2011; Taniguchi & Kaufman, 2005). College graduation for all students is strongly influenced by the highest mathematics course taken in high school (Adelman, 2006; Trusty & Niles, 2003). In addition, the longer a student waits after high school graduation to enroll in college, the less likely the student is to persist in attaining a college degree (Adelman, 2006; Horn et al., 2005). Adult students, who generally have completed a lower level of high school mathematics than traditional-age students (Horn et al., 2005), and have significantly delayed entry into college, should be at particular risk for not completing their educational programs. Surprisingly, adult students who do persist in college often have higher college GPA's than traditional-age students (Graham et al., 2000; Kasworm & Pike, 1994, Kasworm et al., 2002). Models for understanding traditional-age students' experiences in college may not be applicable to adult students. This section of the literature review presents two early models for college outcomes, and then reviews two models more applicable to adult students.

The Cultural Community Model. Tinto viewed college as a cultural community in which students enter, engage in social and academic interactions, and integrate themselves into the campus community (Graham et al., 2000). The more integrated a student becomes in the community; the more likely he is to remain until graduation. Tinto (1987) presented a model for understanding undergraduate attrition by looking at two main factors that influence departure. First, the entering student brings with him intentions and commitments towards higher education. Second, interactions with the institution—adjustment to the campus community, academic difficulties, and personal feelings of isolation—may affect a student's decision to leave college. Tinto emphasized both social and academic integration as the leading influences on student persistence. This integration occurs over time and how well the student is able to incorporate himself into the college community plays a large role in the student's perceptions of his college experience and the decision to persist in or to leave college.

Tinto's model includes pre-entry attributes including family background, individual skills and attributes, and prior schooling. These shape initial student intentions as well as goal and institutional commitments. Once in the institution, students experience the new community in both the academic system and the social system. These experiences influence the personal and normative integration into these two systems. The degree and quality of this integration, as well as external commitments, can reshape intentions and commitments which affect the decision to either persist or depart from an institution.

Tinto cautioned that his model did not mandate full integration in both the academic and social systems of the institution for persistence. The model did however suggest that some degree of integration must exist as a condition for continued persistence. This model also emphasized the important interplay between the social and intellectual components of student life. In addition, Tinto's model hinged upon the individual's perceptions of his experiences in the college community. Both the individual student and the institution play an important role. Social integration plays as important a role as academic integration. A simplified diagram of Tinto's model is shown below.

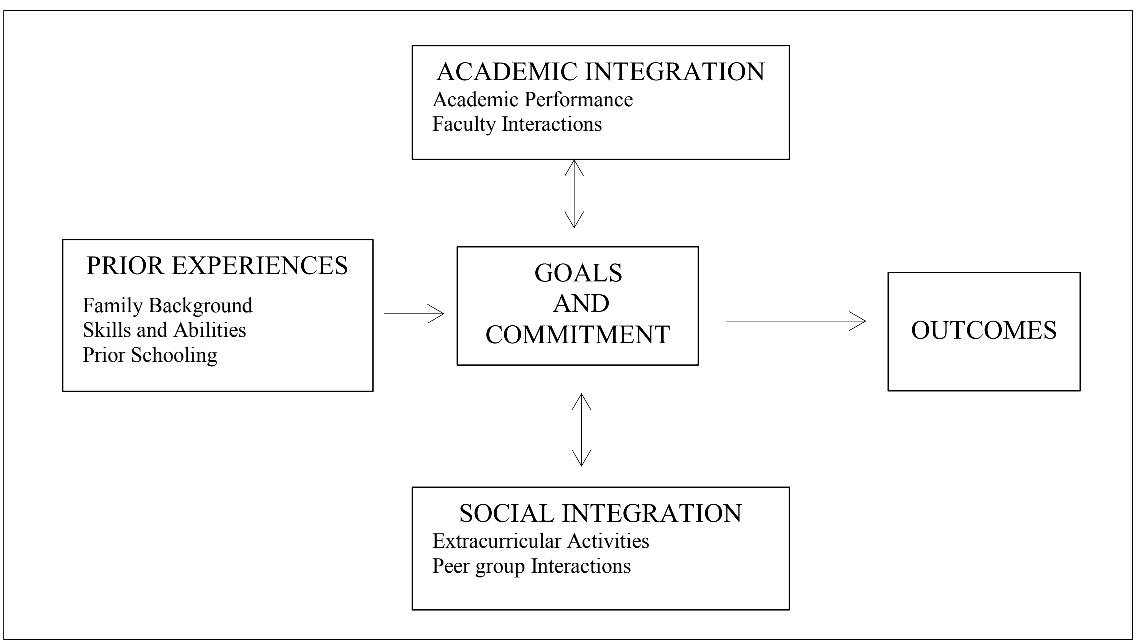

Figure 1. A simplified version of Tinto's model for student outcomes.

The Student Involvement Model. Astin's (1999) model to understand student attrition and development in higher education focused on student involvement in both the academic and the social systems on the college campus. Astin defined student involvement as "the amount of physical and psychological energy that the student devotes to the academic experience" (p. 518). Student involvement always includes a behavioral component. "It is not so much what the individual thinks or feels, but what the individual does, how he or she behaves, that defines and identifies involvement" (p. 519). Astin believed that the amount of student learning and student development was directly proportional to the quality and quantity of student involvement.

Any "curriculum, to achieve the effects intended must elicit sufficient student effort and investment of energy to bring about the desired learning and development" (p. 522). The theory of involvement emphasized active participation of the student in the learning process. It encouraged faculty to focus less on what they do and more on what the student does. Although this construct of student involvement resembled motivation, it implied more than a psychological state, "it connotes the behavioral manifestation of that state" (p. 522). The theory of involvement is concerned with the "behavioral mechanisms or processes that facilitate student development" (p. 522). This theory explicitly acknowledged that student psychic and physical time is finite and that time spent in one activity detracts from another activity.

The roots of this theory came from a longitudinal study Astin conducted to identify factors in the college environment that significantly affect students' persistence in college. Positive factors in student persistence included living on campus (allowing student time and access to campus activities and other students), joining fraternities and sororities and other extracurricular activities, and holding a part time job on campus (giving the student access to other students and faculty). Negative factors were things that took away from time on campus—working off campus, going to a community college where the involvement of both students and faculty is minimal, and for women, marriage and childcare.

Both Tinto's and Astin's models were constructed with traditional-age students in mind. Both emphasized the importance of time spent on campus. Adult students have little time to spend on campus outside of class. Tinto's and Astin's models seem to predict low rates of success for adult undergraduates.

***A Model for Nontraditional Students*.** Bean and Metzner (1985) recognized the growing population of nontraditional students in both 4-year institutions and 2-year community colleges. Nontraditional students included older students, commuter students, and part-time students. These students were "distinguished by the lessened intensity and duration of their interaction with the primary agents of socialization [faculty and peers] at the institution they attend" (p. 488). Because of their limited time on campus, Bean and Metzner believed that previous models for student attrition that were developed with traditional students (residential students who enrolled in college directly after graduation from high school) in mind, were not applicable to nontraditional students. Bean and Metzner's model was based on the personal background of each student, academic performance in college, and external environmental factors that influence the decision to leave higher education.

Bean and Metzner's model is similar to Tinto's in that it takes into account the continuing process of a student experiencing college. It begins with background and defining variables (age, enrollment status, residence, educational goals, high school performance, ethnicity, and gender). These beginning variables influence both academic variables (study habits, academic advising, absenteeism, major certainty, and course availability) and environmental variables (finances, hours of employment, outside encouragement, family responsibilities, and opportunity to transfer). Academic and environmental variables may have mitigating effects on each other. For example, if a students' GPA is low, but he gets ample encouragement from family, then he would be expected to remain in college. On the other hand, if a female student cannot find adequate childcare, then she may decide to drop out regardless of her GPA. Academic variables affect both academic outcomes (GPA) and psychological outcomes (perception of utility, satisfaction, goal commitment, and stress). Environment variables affect psychological outcomes. All of these components together affect the decision to drop out.

A Model of College Outcomes for Adults. Donaldson and Graham (1999) believed that past models for student attrition "may not capture the essence of the experience for adults in higher education" (p. 25). While models that focused on younger students stressed time on campus and social integration, adult students have little time to spend on campus. Because of past research that found that in spite of rusty skills, low self-confidence, and fear about returning to college, as well as little involvement outside the classroom, adult students could do as well academically as traditional-age students; Donaldson and Graham concluded that adults use different skills, techniques, and interactions than traditional-age students to achieve their educational goals.

Donaldson and Graham developed their model based on past research that found that adults have complex and rich mental schemas that make learning more personal, that adults integrate new learning by making connections to existing knowledge, and that adults apply this learning immediately in real-life contexts. This model identified five factors that influence student outcomes. The first is the prior experience and personal biographies adult students bring with them to college. Second, the psychosocial and value orientations, including adult student attitudes towards their education and their perceptions of the usefulness of a college degree, influence the adult student's experience on campus. The third is adult student cognition and how adult students may learn differently from traditional-age students. An important factor in retention is the adult student's life-world environment—the different contexts in which adults live which are defined by the roles they occupy at work, in their families, and in the community. The most important component in this model is the connected classroom as the central venue for academic and social engagement on campus.

Donaldson and Graham believed that adult students use the college classroom differently than traditional-age students. While traditional-age students have the opportunity to form peer study groups and to meet with the instructor informally outside of class, the classroom is the center for adult learning in college. In addition, "classroom interactions provide a social context for learning and shape adults' roles as students" (Graham et al., 2000, p. 8). Adults value and seek out classroom experiences that have relevancy, respect adult dignity, and encourage relationships. This model was influenced by Cobb's (1994, 2000) theories of constructivist learning. Although learning is individually constructed, learning occurs as adults participate in a social learning community. Donaldson and Graham's model emphasized the importance of the social aspect of the college classroom for adult students. While Tinto separated social and academic experiences in his model of retention, Donaldson and Graham consolidate these two realms into the connecting classroom. Donaldson and Graham suggested that this model would be useful in exploring the dynamics of adults in a college classroom.

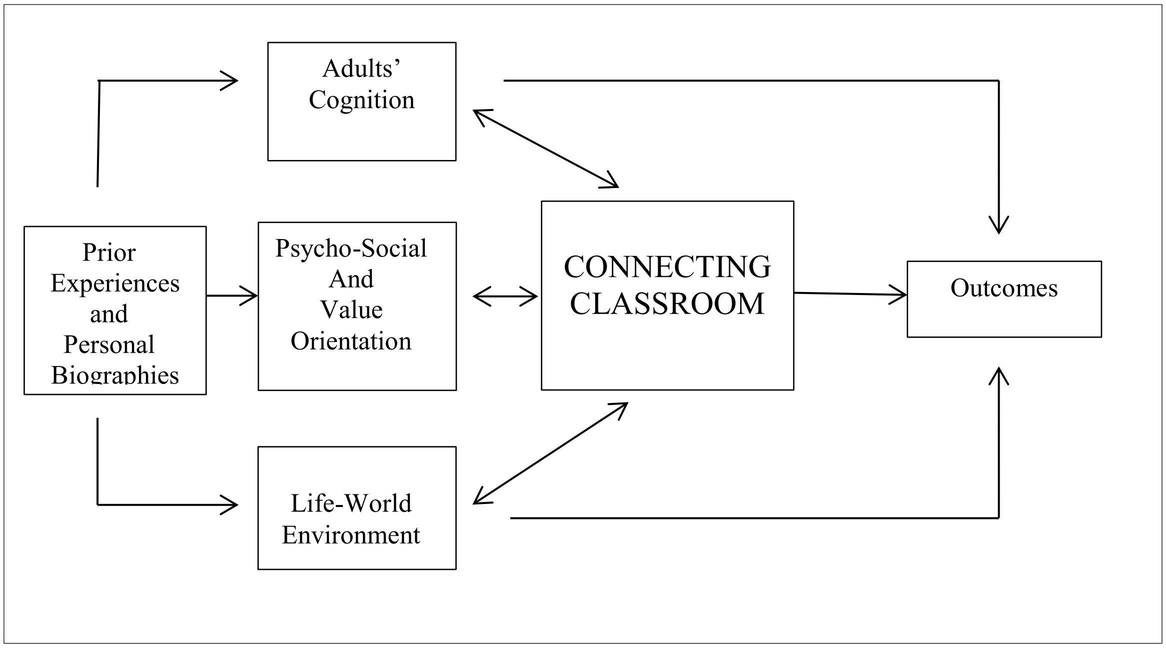

Figure 2. Donaldson & Graham's Model of College Outcomes for Adult Students. Adapted from Donaldson & Graham, 1999.

The influence of the models on the present study. This study focuses on adult success in higher education. Each of the models presented above recognize the importance of the past educational experiences a student brings to his college experience as well as the importance of college academic performance on the decision to persist in college. While poor academic performance may be mitigated by positive support from family and other external communities, it still remains an important factor in the success of adult students. While acknowledging the impact of social and external environmental factors of adult persistence, the first part of this study focuses on the influence of academic factors in the decision to leave college. While only 15% of departures from college are the result of academic dismissal, many poorly performing students leave college voluntarily before formal dismissal (Tinto, 1987). Because adult students have a poorer foundation in mathematics than traditional-age students (Adelman, 2006; Horn et al., 2005; Kasworm & Pike, 1994; Kasworm et al., 2002), and each of the models above predict that college academic outcomes will be affected by high school academics, this study focuses on mathematics as a possible major influence in adult students' decision not to persist in college. Donaldson and Graham's model of adult college outcomes which emphasizes the importance of the college classroom as the focus for adult student learning also adds to the framework of the second part of the study which investigates adult student behavior in a roadblock mathematics course.

Part 2: Adult Student Learning Behaviors in a Roadblock Mathematics Course

Learning behaviors, including classroom behaviors and study habits, have a direct impact on the learning that takes place in college. Because the college classroom experience plays a pivotal role in the learning of adult students (Faust & Courtenay, 2002; Graham et al., 2000), learning behaviors in the classroom are especially important for adult students. This section includes research on the importance of learning behaviors for student success, factors that influence traditional student's behaviors in the classroom, research on adult student learning behaviors in the classroom, and the theoretical framework that shapes this part of the research.

The impact of learning behaviors on the success of adult students in mathematics. Learning behaviors are tied to students' success in college coursework (Boaler, 1998; Hsu, Murphy, & Treisman, 2008; Johnson et al., 1998; Lundberg, 2003; Michael, 2006; Rau & Heyl, 1990). Learning occurs most effectively when students are engaged with the material, other students, and their instructor (Howard & Baird, 2000). Engagement with learning implies the undertaking of actions and activities, both mental and physical, which provide a closeness and familiarity with the material learned (Pritchard, 2009). The mathematics reform movement has placed more emphasis on student-centered learning and has been more concerned with students' experiences in the learning process (Callahan, 2008). Students learn more when they take an active role in learning—"when they are engaged participants rather than passive recipients of knowledge" (Howard & Henney, 1998, p. 400). In the mathematics classroom, this is implemented by encouraging student participation in class with whole class discussion, small group activities, and facilitating students' reflection on their learning (Callahan, 2008).

For adult students who often have family and work obligations, the college experience is almost entirely limited to the classroom (Faust & Courtenay, 2002; Kasworm et al., 2002). Adult students often do not have the time to take advantage of faculty office hours or meet with classmates outside of class. The classroom environment becomes especially important and the behaviors adult students exhibit in class may impact their success to a greater extent than for traditional-age students who have time to seek academic help outside of class. The college classroom also serves as a social context for adult students and the interactions in the classroom shape their perceptions of their role as students (Graham et al., 2000).

Success in mathematics courses depend on attitudes, beliefs, and emotions students hold about mathematics as well as the behaviors students use in the mathematics course (McLeod, 1994). While surveys attempt to capture information about students' attitudes, beliefs, and emotions, often surveys are inadequate to accurately describe student beliefs and behaviors (Fritschner, 2000; Karp & Yoels, 1976). In addition, the role that emotional and attitudinal factors play in the success of students is not well understood (Grootenboer & Hemmings, 2007). Learning behaviors such as interaction in the classroom, visits to the instructor's office, and obtaining assistance from student support services or private tutors is verifiable through observations and can be confirmed by the instructor. In addition, learning behaviors have been linked directly to student success in the college classroom (Boaler, 1998; Johnson et al., 1998; Michael, 2006; Rau & Heyl, 1990). While other factors impact success in the mathematics classroom, this research considers only the observable, confirmable learning behaviors students use in the course. The emotions, beliefs, and attitudes students hold about mathematics will be explored only for their impact on student behaviors.

Understanding how adult students participate and engage with the material, other students, and the instructor in mathematics classrooms and the factors that influence their participation is necessary to aid adult students to be successful in mathematics courses that may act as roadblock courses. This section of the literature review first presents empirical evidence of the impact of learning behaviors on the success of all students in college courses, then focuses on research on classroom participation in college classes with particular attention to adult students' participation.

Empirical evidence for the impact of learning behaviors. Past research on the impact of student behaviors on student achievement focuses on two aspects of learning behaviors—study habits outside of class and student behaviors during class. Study habits outside of class have a great impact on student success in college courses. Students who score high on instruments measuring study skills including low distractibility and high inquisitiveness are more likely to be successful than lower scoring students (Blumner & Richards, 1997). After Scholastic Aptitude Test (SAT) scores and previous college grades, study habits are the best predictors of student success as measured by college GPAs (Crede & Kuncel, 2008). Study habits explain why some students succeed despite predictions of failure and why some fail despite predictions of success. The effect on course grades of studying is not limited to the time and quality of study session.

Participating in a peer study group has an important impact on success in college mathematics courses.

The Treisman Workshop Model and the Emerging Scholars Program have demonstrated that students who do homework together and study in groups that provide both social and academic support have higher grades in introductory mathematics courses than students who study alone (Hsu, Murphy, & Treisman, 2008; Treisman, 1992). Treisman (1992) noted in his calculus teaching as a graduate student at Berkeley that Black students were among the least successful students, while Chinese students were the most successful. Treisman observed both groups of students outside of class to determine if their study habits were different and how these might affect their success in the course. Black students typically studied alone and were reluctant to seek learning assistance. On the other hand, Chinese students often formed study groups that met regularly to do homework and study for exams. In addition to academic support, these study groups supplied social support and enhanced the students' integration into the campus culture. Treisman concluded that the social, interactive aspects of group sessions promoted learning as well as retention in college. This led to the formation of special recitation sections for at-risk students across the nation that included working on problems in a group setting as well as incorporating social activities (Hsu et al., 2008; Treisman, 1992). Treisman convinced his students "that success in college would require them to work with their peers, to create for themselves a community based on shared intellectual interests and common professional aims" (Treisman, 1992, p. 368).

Lundberg (2003) examined the effects of peer relationships and faculty interaction on student success in college. Using a sample of 4,466 students from 20 institutions, Lundberg found that educational peer discussions and quality relationships with faculty was associated with higher success rates in college for students of all ages. While the total effect of peer discussion got lower with each progressive age group, it remained relatively high even for the oldest group studied. Frequency of interaction with faculty had increasing effects with age and was a stronger predictor of gains for older students than for younger ones. These interactions were important whether they took place in the classroom or outside of class time.

A second area of research is the impact of classroom behaviors on student achievement. There is empirical evidence that a social constructivist culture in the classroom produces positive results. Active learning, including group work of all kinds, problem-based learning, and peer instruction, has been linked with greater student understanding across disciplines (Boaler, 1998; Johnson et al., 1998; Michael, 2006; Rau & Heyl, 1990). An important component of each of these learning strategies is that "learning is facilitated by articulating explanations, whether to one's self, peer, or teachers" (Michael, 2006, p. 162).

Rau and Heyl (1990) evaluated the effectiveness of collaborative learning in a college sociology course. Especially at commuter and large universities, students were often isolated in their studies and the social organization of the classroom was low. The researchers hypothesized that "isolated students do not learn as much or as well as students who are embedded in a network of informal social relations" (p. 143). While there was no control group in their study, Rau and Heyl found that when students worked collaboratively and were actively engaged in the learning process, students scored significantly higher on exams.

Johnson, Johnson, and Smith (1998) investigated the impact of cooperative learning on student success in college. First, the researchers noted that "the myth of individual genius and achievement—as opposed to cooperative efforts—is deeply ingrained in American culture" (p. 27). Cooperative learning techniques, which Johnson et al. defined as students working together in small groups to accomplish shared learning goals, may be unnatural for many teachers. To determine whether cooperative learning was effective, Johnson et al. examined 305 studies that compared the effect of cooperative learning on individual achievement in college and adult settings. The researchers found that cooperative learning promoted higher individual achievement in verbal tasks, mathematical tasks, and procedural tasks. In addition, cooperative efforts enhanced the interpersonal relationships within the class that promoted the social adjustment to college.

Boaler (1998) investigated two different styles of teaching in a middle school mathematics course. One set of classes was taught traditionally with students working individually on workbooks with individual assistance from the instructor. The other classes were taught by assigning mathematical tasks to groups of students to work on collaboratively. While the students in the traditional classes were quieter and spent more time on-task, the students in the classes organized in groups demonstrated a greater understanding of mathematics and were better able to transfer their understanding to new situations.

Each of these studies shows that classroom interaction has a positive impact on student learning. These studies focused on teaching methods that encouraged students to engage with each other and the instructor. However, none of these studies addressed the factors that influenced students to participate in small group and classroom discussions at high levels.

Traditional student participation in the college classroom. Research in student participation in the college classroom has provided a consistent picture of the factors influencing the level of participation. Most researchers agree that gender of the student (males participate at a higher level), the gender of the instructor (male instructors are more likely to call upon male students), class size, and classroom climate all affect participation in classroom discussions and activities (Crombie, Pyke, Silverthorn, Jones, & Piccinin, 2003). Other studies showed that student expectations (Howard et al., 1996), classroom norms (Fritschner, 2000; Howard & Baird, 2000; Karp & Yoels, 1976), and student apprehension levels (Neer & Kircher, 1989) also affected student participation.

Karp and Yoels (1976) were among the first researchers to study social interactions within the college classroom. Karp and Yoels observed 10 classrooms at a private university to determine how students participated in the class by responding to direct questions by the instructor, responding to questions directed at the class as a whole, and responding to questions by other students. At the end of the semester, each student completed a survey to determine how the student perceived his own and others' participation and the factors that influenced the student's participation. Several interesting findings came out of this study. The survey responses indicated that the gender of the instructor did not influence participation and that only a small number of students were responsible for the majority of verbal interaction in the class. The observations confirmed that only a small number of students, "talkers", accounted for most of the interaction regardless of the size of the class. Karp and Yoels characterized this phenomenon as the "consolidation of responsibility" (Karp & Yoels, 1976, p. 429), in which a few students take on the social responsibility of asking and answering questions while the other students engage in "civil attention", paying sufficient attention to appear attentive without risking active participation. However, in contrast to survey results, classroom observations found that the gender of the instructor did affect participation. This pointed to the unreliability of student surveys as the sole data collection method when studying classroom interaction.

Howard, Short, and Clark (1996) built on Karp and Yoels' research. Howard et al. viewed the college classroom as a social entity. The researchers believed that students came to the classroom with clear conceptions of acceptable and expected behaviors for all participants. Many times this included the perception of the role of student as sitting quietly instead of being actively engaged in learning. This may be especially true in mathematics classes in which many students prefer to be told how to solve problems rather than work in groups to discover solutions (Diamond, 2001; Leonelli, 1999; Miglietti & Strange, 1998; Nonesuch, 2006).

In studying classroom participation patterns, Howard and Baird (2000) confirmed Karp and Yoel's (1976) earlier finding that a classroom norm often evolves in which a very few students take on the responsibility of "talkers" while the other students in the class come to rely on these students to sustain classroom discussions. These classroom norms are often set by the third class day (Fritschner, 2000).

Several researchers have attempted to identify factors that encourage verbal participation in the college classroom. Students with high levels of apprehension in the classroom often prefer to participate in classroom discussions only after an opportunity to get to know their fellow classmates on a personal level (Neer & Kircher, 1989). The researchers in this study concluded that a main inhibiter of participation was the fear of being evaluated by peers and instructors. Other common reasons students give for not participating in classroom discussions include the student not having fully developed ideas, the student not knowing enough about the subject, the student not having done the assignment, and the large size of the class (Howard et al., 1996). The impact of age on classroom participation has yielded mixed results which will be discussed in the next section.

None of the above studies included observations in a mathematics classroom. Neer and Kircher (1989) emphasized the need for students to feel comfortable and at ease with their classmates and instructors before speaking out in class. This may be a challenge for adult students who often feel different from traditional-age students and may not be as comfortable with mathematics as younger students.

Adult students' classroom behavior. Institutions of higher learning have shown an increased interest in adult college students and how their behaviors differ from traditional-age students. Kasworm (2006) reported that many adult students have conflicting images of themselves as adults and students that affect their behavior in the classroom. Adult undergraduates often feel isolated and do not form relationships with other students in class regardless of the other students' age. Adult students believe they need to be self-sufficient and accomplish their academic goals on their own. Because their engagement with college is almost entirely focused on the classroom (Graham et al., 2000), it is important to understand the factors that influence adult participation.

There are conflicting findings regarding adult participation in the college classroom. Some researchers report that adults participate in classroom discussions and activities at a higher level than traditional students (Fritschner, 2000; Gregoryk & Eighmy, 2009; Howard & Baird, 2000; Kasworm, 2006; McClenney, 2005; Weaver & Qi, 2005), while others report that adult students may be reluctant to join in classroom discussions (Nonesuch, 2006; Spellman, 2007). Still others have found no difference in the behaviors of adult and traditional-age students (Faust & Courtenay, 2002; Justice & Dornan, 2001).

Howard and Baird (2000) extended Karp and Yoel's research to study student participation in seven different college classrooms. Through interviews, observations, and surveys the researchers attempted to understand why some students participate and others do not. Howard and Baird found that adult students participated at a higher level than traditional-age students. The researchers reported that the non-participators had a greater concern with how they were perceived by classmates and the instructor than participators, and that participators felt a responsibility to actively engage in classroom discussions to help themselves learn as well as to help their classmates.

Fritschner (2000) did a similar study in which 10 to 12 observations were made of each of several college classrooms. Using a seating chart, interactions with the instructor were counted and categorized as either instructor initiated, student initiated, in response to a question directed to that specific student, or an off subject remark to another student. Fritschner found that age had a great impact on the level of participation. Older students participated at twice the level of traditional-age students. This difference was most pronounced in higher level courses; in lower level courses, the gap between the levels of participation of traditional-age students and adult students was much lower. In interviewing both adult and traditional-age students, Fritschner found that traditional-age students were often inhibited from talking in class by the fear of being judged by their classmates. Adult students were less concerned with the potential negative evaluations of their classmates but more concerned with the evaluations of their instructors.

Weaver and Qi (2005) researched student participation in the college classroom from the lens of the classroom as a social organization. The researchers introduced the term *para-participation* as the subtle forms of student-initiated participation such as sitting in a location where they are clearly visible to the instructor and informally asking the instructor questions before or after class. Over 1,000 undergraduate and graduate students completed surveys on their levels and perceptions of classroom participation. Older students reported a higher level of participation than traditional-age students. Similar to Fritschner (2000), Weaver and Qi found that adult students had a significantly lower level of fear of disapproval from classmates, and a significantly higher level of confidence and preparedness for class than traditional-age students.

In order to determine whether the age of students affected undergraduate interaction, Gregoryk and Eighmy (2009) surveyed over 1,000 students. The researchers found that younger students (17–25) were less likely to voice their opinions in class than adult students. Traditional-age students were much more likely than adults to disagree with the statement, "I feel personal involvement is crucial to learning."

In the 2005 Community College Survey of Student Engagement, McClenney (2005) received responses from over 133,000 community college students from 257 institutions in 38 states. Seventy-three percent of adult students versus 59% of traditional-age students responded that they ask questions in class or contribute to classroom discussions often or very often. Twice as many adult students than traditional-age students (42% vs. 22%) reported that they never come to class unprepared. Twice as many adults (67% vs. 36%) said that they never miss class. In spite of this, more adult students than traditional-age students rated their exams as very difficult.

Kasworm (2006) found that adult students often reported that their age put them at a disadvantage in the classroom because they had trouble memorizing facts and had rusty academic skills. In spite of this, adult students were more active in the classroom than their younger classmates and often felt that they were the only students engaged in the course.

In contrast to these studies, there are findings that adult students may participate in the college classroom at a lower level than younger students. Spellman (2007) focused on the affective factors which inhibited adult participation in the college classroom. Because the adult students in Spellman's study had been away from an academic environment for several years, many were intimidated by the classroom environment. Adult students took longer to develop a sense of autonomy and self-efficacy than younger students. This affected their participation levels in the classroom. Nonesuch (2006) reported that many adult students were reluctant to participate in classroom activities because of their fear of exposing their ignorance. As one student expressed, "others can see that they are dumb, stupid, and not as smart" (p. 12).

A third group of researchers found no difference in the levels of participation of adult and traditional-age students. Faust and Courtenay (2002) researched student interaction in freshman level college classes. Ten students in a freshman English class participated in interviews. The researchers identified two factors that seemed to influence student participation. First, the classroom environment—the physical space, the social climate, and the instructor—seemed to influence participation. Second, the nature of the interactions—either social interaction or course-related interactions—influenced the level of participation. They found no difference in the levels of participation between adult and traditional-age students. This is consistent with the findings of Justice and Dornan (2001) who compared traditional-age students to adult students in a psychology class. Justice and Dornan found no difference in the study activities and behaviors between the two groups.

The conflicting results of these studies illustrate the need for closer examination of the factors that encourage participation in the classroom, particularly for adult students. In entry-level courses, typically taken in the first semesters in college, there seemed to be little difference between the participation levels of adult students and traditional-age students (Faust & Courtenay, 2002; Fritschner, 2000). This may reflect the initial insecurity of adult students who are unsure of their academic abilities (Bourgeois et al., 1999; Kasworm, 2008; Kasworm et al., 2002). An adult student reported, “I used to feel that other students knew more than I did, so I kept quiet” (Bourgeois et al., 1999, p. 110). As adult students gain confidence in themselves as learners, they may develop into the assertive, proactive students found by Fritschner (2000), Weaver and Qi (2005), and others. As one adult student expressed, “I feel like now that I can really understand it. It is all coming together and making sense” (Bourgeois et al., p. 111).

A second possible explanation for the differing levels of classroom participation between adult and traditional-age students may be a reflection of the different expectations adult students bring to the classroom. Often, adult students are surprised by the interaction in the college classroom—“I thought it was going to be like school – teacher tells you what you do and you do it” (Bourgeois, 1999, p. 107). Especially in mathematics classes, adult students often express the preference for being told rules and procedures to memorize and having minimal discussion in class (Leonelli, 1999; Nonesuch, 2006; Miglietti & Strange, 1998).

Few of the studies above focused on the mathematics classroom. Nonesuch, who found adult students reluctant to participate in classroom activities, was the only researcher cited above to focus on a mathematics classroom. Given that adult students often enter college with lower mathematical skill than younger students, they may feel less secure in the mathematics classroom. This may lead to a different level of participation in the mathematics classroom than in other classes.

Adult student behavior in mathematics courses. Adult behavior in college mathematics courses has not been an extensive focus of research. Most of the research in this area focused on mathematics courses designed for a homogenous class of adult students. These studies showed that adult students were more comfortable and open to participation when in an adults-only mathematics classroom (Civil, 2003; Safford, 2002). Studies that focused on adult learning behaviors in mixed-age mathematics classrooms are more limited.

Le (1997), in a qualitative case study, followed five adult students through a mixed-age college algebra course. All five students approached the course with confidence and high expectations. They attended class regularly, took copious notes, completed all course assignments, and asked for learning assistance when needed. Nonetheless, only one was successful in making at least a C in the course. All expressed surprise that the strategies they had used to be successful at the developmental level of mathematics were not adequate for success at the college mathematics level. Although all five students received tutoring, they could not develop strategies that would help them in college algebra. Le did not report on the level of participation these students exhibited during class itself. It would be interesting to note how these students compared to traditional-age students in classroom behavior.

Understanding learning behaviors—a theoretical framework. Examining learning behaviors to understand adult student success in a roadblock mathematics course draws heavily on the social constructivist theory in mathematics education. In contrast to behaviorist theories of learning "focusing on observable behaviors and discounting any mental activity" (Pritchard, 2009, p. 6), social constructivism focuses on the acquisition of knowledge and cognitive change that is instigated by social interaction (Palincsar, 1998). Social constructivism evolved from both Piaget's theory of constructivism and from Vygotsky's activity theory (Bussi, 1994). Piaget's constructivism considered learning to be the result of two complementary processes—assimilation, the process of integrating new objects or situations into an individual's pre-existing cognitive schema; and accommodation, the individual's effort to adjust the existing cognitive framework to incorporate conflicting environmental objects. Vygotsky's activity theory was centered on the internalization of interaction between individuals by the individual. Thus, Piaget focused on individual schema, while Vygotsky focused on social relations. For Piaget, the learning process was determined from the inside; for Vygotsky, learning was determined from the outside (Bussi, 1994). Social constructivist theory takes aspects of both of these theories. Some social constructivists lean more towards individual construction of knowledge while others lean more toward social construction. While there are disparities in precisely what is meant by the term *social constructivism*, all viewpoints share the notion that "the social domain impacts on the developing individual in some formative way, with the individual constructing her meanings in response to experiences in social contexts" (Ernest, 1999, p. 2). Social constructivists in mathematics emphasize the importance of the social context of the classroom as an organized social entity that includes (a) persons, relationships, and roles, (b) material resources, and (c) the discourse of school mathematics (Ernest, 1999).

An important concept for this study is Vygotsky's zone of proximal development. Vygotsky, whose work centered on language and culture acquisition, proposed that learners obtain new knowledge in social settings. He described the zone of proximal development as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1978, in Lock & Strong, 2010, p. 110). Trying to teach topics beyond this zone is not effective as the student does not have the foundation to make connections between known and new knowledge.

Bishop (1985), as both a practitioner and researcher sought to understand the “mysteries and complexities of the mathematics classroom” (p. 24). Bishop introduced the idea of social constructivism to mathematics education by recognizing that “each classroom group is a unique combination of people—it has its own identity, its own atmosphere, its own significant events, its own pleasures, and its own crisis” (p. 26). Bishop, drawing from the work of classroom ethnographers, sociologists, and those who study verbal interactions, developed a model to understand the mathematics classroom as a social entity. Bishop used the term *social construction* to describe how students construct knowledge through mathematical activities, communication, and negotiation. Bishop’s view of social constructivism featured emphasis on the dynamic and interactive nature of teaching and the importance of connecting new ideas with present knowledge – both in mathematics, in other subjects, and with real world situations. Communication played a vital role in the development of new mathematical ideas as students shared their own understandings and together develop new meanings.

Bauersfeld (1988) focused on the patterns of interaction that develop in the mathematics classroom. Bauersfeld viewed the classroom as a micro-culture in which the teacher and students together shape classroom norms and expected behavior. This researcher drew from the two traditional viewpoints of Piaget and Vygotsky in recognizing the importance of the individual learner—his intelligence, abilities, and thinking—while also acknowledging the social influence on learning (Bauersfeld, 1994). Because of the advent of the use of videotapes in mathematics education research, Bauersfeld was able to observe rich interactions that took place in the classroom. Bauersfeld developed his interaction model combining established learning theories with theories from sociology. This interaction perspective viewed instructors and students interactively setting the norms for the classroom, both for subject matter and for social behaviors.

Cobb (2000) extended Bauersfeld's research to develop a social constructivist theory that "locates students' mathematical development in social and cultural context" (p. 152). Individual student's mathematical interpretations and explanations were not only individual acts, but also acts of participation in communal classroom processes. In understanding mathematical learning, attention needs to be paid to both the development of the individual student as well as the development of the classroom communities in which the students participate. Cobb suggested three steps in analyzing mathematical learning. First, the social norms of the classroom must be documented to delineate classroom participation structure. Next, socio-mathematical norms including what counts as an acceptable explanation, what counts as a different solution, and what counts as an insightful solution, should be analyzed as these will be unique for each classroom. Third, the classroom's accepted mathematical practices, which include mathematical processes that can be used without justification, should be identified. These three factors can be analyzed both from the individual's perspective and the classroom community's perspective to understand the learning taking place in the classroom. This theoretical framework is "one that focuses on both individual students' activity and on the social worlds in which they participate" (Cobb, 2000, p. 173).

This study focuses on how the individual student participates in the mathematics classroom viewed through the lens of social constructivism. Recognizing that the behavior of the individual student is reflexively related to the social norms of the classroom, the behavior of individual adult students is analyzed in the context of the classroom. Because a vital element of social constructivist practice is to encourage students to explain their way of thinking and to defend their solutions to problems (Hand, Treagust, & Vance, 1997), verbal interaction is one of the foci of this research. This verbal interaction is key to cognitive change (Palincsar, 1998). Cognitive conflict found through individual experiences is not enough if there is insufficient verbal interaction or if the student passively observes others solve problems (Forman & Kraker, 1985). Because of the importance of verbal interaction and the importance of the classroom environment for adult students, participation in classroom discussions is particularly important for adult students.

Summary

Adult undergraduates have unique characteristics that distinguish them from traditional-age students. These include uneven academic preparation, time commitments to work and family, financial constraints, as well as complex and rich life experiences. Adult students pursuing their first undergraduate degree have graduation rates lower than traditional-age students. Mathematics seems to play a pivotal role in the success of these students. Although several roadblock mathematics courses have been identified for different populations, no specific mathematics course has been identified that acts as the biggest roadblock for adult students. Identifying this course will help policy makers focus their attention and resources in providing the needed support for adult learners to be successful in this course.

Students who are fully engaged with the material of a course, their classmates, and their instructors have greater success in college courses than those students who sit passively in class. In addition, having a sense of connection with peers and faculty in courses that have been identified as roadblock courses substantially impacts students' persistence in education. For adult students, whose learning experiences are focused on the classroom environment, classroom participation in discussions and activities may be essential factors for their success in roadblock mathematics courses. Past research in the learning behaviors of adult students give conflicting results, especially in the area of classroom participation. Understanding what learning behaviors adult students use in a roadblock mathematics course and the reasons they give that influence their participation in the classroom will add to understanding why adult students find a particular mathematics course difficult.

This study proposed to identify a particular mathematics course that serves as the greatest roadblock for adult students. Once this course was identified, four students from two different sections of this course were followed through the semester to explore what learning behaviors they used in the classroom and the factors that influenced their level of participation in classroom discussions and activities.

CHAPTER 3

METHODOLOGY

Adult students graduate from college at a lower rate than traditional-age students. Mathematics courses may serve as a major roadblock for adult students. The purpose of this study was twofold. First, the mathematics course that served as the greatest roadblock for a cohort of adult students at a central Texas 4-year university was identified. Second, the learning behaviors of adult students in the roadblock mathematics were examined. A mixed method design was used to address the research questions. To identify possible roadblock mathematics courses, transcript analysis was used to follow both adult and traditional-age freshmen enrolled in the fall of 1999 at Texas State University-San Marcos. Roadblock mathematics courses were identified for each group of students. After comparing the roadblock courses in each group of students, a single mathematics course was chosen as the particular course that served as the biggest roadblock for this cohort of adult students. Once this course was identified, an embedded case study (Creswell, 2007) focusing on four adult students currently enrolled in one of three sections of the roadblock mathematics course was performed in order to explore the learning behaviors of adult students in this difficult course and how their learning behaviors impacted the adult students' success in the course. The Texas State Institutional Review Board granted an exemption for this research on August 16, 2011.

Part 1: Transcript Analysis on 1999 Cohort

Transcript analysis is defined as "the coding and use of enrollment files, college application data, financial aid records, and other data" that colleges routinely collect to comply with state and federal reporting mandates (Hagedorn & Kress, 2008, p. 7). Transcript analysis has been used in several studies to identify trends and patterns among student groups in higher education (Adelman, 1990, 1995, 1999, 2006; Alfonso, 2006; Calcagno et al., 2007; Trusty & Niles, 2003). Transcripts are a source of accurate information concerning course-taking, grades, and graduation. Transcripts are rich, important data sources as transcripts "do not lie, they do not exaggerate, and they do not forget. They tell us what really happens, what courses students really take, the credits and grades they really earn, the degrees they really finish and when those degrees are awarded" (Adelman, 1995, p. vi).

Adelman (1990) analyzed college transcripts of a large, national sample of the high school class of 1972 in one of the first national longitudinal studies that focused on undergraduates in order to set a foundation for further research. Adelman later analyzed transcripts of other cohorts of students to determine trends in undergraduate education (Adelman, 1995, 1999, 2006). Alfonso (2006) used transcript analysis to explore the effect of attending community college on attaining a bachelor's degree. Calcagno et al. (2007) used transcripts to compare graduation rates between adult students and traditional-age students at community colleges in Florida. Hagedorn and Kress (2008) gave examples of the use of transcript analysis to track both individual student progress and the progress of students through developmental programs.

Transcript analysis is especially appropriate in identifying roadblock courses because "transcripts offer a map of the curriculum as traveled by the student, serving as a guide to fast roads, slow roads, danger spots, and insurmountable barriers" (Hagedorn & Kress, 2008, p. 8). This current study extends Calcagno et al.'s (2007) research on the factors that affect adult graduation rates at community colleges to a four-year institution, following their methods along with the procedures outlined by Hagedorn and Kress (2008) to identify a roadblock mathematics course.

Context of study. To identify the mathematics course that acts as the greatest roadblock for adult students, this study used a cohort of freshmen students at Texas State. Currently, Texas State is the sixth largest university in Texas with over 32,000 students. Minority students comprise over 30% of the student body and the average age of all students is 21 (College Portrait of Undergraduate Education, 2012). In the fall of 1999, from which the freshman cohort was chosen, Texas State had approximately 22,000 students (Texas State University-San Marcos, 2012b). The demographics of the sample for this study are discussed below.

Population. To compare the success in mathematics courses between adult and traditional-age students at Texas State, the freshman class of 1999 was chosen to be the cohort examined. Selected students in this cohort were tracked through the spring of 2011. This cohort was chosen for several reasons. First, the Department of Institutional Research at Texas State had full records on the mathematics courses taken by students enrolled from 1999 to the present. Second, there is literature to suggest that adult students are more likely to attend college part-time and are more likely to "stop out" for a few semesters than traditional-age students (Kasworm et al., 2002; Schatzel et al., 2011). The long time frame of this study captured information on students who might not be able to graduate within the six years that most graduation studies consider. Third, the fall of 1999 contained an adequate number of adult freshmen to allow a meaningful comparison with traditional-age students.

All students aged 25 or older and classified as freshmen in the fall of 1999 made up the adult student group for this research. All students aged 17 to 20 and classified as freshmen in the fall of 1999 made up the traditional-age student group. This grouping mirrored Calcagno et al.'s (2007) work at community colleges in Florida. Students falling in between these ages were excluded from the study. Students in this mid-range age have behaviors similar to younger students (Trueman & Hartley, 1996) and may or may not have significantly delayed entry into college. The exclusion of these students ensured a clear distinction between the groups being compared. A preliminary view of the demographics of the sample is found in Table 1.

The original cohort of adult students, identified by being freshmen in the fall of 1999 and 25 years or older, included 126 students. Because this research focused on adult students in college mathematics, the adult cohort was examined carefully to identify students who did not fit the definition of adult student for this study. Students who began their enrollment at Texas State before the age of 25 and had consistent enrollment up to the fall of 1999 were eliminated from the study even though they met the criteria of being 25 or older and freshmen in that semester. This eliminated eight students. Several of the adult students in the cohort had originally enrolled at Texas State as 18 to 20 year olds, dropped out, and then reenrolled as adult students. The mathematics courses taken as traditional-age students were dropped from consideration in the analysis. The resulting group of adult students numbered 118. The table below shows the demographics for the final study participants.

Table 1

Characteristics of Adult and Traditional-Age Freshmen in Fall 1999

Characteristic		Traditional-age (17-20)		Adult (25 and older)	
		Number	Percent	Number	Percent
Total		3,747	100%	118	100%
Admit Category	First time	2,459	65.6%	11	9.3%
	Transfer	261	7.0%	25	21.2%
	Continuing	980	26.2%	59	50.0%
	Re-entry	47	1.3%	23	19.5%
Gender	Male	1,600	42.7%	60	50.8%
	Female	2,147	57.3%	58	49.2%
Ethnicity	Asian/Pacific:	48	1.3%	0	0.0%
	Indian	24	0.6%	1	0.8%
	White(non-Hisp.)	2,759	73.6%	60	50.8%
	Hispanic	626	16.7%	41	34.7%
	Black	228	6.1%	11	9.3%
	International	43	1.1%	3	2.5%
	Unknown	19	0.5%	2	1.7%
Status	Full-time	3,554	94.8%	48	40.7%
	Part-time	192	5.1%	70	59.3%
Major College	Applied Arts	192	5.1%	31	26.3%
	Business Admin	579	15.5%	21	17.8%
	Education	347	9.3%	12	10.2%
	Fine Arts	520	13.9%	6	5.1%
	Health Professions	164	4.4%	4	3.4%
	Liberal Arts	337	9.0%	15	12.7%
	Science	510	13.6%	15	12.7%
	University College	1098	29.3%	14	11.9%

Note: This information was gathered from the transcript information provided by institutional research.

As can be seen from Table 1, the two groups of students were very different. The adult group had a greater percentage of minority students. This may be due to the greater percentage of minority students who delay entry into college (Bozick & DeLuca, 2005;

Horn et al., 2005). The difference in part-time student status is consistent with studies that show that adult students are more likely to be part time than traditional-age students (Horn et al., 2005; Kasworm et al., 2002). The high percentage of adult students with majors in the College of Applied Arts can be explained by the existence within the college of a major specifically designed for adult students which gives credit for knowledge acquired as part of career training. A large percentage of traditional-age students were in the University College because students enrolling without a declared major are placed there for advising purposes. Few adults are expected to be without a major as adult students generally have practical goals when returning to college (Kasworm, 2008; Kasworm et al., 2002)

Data collection and organization. The first step for the transcript analysis was to build a database with information pertinent to the research. With assistance from the Institutional Research Department of Texas State, students that fit the criteria of being classified as freshmen in the fall of 1999 and being either 17-20 years old or 25 years old or older were identified and given an anonymous identifying number. The admittance and course enrollment information for these students through the spring of 2011 was gathered. This information was organized into a spreadsheet including fields for gender, ethnicity, high school GPA, high school rank, SAT verbal and mathematics scores (or ACT scores), college graduation date and major, and, for each semester beginning in the fall of 1999, major, mathematics courses enrolled and outcome of each mathematics course. This followed the example of using transcripts to analyze course completion ratios by Hagedorn and Kress (2008).

Data analysis. Following Calcagno et al.'s (2007) methodology and before more in-depth analysis on how mathematics requirements affected the educational goals of adult students, a preliminary comparison was conducted on the academic preparedness for each group. The two groups were compared to determine whether they differed significantly in the areas of high school GPA, high school rank in class, college aptitude scores and mathematics placement scores using t-tests to compare means of each group with a significance level of 0.05.

The second step in this analysis was to compare the end results of these students' college endeavors. First, college graduation rates were compared between the two groups using a chi-squared test for independence. This determined if graduation rates were affected by the age of the students. Second, a Kaplan-Meier survivor test was done comparing the time to graduation of each group. The Kaplan-Meier test measures the number of survivors over time (in this case, surviving means remaining enrolled and not completing a degree) and has been used to compare the persistence in postsecondary education of groups of undergraduates in past research (Ishitani, 2006; Stinebrickner & Stinebrickner, 2003). Students who dropped out of school were censored and eliminated from the analysis. The time to graduate may be significantly different for adult and traditional-age students as many adult students attend college only part-time (Kasworm et al., 2002; Sandmann, 2010).

Because past research has demonstrated that the need to take developmental courses may affect graduation rates (Bryk & Treisman, 2010; Kolajo, 2004), the graduation rates of students beginning their mathematics coursework at both levels of developmental mathematics were compared. This mirrored Calcagno, et al.'s study (2007) by controlling for incoming mathematics ability. The graduation rates of students in each group who began their mathematics coursework with Math 1300-Pre-college Algebra, with Math 1311-Basic Math, and with a college-level mathematics course were compared to determine if the need for developmental mathematics affected adult students' graduation rates and to compare the effect to traditional-age students.

A serious limitation of this study was that students could not be tracked if they transferred to other institutions. If a student was a freshman at Texas State, then completed his degree at a different university, this study listed him as not completing a degree. The lack of means to track undergraduate students among institutions of higher education and how to compare courses at different institutions remains a serious problem (Adelman, 1995). In a recent study, 60% of undergraduates were found to have attended more than one postsecondary institution (Adelman, 2006). This is especially true for adult students who may attend several schools before graduating (Horn et al., 2005).

After analyzing graduation rates and times, several methods were used to identify roadblock mathematics courses. First, based on the results of past research, several mathematics courses were identified as potential roadblock courses. These included developmental mathematics, college algebra, and the first semester of calculus. To confirm that these courses were candidates for further analysis, the percentage of successful students in each mathematics course attempted by the adult students in the cohort was calculated. As a result of this preliminary analysis, courses were added or eliminated from the potential roadblock list. In addition, courses taken only by a small number of adults in the cohort were eliminated as not playing a large role for adults in general. Courses were added if a large number of adult students attempted the course. Once a list of potential mathematics roadblock courses was assembled, further analysis was done. First, courses that may have influenced students to either change their majors or to drop out of school were identified. Next, several methods identified courses that were particularly difficult for adult students in that more than one attempt was necessary for success in the course or the course was never successfully completed. With each method of analysis, two courses were chosen to be candidates for the greatest roadblock mathematics course for adult students. The course that was identified as the most difficult for adult students using each method, as well as the course that had the most different results from traditional-age students, were both contenders for the roadblock mathematics course to be focused on in the second part of this study.

Method 1. First, the percentage of students who were eventually successful in each mathematics course attempted by any adult student was calculated for each group. The number of students in both the adult group and the traditional students who attempted each mathematics course was counted and then the percentage of successful students for each group was calculated. In addition to measuring the difficulty of each course for adult students, this analysis had the additional purpose of adding or eliminating courses from the originally suspected candidates for roadblock courses identified by past research. This narrowed the focus of further analysis.

Method 2. In this analysis, mathematics courses were identified that may have influenced students either to change their major to one requiring a lower level of mathematics or to drop out of school. For the purpose of this study, the majors at Texas State were classified into three levels based on their mathematics requirements. Level 1, the lowest level included all majors requiring only one college-level mathematics course. These majors were typically in the College of Liberal Arts, Fine Arts, or Applied Arts. Level 2 majors required some form of calculus but no mathematics courses beyond a second semester of calculus. These included all majors in the School of Business and biology and chemistry majors. Level 3 majors required extensive mathematics and at least one mathematics course past the second semester of calculus. These included majors in mathematics, physics, engineering, and computer science. The complete list of majors and their classification is included as Appendix A.

Students who changed their major to one requiring a lower level of mathematics or did not continue their education were identified. These students' last mathematics course before the change was determined. The overall percentage of students changing their major to a lower level or dropping out of school after taking each of the courses was calculated for both adult students and traditional-age students. Although students change their majors for many reasons, and mathematics may or may not play a role in this decision, this analysis gave insight as to how mathematics might influence the decision to drop out of school or change a major to one requiring a lower level of mathematics.

The next methods of analyses were based on the number of times students attempted each potential mathematics roadblock course. These involved counting the number of attempts, the number of successes, and the number of students who repeated each course.

Method 3. The number of attempts necessary to successfully complete (defined by earning a "C" or above) each potential roadblock mathematics course was counted for each student eventually successful in the course. The mean number of attempts for each course was calculated separately for both adult students and traditional-age students. The course with the greatest average number of attempts before success for adult students became one candidate for the roadblock course. The second candidate was the course with the greatest statistical difference in average number of attempts per success between the two groups of students.

Method 4. Next, the ratio of attempts per success for each of the courses was calculated for each student group. The total number of attempts for each course, whether the student was eventually successful or not, and the number of successful students (grade of "C" or better) for each course was calculated. The ratio of attempts per success was calculated for each group for each course. The course that had the highest ratio of attempts per success within the adult group and the course that has the greatest difference in ratios between the adult and traditional age group were considered candidates for the roadblock mathematics course for adult students.

Method 5. Finally, the percentage of students who repeated each potential mathematics roadblock course at least once was calculated. Again, the course that had the highest percentage of adult repeaters and the course that showed the most difference between adult and traditional-age students were candidates for the roadblock course.

The results of these five different methods were considered in order to identify one particular mathematics course that posed the greatest roadblock for adult students. An informed decision, based on the outcomes of the five methods and the extent of the difference between adult and traditional-age students was made after this part of the analysis was done. A single mathematics course was identified as the target roadblock mathematics course to explore in the qualitative portion of this research. The procedure for data analysis is summarized in Figure 3.

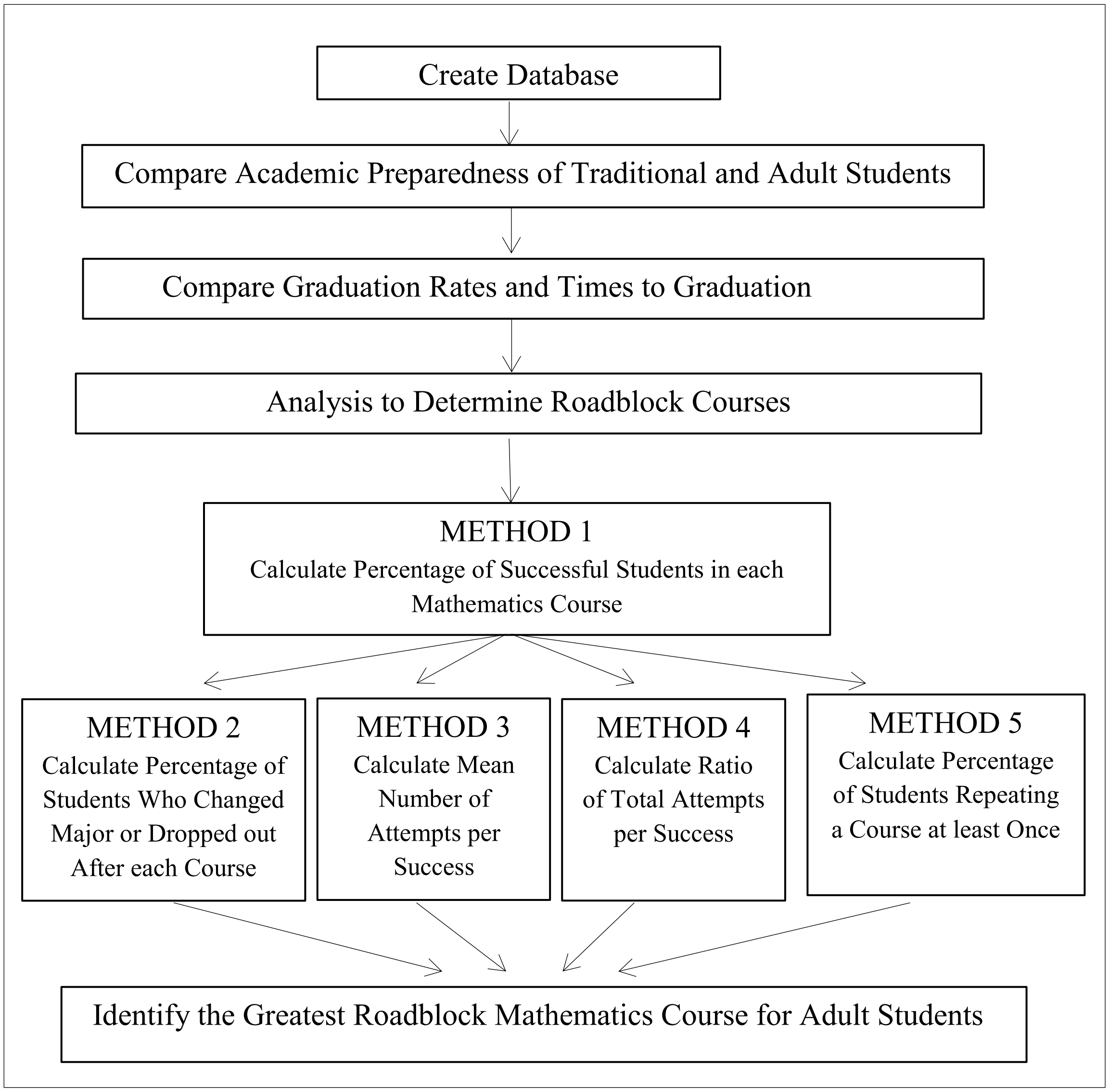

Figure 3. Steps for data analysis for Part 1.

Part 2: Exploring Adult Learning Behaviors in a Roadblock Mathematics Course

Once a roadblock mathematics course was identified, a qualitative, embedded case study methodology (Creswell, 2007) was used to examine the learning behaviors of adult students in this course and the reasons adult students gave for their behaviors. Understanding what type of learning behaviors adult students use and why they use these behaviors helped to illuminate why this course was particularly difficult for adult students. A case study was appropriate in this situation as there was a need for "providing an in-depth understanding of a case or cases" (Creswell, 2007, p. 78). Four adult students enrolled in three sections of the roadblock course during the spring of 2012 were identified and followed through the semester. Data was collected using classroom observations, class surveys, and individual interviews. Because this research viewed learning from a social constructivist framework, the interactions with instructors and classmates within and outside of class were of interest. Special attention was paid to interactions in which students explained or defended their mathematical understandings. Also, because the classroom can be viewed as a social entity with its own norms for behavior, data was collected from all the students in the targeted classes in order to understand the context of each case. The focus for this part of the study was the learning behaviors adult students used when enrolled in a roadblock mathematics course. How the students perceived the effectiveness of these behaviors and the factors influencing these behaviors were explored.

In this research, the term *learning behaviors* refers both to the observable behaviors and the reported strategies that students used to acquire new knowledge. These included interactions with classmates and faculty during class, the formation of study groups and collaboration on homework, meeting with faculty during office hours, and making use of school-provided tutoring labs or employing private tutors. Although behaviors outside of class were noted, because the college classroom serves as the main venue for learning for adult students (Graham et al., 2000), the main focus of this study was the learning behaviors adult students used during class time.

Pilot study. In preparation for this portion of the research, a pilot study was conducted in the spring of 2011. Two adult students in a mathematics course designed for liberal arts majors served as the cases for this preliminary study. Data was collected in the form of classroom observations, a class survey, and interviews with each of the two adult participants. The purpose of this pilot was both to test the data collection instruments used in this study and to gain insight into factors that influence adult student participation in class.

From the classroom observations, it became apparent that Karp and Yoel's (1976) model of student participation was valid in this classroom. Only a small minority of students in this class was very vocal in class, while the majority was silent. While the most vocal student was an adult male, the active participants came from both adult and traditional-age populations. The active students seemed to vary in their participation levels dependent on the mathematics content being discussed. It seemed that the more confident a student was about the current topic, the more likely he was to participate in classroom discussion.

The two adults interviewed for the pilot study exhibited different behaviors in the classroom. Mary, a single parent who worked full time in addition to attending school, was quiet and rarely responded to questions asked by the instructor. In contrast to this, Joe, a military veteran, was outspoken in the classroom. Despite the difference in their participation in classroom discussions, both students struggled in the course. While Mary identified shyness and insecurity as the major reasons for her quietness, she explained that she was making an effort to be more active in class. An example of this was her seat selection in the second to the last row instead of her usual back row preference. Joe, who believed he was a more serious student than his younger classmates, expressed that he was going to speak up and ask questions without regard to what his classmates thought of him. However, when he was confused by material in the class, he was silent.

Interaction between students varied greatly in this classroom. There were many opportunities for collaboration when the students were given the choice to work individually or in groups. While some students consistently worked collaboratively, others never spoke to their classmates.

As a result of the pilot study, the data collection instruments were adjusted both for ease of use and to include questions about interesting results that emerged from the pilot. One of these results was the variation in the interaction between classmates. Some of the students in the class had had a previous course together and were acquainted with each other, while others came into the class not knowing anyone. Knowing their classmates names might be a factor in students' interactions in the classroom. Another observation was that Joe, when presented with totally new material, changed his behavior from being the most talkative student to being silent. Confidence to do mathematics might be another factor that influences participation in the classroom. The instrument changes are discussed in more detail later in this chapter.

Participants. Participants for this part of the research were four adult students enrolled in three sections of a mathematics course identified as a roadblock course. The adult students were chosen based on the criteria of being 25 years or older, pursuing their first undergraduate degree, and being enrolled in the roadblock mathematics course identified in the first part of this research. Each participant signed a consent form acknowledging their willingness to participate in the study and informing the participants as to how their information would be used. Participants were assured that their identities would be protected and that pseudonyms would be used in place of their real names in any written report or oral presentation. The consent form can be found as Appendix B.

In order to identify potential study participants, the researcher, after obtaining the consent and cooperation of the instructors, made a short announcement summarizing the study in each of several sections of the targeted course during the first week of the semester. A survey was given to each student in class with items concerning demographics and their attitudes towards mathematics. The survey included an invitation for adult students to participate more fully in the study by volunteering to be interviewed twice during the semester. Participants were chosen from the available adult students based on their diversity. An effort was made to include students from both genders who reported the greatest diversity in attitudes towards mathematics. This allowed the exploration of the full range of experiences of adult students in mathematics classes. A more detailed description of each participant is included in the results section of this paper.

Data collection. The data for this part of the research focused on the learning behaviors adult students used in a roadblock mathematics course. Karp and Yoels (1976) were pioneers in the investigation of learning behaviors in the college classroom. Their research generated interest in determining the teaching methods that encouraged classroom participation and identifying characteristics of students who fully participated in classroom discussions and learning activities. Researchers in this area used surveys, observations, interviews, or combinations of these to explore the topic of student participation and engagement with learning (Callahan, 2008; Fritschner, 2000; Howard & Baird, 2000; Howard & Henney, 1998; Weaver & Qi, 2005). After reviewing the methods used by these researchers, the methodology for this part of the research was adapted from these past studies. Like Howard and Henney (1998) and Howard and Baird (2000), the data was triangulated using observations, surveys, and interviews. Because "what students say or believe about their participation in the classroom may differ from their actual participation" (Fritschner, 2000, p. 343), observations and interviews were used to verify survey responses. This collection of data from several sources followed the protocol for case studies (Creswell, 2007).

As the first step in data collection, a survey was given to all students enrolled in the targeted sections of the roadblock course. This survey included demographic information, an invitation to adult students to participate further in the study and a short instrument to measure attitudes towards and perceived usefulness of mathematics. Attitudes towards mathematics and mathematics self-efficacy were examined in order to explore the impact these have on participation in classroom discussions and activities. Because adult students enter college less prepared in mathematics (Calcagno et al., 2007; Kasworm & Pike, 1994) and many have negative attitudes towards mathematics (Lawrence, 1988; Nonesuch, 2006), their learning behaviors may be affected by these attitudes. Additionally, adult students are more engaged in their learning when they perceive a practical use for the subject (Graham et al., 2000; Kasworm et al., 2002). How students perceive the usefulness of mathematics may affect their learning behaviors. The instrument used to measure attitudes towards mathematics was adapted from one used and validated by Elliot (1986) for his dissertation on the predictive power of mathematics attitudes in adult students' success in mathematics courses. The instrument measured mathematics confidence—how students' perceive their ability to learn and do well in mathematics courses, and mathematics usefulness—the extent to which students believe mathematics will be instrumental in attaining the college degree and in their future professional life. Elliot's survey was shortened from 40 items to 24 items in order to take less class time and to make its use more acceptable to the participating instructors.

Students were able to complete the adapted survey within ten minutes of classroom time. The shortened survey was piloted to check its reliability the semester before its use in this study. The shortened survey, when used in the pilot study and administered online, had comparable Alpha-Cronbach scores to Elliot's (1986) survey except in the area of the usefulness of mathematics in obtaining a college degree. Within this construct, the reliability of the pilot survey was .706 compared to Elliot's reliability of .86. The shortened survey, when used in the present research and administered in a paper format, was slightly lower than the pilot, especially in the construct of usefulness of mathematics for educational goals. The table below summarizes the reliability results of the survey. The full survey used in both the pilot study and in the present research is included as Appendix C.

Table 2

Reliability of First Classroom Survey

Construct	**Cronbach's Alpha in Elliot's Research (10 items each)**	**Cronbach's Alpha in Pilot Study (6 items each)**	**Cronbach's Alpha in Dissertation Study (6 items each)**
Usefulness in Educational Goal	.86	.706	.626
Usefulness of Content for Future Career	.86	.865	.741
Confidence to do Mathematics	.89	.88	.881
Enjoyment of Mathematics	-	.832	.804

Note: Elliot included items on the enjoyment of mathematics but did not test those items for reliability.

Initially nine adult students volunteered to participate in this study. Initial interviews were arranged for five of these students and four adult students completed all parts of the study, including participating two interviews and completing both surveys. All of these were included in the final study.

Once the four adult student participants were identified, they participated in an initial, individual interview with the researcher. This interview had a semi-structured format (Creswell, 2007) focusing on the students' mathematical history, their first impressions of the mathematics course they were currently enrolled in and the learning behaviors they have used in past mathematics courses. Their goals for the course and their plans to achieve those goals were discussed. Because students' beliefs about their role in the classroom can affect their participation (Hand et al., 1997), the adult students' perceptions of their responsibilities as students and the responsibilities of the instructor were explored. The interview protocol is included as Appendix D.

Over the course of the semester, a series of three classroom observations were done in each section of the targeted course. The purpose of the observations was to determine the usual level of student participation in the class as a whole and how the adult students who were the focus of this research behaved in the classroom setting. The observations were used to verify the second survey that focused on learning behaviors. For each observation, the researcher sat at the back of the classroom with a seating chart. Student comments were marked according to the classification system used by Fritschner (2000). These included (a) student initiated remarks, such as questions about content, questions about classroom procedures, and comments adding to the classroom discussion; (b) instructor initiated remarks, such as responses to the instructor asking the whole class a question, or the instructor asking for comments on a topic; (c) direct questions by the instructor, when the instructor calls for a response from a particular student; and (d) off hand remarks—any remark not related to the course, but loud enough to be heard by the class. In addition to counting the number of times students participated in whole class discussions, the researcher recorded impressions of student-to-student and student-to-instructor interactions as well as the number of students not engaged in the classroom activities. Particular focus was on the behavior of the research participants.

The observation instrument was field tested in the pilot study and several adjustments were made to the original instrument. In the present instrument, each seat in the classroom was numbered in order to make references to particular students easier. In the classroom observations in the pilot study, there was an attempt to identify adult students in the class that were not included as one of the two cases in order to compare general adult student behavior from traditional-age student behavior. It became clear that adult students could not be identified by appearance alone. For this study, no attempt was made to distinguish adult students from traditional-age students except for those included as one of the four students that were studied in depth. Observations in the classroom were made in order to understand the context of the cases and to determine the norm behaviors within the classroom. The final instrument also allowed for the recording of student to student interaction and para-participation behaviors (subtle, student initiated actions such as asking questions before and after class). The observation instrument is included as Appendix E.

In the seventh week of class, a survey was given to all students in the class. This attempted to capture both in-class and out-of-class learning behaviors and the reasons students give for their learning behaviors. The survey was adapted from surveys developed by Howard and Baird (2000), Weaver and Qi (2005), and Howell (2006). The survey was adapted so that it could be completed within ten minutes. The survey included items about the frequency of classroom participation, the frequency of para-participation, reasons for the students' level of classroom participation, and whether or not the student studied by himself or with others. The items pertaining to the extent of students' participation in class discussion were answered with a Likert-type scale indicating the number of times a behavior was used by the student. Items asking for reasons for student behaviors included a list of possible reasons. The students were instructed to circle as many that applied to themselves (Howard & Baird, 2000). Space was provided for the student to include reasons not listed in the survey. The survey included a short description of the research study as well as the researchers name and contact information. The four research participants were asked to place their name on the survey in order that it could be used to compare to classroom norms. Otherwise, the survey asked for no identifying information. This survey was used as part of the earlier pilot study. Three items concerning how well the student was acquainted with both their instructor and their classmates were added as a result of the pilot study. Students in the pilot study were more likely to ask students seated next to them for clarification of a classroom issue if they knew the name of that student. The full survey is included as Appendix F.

A final interview was scheduled with each participant near the end of the semester. A semi-structured protocol was used to structure the interview while allowing for leeway if unexpected topics arose (Creswell, 2007). This interview focused on the learning behaviors the adult students used in the roadblock mathematics course, the perception of the usefulness of these strategies, and the students' final impressions of the course. The interview included delving deeper into the motivations that prompted the level of participation in the classroom. In addition, students' perceptions of the difficulty of the course were explored. The protocol for this final interview is included as Appendix G.

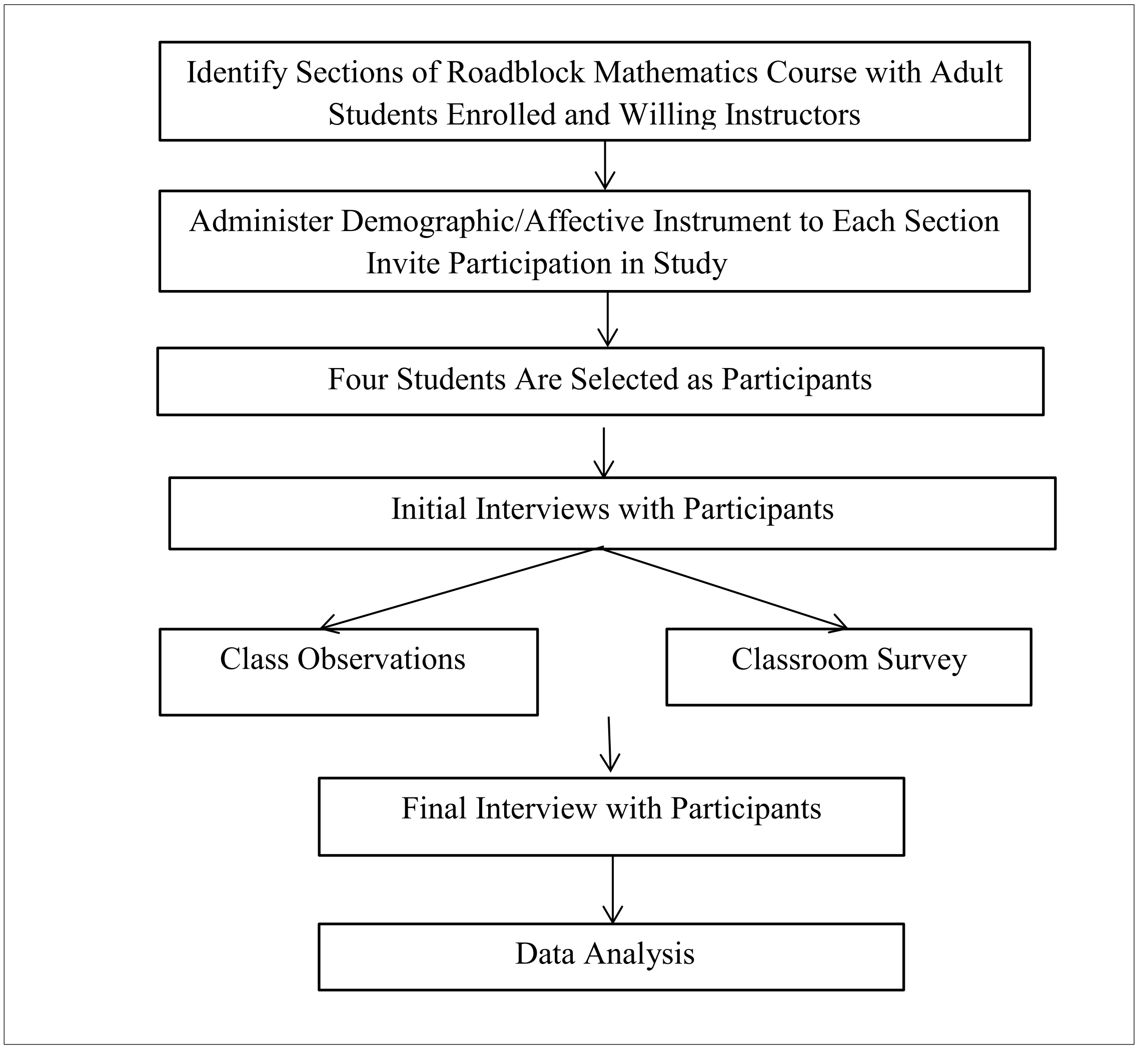

Figure 4. Steps for data collection for Part 2.

Data analysis. Because research shows that that active engagement with the material, instructor, an and classmates promote learning (Howard & Baird, 2000; Howard & Henney, 1998), the data collected in this part of the study was analyzed from a social constructivist framework (Cobb, 2000). Adult students' perceptions of their participation and the factors that encourage or inhibit participation were examined.

Because learning occurs in context, the interviews and observations were analyzed focusing on classroom social norms and expectations.

First, results from the mathematics attitudes survey and learning behavior surveys were analyzed to determine the social norms of each classroom and then the four adult students that were the focus of this study were located within this norm. These comparisons provided information on the adult student's attitudes, behaviors, and success in the class in relation to the class as a whole. After the classroom context of each adult student was clear, the transcripts of the interviews of the four participants were coded and analyzed in order to better understand the learning behaviors adult students used. Particular focus was placed on social interactions that take place in the classroom.

The analysis of the interview transcripts took place in several phases. A priori codes guided the analysis although the researcher was open to any unexpected emergent themes (Creswell, 2007). The initial interview was first coded using the themes of experiences as adult students in a four-year university, mathematics background, and first impressions of the roadblock mathematics course. Adult students who often enter the university unsure of their place in the college classroom (Kasworm et al., 2002; Stone, 2008) may be hesitant to participate fully in classroom discussions. In contrast to this, adult students often exhibit more motivation than traditional-age students (Hansman & Mott, 2010; Kasworm, 2008; McGivney, 2004) which may counter this insecurity. In addition, high school mathematics proficiency and past mathematical experiences play a major role in college graduation rates (Adelman, 2006). These themes, as well as others that emerged as the researcher and participants got to know each other were explored in this initial interview.

The final interview, near the end of the semester, focused on the observed and reported learning behaviors the adult students used in the roadblock mathematics course. First, the interview transcripts were coded looking for references to learning behaviors and the reasons behind these behaviors. Next, references to other factors that the adult students identified as contributing to their success or difficulty in the course were coded. During this interview, discrepancies between survey responses and observed behaviors were discussed and explained. Also, any unusual classroom behavior was explored.

For the analysis of the interview transcripts, while each case was explored in detail, common themes were identified, and unusual experiences were explored in order to identify which learning behaviors were helpful for adult students to succeed in the course and what factors seemed to influence learning behaviors.

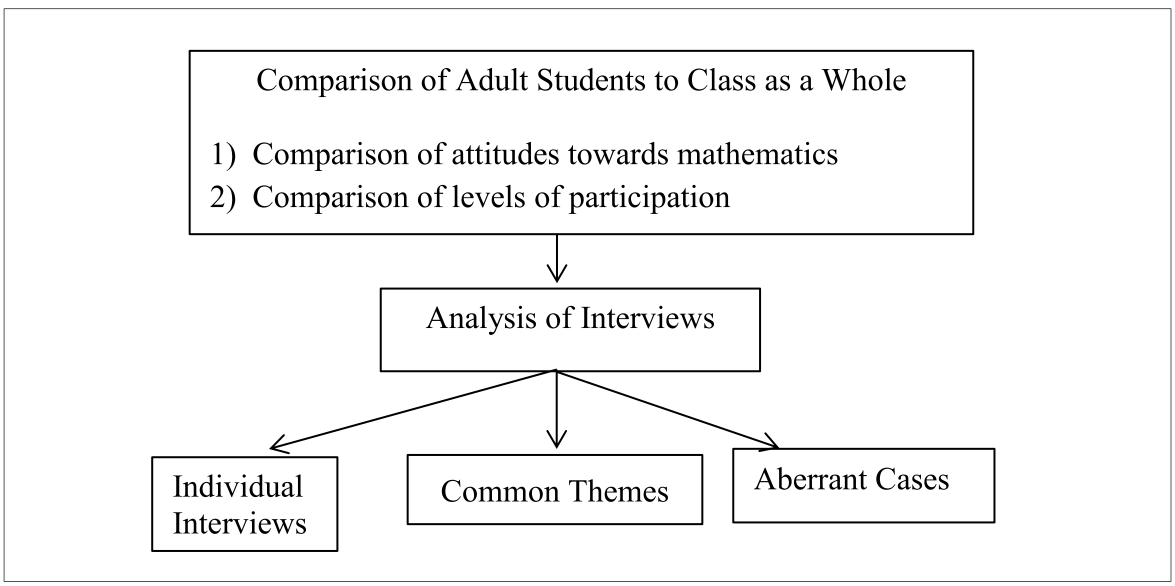

Figure 5. Steps for data analysis for Part 2.

Expected results. Because this study was conducted with a social constructivist framework, the adult student participants' success in the roadblock mathematics course was expected to be influenced by their active participation in classroom discussion and their collaboration with classmates and instructors both during and outside of class.

Because attitudes towards mathematics and social comfort in the classroom may affect these learning behaviors, a survey addressing attitudes was given as well as these topics being brought up during interviews. A proposed model of the expected results is shown in the figure below.

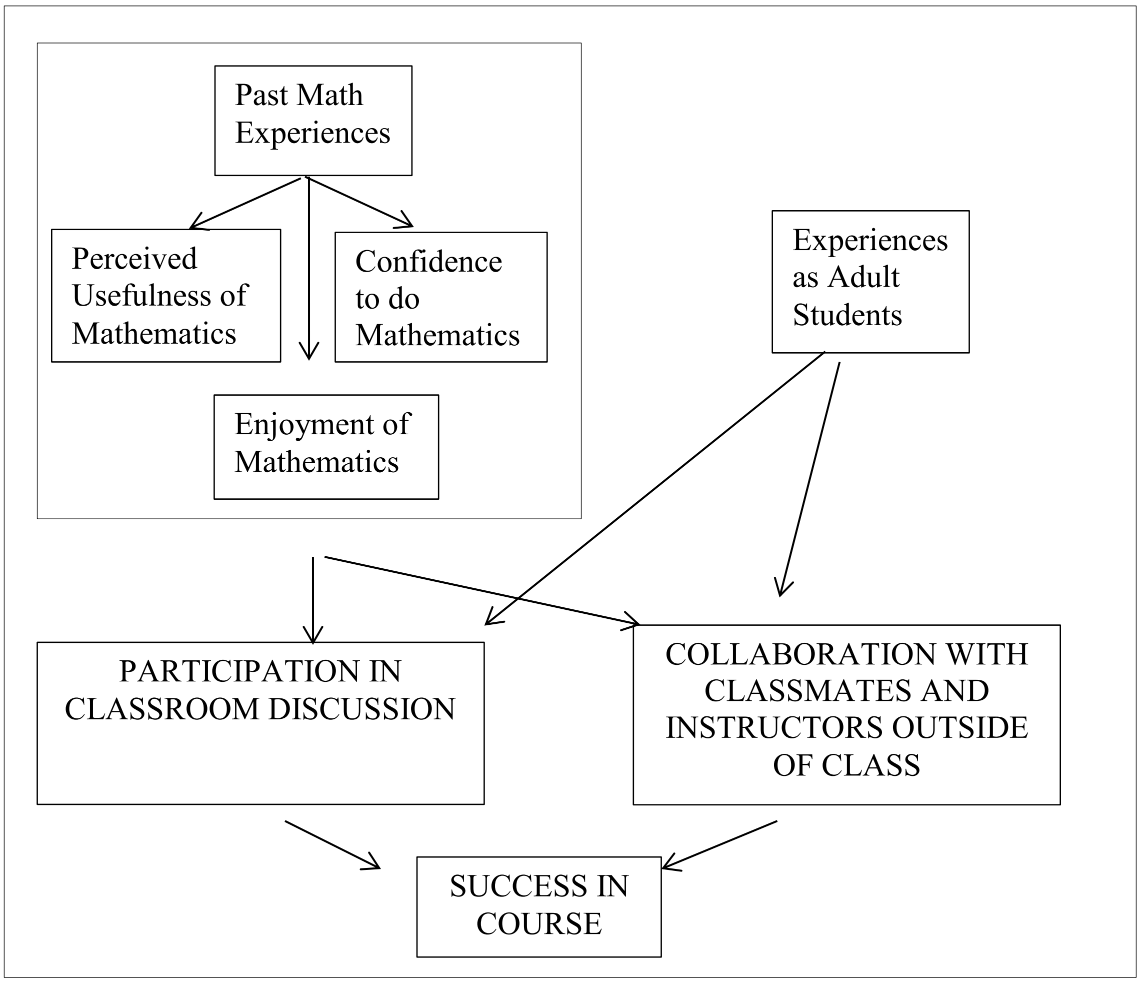

Figure 6. Expected results for Part 2

Summary

The purpose of this study was to both identify a college mathematics course that acted as a roadblock to the educational goals of adult students and to examine the learning behaviors of four adult students currently enrolled in the course. By identifying this course and examining the behaviors of adult students in the course, changes could be suggested to policy makers and instructors in order to meet the educational needs of the increasing population of adult students on college campuses.

In order to identify the mathematics course that acted as the greatest roadblock for adult students, the transcripts of adult and traditional-age students who were classified as freshmen in the fall of 1999 at a central Texas university were collected and analyzed. Five methods were used to identify mathematics courses that were particularly difficult for adult students and mathematics courses for which the adults had significantly different outcomes from traditional-age students. The results of five methods were considered together to identify as single mathematics course that acted as the greatest barrier to the educational goals of adult students.

Once the roadblock course was identified, four adult students currently enrolled in the course were interviewed, observed during class, and surveyed in order to analyze the learning behaviors the adult students used in the class. Because of the social constructivist framework of the study, the interactions of adult students with classmates, instructors, and tutors were of particular interest.

Combining the results from both parts of this research will allow recommendations to be made to help adult students become more successful in the identified roadblock mathematics course. Mathematics departments could adapt the course structure and curriculum to better serve adult students. Instructors could be made aware of teaching techniques that encourage more participation in classroom discussion by adult students. Finally, adult students themselves could be made aware of the challenges they may encounter in the course and be better prepared for the time and effort that might be necessary for them to succeed in the course.

CHAPTER 4

RESULTS

This study addressed the low college graduation rate of adult students. Past research has pointed to the important role college mathematics plays in graduation rates of all college students (Adelman, 1999, 2006; Trusty & Niles, 2003) and of adult students in particular (Calcagno et al., 2007; Horn et al., 2005). The purpose of this study was to use quantitative methods to identify the college mathematics course that acted as the greatest impediment or roadblock for adult students by analyzing the transcripts of a cohort of students and then to use qualitative methods by following several adult students currently enrolled in the identified course, focusing on their behaviors in the mathematics classroom. The research questions for this study were:

1. For adult undergraduates pursuing their first baccalaureate degree at a four-year university, what mathematics course serves as the greatest roadblock to the successful completion of their originally declared major?
2. What learning behaviors do adult students use in the roadblock mathematics course and how do these differ from traditional-age students? What factors influence the learning behaviors? What influence do adult students' learning behaviors in the roadblock mathematics course have on their success in the course?

Because of the two-part nature of this study, this chapter is presented in two sections. The first section presents the results and conclusions from the quantitative, transcript analysis. This is followed by the results and conclusions from the qualitative portion of the study.

Part 1: Identifying a Roadblock Mathematics Course for Adult Students

In order to identify the mathematics course that posed the greatest roadblock for adult students, transcripts were collected from a cohort of students, all of whom were freshmen in the fall of 1999 at Texas State University-San Marcos. This cohort of students was separated into two groups; one consisting of freshmen who were between the ages of 17 and 20; the other consisting of freshmen who were 25 or older. Following the lead of Trueman and Hartley (1996), students aged 21 to 24 were eliminated from the study in order to better distinguish between students entering college directly after graduation from high school and those having a significant delay before enrolling in college. In addition, students who met the criteria of being 25 or older and freshmen in the fall of 1999 but had been enrolled at Texas State within the preceding two years and were younger than 25 during that enrollment were eliminated in order to concentrate the study on students beginning their college career as adults.

This part of the study had two goals. First, preliminary comparisons were made in regards to the academic preparation and college graduation rates between adult and traditional-age students. After the preliminary comparisons were complete, several methods of analyses were performed to identify the roadblock mathematics course. First, the percentage of successful students in each group for each mathematics course attempted was calculated. Next, the difficulty of each course was measured in several ways based on how often students repeated the course.

Transcript data for all freshmen in the fall of 1999 was obtained from the Institutional Research Office at Texas State. The raw data consisted of four separate files. The first contained demographic and pre-college academic records for each student. This included high school GPA, high school rank in class, birthdate, ethnicity, gender, and other demographic information. The second file contained all the mathematics courses attempted by each of the students while at Texas State along with the outcomes of these courses. For the college-level courses, outcomes of each course were coded as A, B, C, D, F, or W. For developmental, non-credit bearing mathematics courses, outcomes were coded as E, signifying a student had a high enough course average to pass the course; P, signifying progress in the course but not enough to advance to college-level courses; F, failure; and W, withdrawal. There was no record of a student taking a course if the course was dropped before the census date, usually the 12^{th} class day of the semester. Mathematics courses taken by adult students in a previous enrollment at Texas State as traditional-age students were not considered for the purposes of analysis. The third file contained the number of hours attempted each semester and the declared major for each semester for each student. The fourth contained the graduation date and major for those students who graduated. This information was merged into one file using the SPSS statistics program which was used to analyze the data.

Based on the past research that identified developmental mathematics (Bryk & Treisman, 2010; Burton, 1987; Carnegie Foundation for the Advancement of Teaching, 2010), college algebra (Reyes, 2010; Small, 2010) , and calculus (Cipra, 1988; Gerhardt et al., 2006; Suresh, 2006; Walsh, 1987) as barriers to college students' success, several mathematics courses were considered as potential candidates for the mathematics course that posed the greatest roadblock for adult students. At Texas State, these were developmental mathematics, consisting of Math 1300-Pre-College Algebra and Math 1311-Basic Mathematics; beginning algebra, consisting of Math 1316-A Contemporary

Survey of Modern Mathematics, Math 1315-College Algebra, and Math 1319-Mathematics for Business and Economics 1; and beginning calculus, consisting of Math 1329-Mathematics for Business and Economics 2, Math 2321-Calculus for Life Sciences, and Math 2471-Calculus. Although the roadblock mathematics course for adult students was suspected to be among these courses, every mathematics course attempted by an adult student in the cohort was considered in the first method of analysis. Analyses were done based on the percentage of students who were successful in each course as well as the number of attempts in each course. The course that posed the greatest problem for adult students as well as the course that was most difficult for adults compared to traditional-age students became candidates for the roadblock mathematics course focused on in the second part of the study.

Preliminary comparisons between the adult and traditional-age cohorts. Before identifying the mathematics course that acted as the greatest roadblock for adult students, preliminary comparisons were made on the academic preparedness and the graduation rates of adult and traditional-age students. Past research has shown that adult students enter college less prepared and have lower graduation rates than traditional-age students. These previous findings were confirmed by this study.

Academic preparedness. One of the barriers many adult students face as they pursue a college degree is their poor academic preparation for college-level work. Past research has shown that adult students are generally less prepared than traditional-age students (Calcagno et al., 2007; Kasworm & Pike, 1994; Kasworm et al., 2002).

Although there was substantial missing data for the adult students in this cohort, the data available supported earlier findings on the lower academic preparedness of adult students. As can be seen in Table 3, adult students in this cohort had lower high school

GPAs and rank in high school class, as well as lower scores on college admissions and placement exams.

Table 3

Academic Readiness of Adult and Traditional-Age Freshmen in Fall 1999

Item		Number of Students	Mean	Standard Deviation	Sig
Number in Cohort	Adult	118			
	Traditional-age	3,747			
High School GPA	Adult	49	0.36	1.012	
	Traditional-age	3,728	2.43	1.660	.000
High School Rank (Percentile)	Adult	5	.4718	.2147	
	Traditional-age	3,418	.7183	.1537	.062
SAT Math Score	Adult	19	480.00	77.675	
	Traditional-age	3,284	512.36	72.824	.0866
SAT Verbal Score	Adult	19	495.26	92.878	
	Traditional-age	3,284	514.72	73.255	.374
ACT Math Score	Adult	13	18.46	2.817	
	Traditional-age	1,882	20.74	3.474	.003
ACT English Score	Adult	13	17.92	5.894	
	Traditional-age	1,882	20.94	3.973	.089
Math Placement Score	Adult	26	12.81	7.272	
	Traditional-age	545	20.96	5.473	.000

Although the difference in scores on the SAT exams was not statistically different between the adult and traditional-age students, they were significantly different on the math portion of the ACT exam. Other researchers have found that adult students often score higher than younger students on verbal portions of admissions tests (Calcagno et al., 2007; Kasworm et al., 2002). This was not true with this cohort of students. While not significantly lower, the adult students in this cohort had lower average scores on both the SAT Verbal exam and the English portion of the ACT exam. The most profound difference in exam scores was for the mathematics placement exam in which adult students scored much lower than traditional-age students. This may be due to the fact that students with high enough SAT or ACT math scores are not required to take mathematics placement exams. Students who have low scores on admission exams or are entering programs not requiring admission exams may be the same students who have struggled with mathematics in the past.

The lack of information on adult students may be partially due to the number of returning and transfer students among adult learners. In this cohort, only 11 of the 118 adult students were first-time freshmen. Although all were classified as freshmen in the fall of 1999, most were either transfer, returning, or continuing students. Because transfer students already have college credit, they may not have been required to supply high school information or take college admissions exams. In addition, 31 of the 118 adult students entered Texas State with a beginning major in the College of Applied Arts which has a special program for adult students in which they are accepted into the program based on past academic, industrial, or vocational training and may not be required to provide high school or SAT/ACT information.

A second measure of academic preparedness is the need to take developmental mathematics courses before proceeding to college-level mathematics. At Texas State, there are two levels of developmental mathematics, Math 1300-Pre-College Algebra, and Math 1311-Basic Mathematics. Both of these courses are designed to "remediate and review basic academic skills in mathematics" and act as preparatory classes for college algebra (Texas State University-San Marcos, 2012c). The number and percentage of adult and traditional-age students in the cohort that were required to take one or both of the developmental mathematics courses at Texas State are shown in the following table.

Table 4

Students Requiring Developmental Mathematics

		Number of Students	Number in Cohort	Percent of Cohort	Sig
Math 1300	Adult	34	118	28.81%	
	Traditional-age	103	3,747	2.75%	.000
Math 1311	Adult	55	118	46.6%	
	Traditional-age	1,036	3,747	27.65%	.000

Note: The students counted in Math 1311 include any student who took the course. The student may have started in Math 1300 and then was required to take Math 1311.

As seen in the table, a significantly larger proportion of adult students needed mathematics preparation before taking college-level mathematics than traditional-age students. This demonstrated that the adult students in the cohort were significantly less prepared than younger students to handle college work, particularly in mathematics.

Graduation rates. Past research has found that adult students graduate at lower rates than traditional-age students (Calcagno et al., 2007; McGiveney, 2004; Taniguchi & Kaufman, 2005). Having to spend time in developmental courses has been shown to have a deleterious effect on both graduation rates and number of semesters needed to graduate (Bryk & Treisman, 2010; Kolajo, 2004). Along with a comparison of the graduation rates of each group of students in the cohort, the graduation rates of students that required developmental mathematics were analyzed in order to determine the effect on adult students of beginning college mathematics at the developmental level.

For the groups as a whole, adult students in this cohort had a much lower graduation rate than traditional-age students. Of the 118 adult students, only 32 or

27.10%, graduated from Texas State. Of the 3,747 traditional-age students, over half, or 57.43% graduated. This difference has a p-value of less than .000. The findings of this study support past research on the graduation rates of adult undergraduates.

Comparing graduation rates of students based on their first mathematics course at Texas State demonstrated that the greater the incoming mathematics proficiency, the greater the graduation rate for both traditional-age and adult students. This is consistent with past research (Adelman, 1999, 2006; Trusty & Niles, 2003). Supporting this conclusion is the fact the adult students never attempting any mathematics course had a very low graduation rate. Only 82 of the 118 adults in the cohort attempted any mathematics courses at all at Texas State. The 36 adult students who never took a mathematics course at Texas State either enrolled in Texas State with credit for a mathematics course (four adults) or have no record of ever attempting a mathematics course (32 adults). Of these 36, only one graduated. Over half (19) of the adult students that did not attempt a math course at Texas State were enrolled in the College of Applied Arts. Fourteen of these were in a program designed for adult students to earn their degrees based on past workplace education as well as current college credit courses. Regardless of this special program, adult students who failed to attempt any math course at Texas State had a lower rate of graduating than those who did attempt mathematics.

Both adult and traditional-age students in this cohort who enrolled in college prepared for college mathematics had higher graduation rates than their respective groups as a whole. The graduation rate of adults beginning at the college level was only slightly lower than that of traditional-age students starting at the college level. This illustrates the importance of preparedness in mathematics for adults to reach their educational goals Adult students beginning in one of the developmental mathematics courses graduated at rates significantly, or almost significantly, lower than traditional-age students starting at the same level. This seems to contradict Calcagno et al.'s (2007) finding that when incoming mathematics proficiency is controlled, adult students have higher completion rates than younger students. This was not true for the adult students in this study.

Table 5

A Comparison of Graduation Rates Based on Students' First Math Course

First Math Course		Number of Grads	Number of Students	Graduation Rate	Sig
Overall Graduation Rate	Adult	32	118	27.10%	
	Traditional-age	2,152	3,747	57.43%	.00
Math 1300	Adult	7	32	21.88%	
	Traditional-age	37	85	43.53%	.03
Math 1311	Adult	11	27	40.74%	
	Traditional-age	535	945	56.61%	.10
Any College-Level Math Course	Adult	13	23	56.52%	
	Traditional-age	1554	2,572	60.42%	.70

Note: While 32 adults began their math courses at Texas State in Math 1300, two others started in Math 1311 and subsequently took Math 1300. This accounts for the 34 adults who took Math 1300 while only 32 adults began in Math 1300.

While the adult students in this study that took Math 1300, the lowest level of developmental mathematics, had lower graduation rates than the adult cohort as a whole; students who started at the higher level of developmental mathematics, Math 1311, had higher graduation rates than the adult cohort as a whole. This suggests that adult students who lack substantial basic mathematics skills upon entering college are less likely to graduate than those who needed only one semester of preparation. This supports one of Calcagno et al.'s (2007) conclusions that if adults only need a "refreshing" of mathematics skills, their graduation rates may not be seriously affected.

Adult students who were able to begin their college mathematics at the second level of developmental mathematics instead of the first, more elementary level, had almost double the graduation rate of those beginning at the first level. This suggests the need to provide extra support services for these adults who are beginning at a basic mathematics level. This great difference in graduation rates between students beginning in Math 1300 and Math 1311 was not seen among traditional age students. Of the 34 students who took Math 1300, nine graduated. Of those that did graduate, the average time to graduate was 74 months which is longer, but not significantly so, than adult students not required to take Math 1300.

In addition, of the 32 adult students starting their college mathematics at the lower level of developmental mathematics, Math 1300, 72% were successful in the course, but only 15 were successful in the higher level of developmental mathematics and only ten of the original 32, or 31%, were subsequently successful in a college level mathematics course. Of the 27 adult students who started at the higher level of developmental mathematics, 85% were successful in their developmental course and 15, or 56%, went on to be successful in a college level mathematics course. To compare this to traditional-age students, of the 85 traditional-age students who started their mathematics coursework with Math 1300, 64 were successful in Math 1300, 59 were successful in Math 1311, and 40, or 47% went on to be successful in a college level mathematics course. Of the 945 traditional-age students who started in Math 1311, 82% were successful in 1311, and 591, or 63% were subsequently successful in a college level mathematics course. As can be seen in the table below, having to begin at the lowest level of developmental mathematics affects adult and traditional-age students somewhat differently. This effect is not seen with students starting at the upper level of developmental mathematics. This is summarized in the table below.

Table 6

The Effect of Developmental Mathematics On Success in College Mathematics

		Number of students	Number successful in a college level course	Percent successful college level course	Sig
Students starting in Math 1300	Adult Students	32	10	31%	.078
	Traditional-age	85	42	49%	
Students starting in Math 1311	Adult	27	16	59%	.96
	Traditional-age	945	565	60%	

Note: Some students were successful in more than one freshman level mathematics course. These overlaps were accounted for when counting the number of successful students.

When this information is portrayed in a graph, the difference between adult and traditional-age students starting their mathematics college work at the lower level of developmental mathematics is more apparent. The first graph below show the percentage of adult and traditional-age students that begin mathematics with Math 1300 that succeed in their subsequent mathematics courses. The second graph compares adult and traditional-age students that start mathematics with Math 1311, the higher level of developmental mathematics. Adult and traditional-age students who begin mathematics with a college level course have similar success rates and graduation rates.

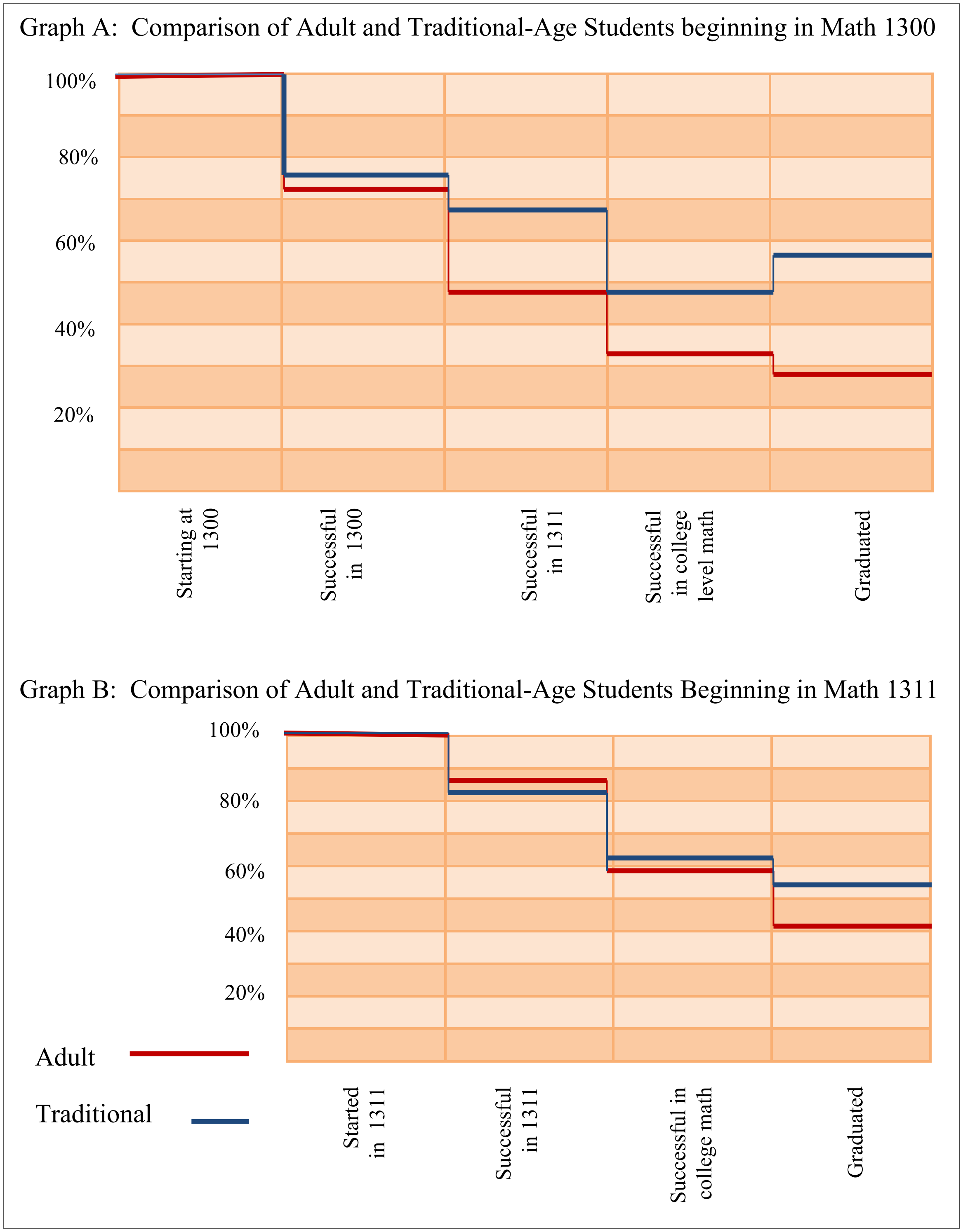

Figure 7. The effect of developmental mathematics on success in college-level mathematics.

Time to graduation. Adult students are more likely to be part-time college students than traditional-age students (Kasworm et al., 2002). Therefore, the time taken to obtain a college degree for adult students may be longer than for younger students. In this cohort of students, of the 34 adults who did graduate, they did so with an average of 68.38 months (SD = 31.38), while traditional students who graduated did so in an average of 54.66 months (SD = 16.71). The difference in the average graduation times was statistically significant ($p < 0.019$).

A Kaplan-Meier Survival analysis was done to present a visual image of the time to graduate for adult and traditional-age students. Here, only students who did graduate were included in the analysis, and each student was eliminated from the analysis as he graduated. Figure 8 shows the results of the Kaplan-Meier analysis. The left hand scale indicates the percentage of the graduating students in each group that remained enrolled in school after the months shown on the horizontal scale. Because this analysis included only students who eventually graduated, the percentage of students in each group dropped to 0% by the end of the observed time frame. As can be seen in Figure 8, several adult students graduated very early. For the first four years after the fall of 1999, adult students graduated in a shorter time period than younger students. The two adult students who graduated first, one in 15 months and the second in 20 months, were both Applied Arts and Sciences majors which includes special provisions for mature students to earn up to 24 semester hours for work and life experiences and up to 30 semester hours for training related to business or industry (Texas State University-San Marcos, 2012d). The next two adults to graduate were both business majors; one started his mathematics coursework with Math 1300-Pre-college Algebra, and continued successfully through Math 1311-Basic Mathematics, Math 1319-Mathematics for Business and Economics 1 and Math 1329-Mathematics for Business and Economics 2, repeating Math 1319 one time. The other started at Math 1311 and was successful in each subsequent math course taken (Math 1319, Math 1329). After about 40 months, traditional-age students graduated at a faster rate than adult students. On average, adult students took longer to graduate than traditional-age students.

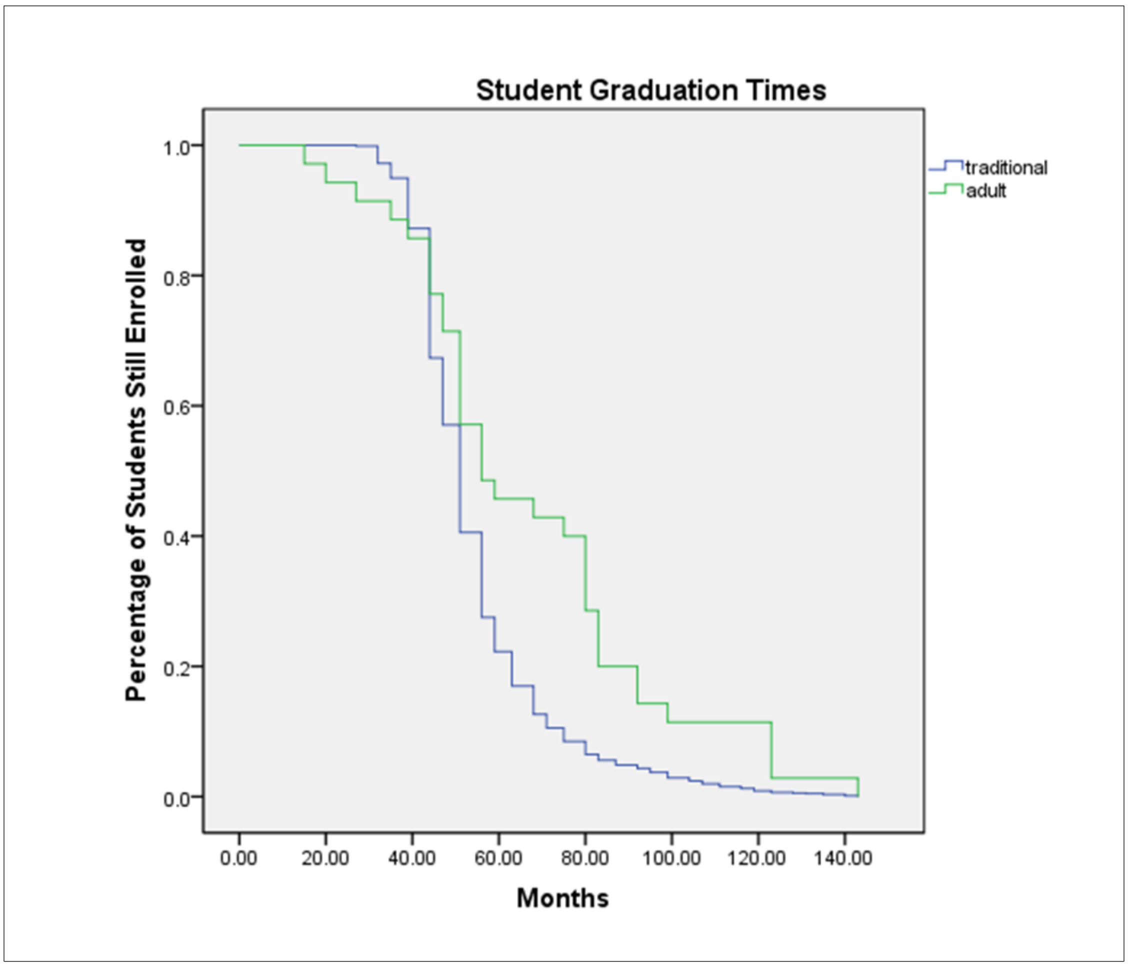

Figure 8. The graduation times of adult and traditional-age students.

Summary of preliminary comparisons. These preliminary analyses showed that the adult students classified as freshmen in the fall of 1999 at Texas State enrolled in college with lower high school academic achievement, lower college aptitude scores, were less academically prepared, particularly in mathematics, and had lower college graduation rates than traditional-age students. Graduation rates were affected by preparedness in mathematics, and contrary to Calcagno, et al.'s (2007) findings, once incoming mathematics ability was controlled for, adult students still had lower graduation rates than traditional-age students. For those students in each group who did graduate, adults took longer to reach graduation.

Identifying a roadblock course for adult students. Once the transcript information for this cohort of students was obtained and the preliminary comparisons between adult students and traditional-age students in the cohort were complete, analysis to find the one mathematics course that served as the greatest roadblock for adult students in the cohort was begun. First, each course attempted by any adult student was identified and the percentage of students eventually successful in the course for each student group was calculated. This method not only identified difficult courses for adults but also served to identify mathematics courses to add or eliminate from the list of potential roadblock courses identified by past research. Next, several methods of analysis were used based on the number of attempts in each course. Each method produced two candidates for the roadblock course—the most difficult course for adults and the course most different from traditional-age students in difficulty. The resulting candidates from each method of analysis were then considered for the one mathematics course that served as the greatest roadblock for the adult students in the cohort. Each of the individual methods and its results are outlined below.

Method 1. In Method 1, all mathematics courses attempted by adult students in the cohort were identified. The number of students in both the adult and the traditional-age groups who attempted each course at least once was counted. Then the number of students who were eventually successful by earning an A, B, C, or E in the course was counted. The percentage of successful students of those who attempted the course at least once was calculated and compared between groups. Because of the small number of adults in some courses, the statistical significance of the difference between adult student success and traditional-age student success in each course was determined using the Fisher Exact test. Courses that had five or fewer adult students or courses in which 100% of the adult students were successful were eliminated from further analysis. The results of Method 1 are listed in Table 7.

Table 7

Results for Method 1: Percentage of Successful Students in Each Course

Course		Number of Students	Successful Students	Percentage	Sig
Math 1300	Pre-College Algebra				
	Adult	34	25	73.53%	
	Traditional-age	103	75	72.82%	1.00
Math 1311	Basic Math				
	Adult	55	39	70.91%	
	Traditional-age	1,036	859	82.92%	.029*
Math 1315	College Algebra				
	Adult	36	23	63.89%	
	Traditional-age	2,485	1,984	79.84%	.011*
Math 1316	Survey of Contemporary Math				
	Adult	9	9	100%	
	Traditional-age	157	113	71.98%	.114
Math 1319	Math for Bus & Econ 1				
	Adult	17	10	58.82%	
	Traditional-age	942	733	77.81%	.078
Math 1329	Math for Bus & Econ 2				
	Adult	14	10	71.43%	
	Traditional-age	859	642	74.74%	.760

Table 7 continued

Course		Number of Students	Successful Students	Percentage	Sig
Math 2311	Principles of Math				
	Adult	6	6	100%	
	Traditional-age	263	250	95.06%	.741
Math 2312	Informal Geometry				
	Adult	4	4	100%	
	Traditional-age	198	184	92.93%	-
Math 2321	Calculus for Life Science				
	Adult	3	3	100%	
	Traditional-age	239	134	49.81%	-
Math 2328	Statistics				
	Adult	1	1	100%	
	Traditional-age	43	38	88.37%	-
Math 2358	Discrete Math				
	Adult	5	4	80%	
	Traditional-age	155	107	69.03%	-
Math 2417	Pre-Calculus				
	Adult	4	3	75%	
	Traditional-age	243	183	75.31%	-
Math 2471	Calculus 1				
	Adult	2	2	100%	
	Traditional-age	298	234	78.52%	-
Math 2472	Calculus 2				
	Adult	2	2	100%	
	Traditional-age	158	136	86.08%	-
Math 3305	Probability and Statistics				
	Adult	1	0	0%	
	Traditional-age	83	75	90.36%	-
Math 3377	Linear Algebra				
	Adult	1	1	100%	
	Traditional-age	46	38	82.61%	-

Table 7 continued

Course		Number of Students	Successful Students	Percentage	Sig
Math 3398	Discrete Math 2				
	Adult	2	2	100%	
	Traditional-age	84	64	76.19%	-
Math 4302	Principles of Math 2				
	Adult	1	1	100%	
	Traditional-age	15	15	100%	-
Math4304	Math Understandings				
	Adult	1	1	100%	
	Traditional-age	14	13	92.86%	-
Math 4311	History of Math				
	Adult	1	1	100%	
	Traditional-age	14	14	100%	-

Note. Courses with 5 adult students or less were eliminated from further analysis because of the low impact on adult student success in general.
-Statistical significance was not calculated for these courses because either the high success rate of adult students in the course or the limited number of adult students attempting the course eliminated the course from further analysis.

In Method 1, Math 1319-Mathematics for Business and Economics 1 was the course with the lowest percentage of success for adult students who attempted the course. There were two courses for which the success rate was statistically significantly different between adult and traditional-age students at the 0.05 significance level. These were Math 1315-College Algebra and Math 1311-Basic Mathematics. The course most significantly different was Math 1315.

Adults were more successful than traditional-age students in several of the courses examined, including several of the courses taken by many adult students—Math 1300 and Math 1316. Although a greater percentage of adult students than traditional-age students were successful in Math 1300, the graduation rate of the adult students beginning their college mathematics at this level was significantly lower than traditional-age students beginning at the Math 1300 level. In addition, adults taking mathematics courses designated as sophomore level or higher (with course numbers greater than 2000) were almost always successful. The difference in the success at higher levels compared to the lower success at lower levels of mathematics may reflect the growing confidence adult students develop as they advance in their studies as well as the goal-oriented nature of adult students (Kasworm, 2006). While adult students may enter the university unsure of their abilities, many often gain new confidence in their new role as student (Kasworm, 2003, 2008). This evolving self-concept of adult students may also account for the ambiguous portrait of adult students in mathematics reflected in past research, as some studies showed adult students had little confidence in their ability to do mathematics (Civil, 2003; Peters & Kortecamp, 2010) while other studies showed no difference between adult and younger students (Elliot, 1990; Gupta, et al., 2006).

As a result of this analysis, further analyses focused on only the mathematics courses that a large number of adult students attended or courses that adult students seemed to have difficulty in. Courses that all adult students were eventually successful in were eliminated from further analysis; and courses that had less than five adult students attempting the course were eliminated. The list of potential candidates for the major roadblock mathematics course for adult students was limited to Math 1300-Pre-college Algebra, Math 1311-Basic Math, Math 1315-College Algebra, Math 1319-Math for Business and Economics 1, and Math 1329-Math for Business and Economics 2.

The courses focused on in this study may be very different from mathematics roadblock courses for traditional-age students. As can be seen in Table 6, the course with the lowest percentage success for traditional-age students was Math 2321-Calculus for

Life Science. This course was not considered in this research because the three adults who attempted the course all were successful.

Method 2. In Method 2, the students in each group who attempted each course at least once were identified. Then the number of students who either left Texas State or changed their major to one requiring a lower level of mathematics after taking the course was determined. Of the 118 adult students in the cohort, 86 left school without completing their degree. For these students, the last mathematics course attempted was counted. Of the 32 adult students who graduated, only three changed their majors to one requiring a lower level of mathematics. Two of these started out as business majors and one originally enrolled as a computer science major. In this method, no distinction was made between courses that may have influenced a student to leave school and a course that may have influenced a student to change his major to one requiring a lower level of mathematics. For both adult and traditional-age students, the percentages of these students were calculated along with the statistical significance between adult students and traditional-age students. A two-proportion t-test was done to analyze the differences between the two groups for each course. The results are listed in the table below.

Table 8

Results for Method 2: Percentage of Students Attempting a Course that Either Left School or Changed Their Major after the Course

Course		Number Attempting Course	Number That Changed or Left School	Percentage	Sig
Math 1300	Adult	34	8	23.53%	
	Traditional-	103	12	11.55%	.099
Math 1311	Adult	55	19	34.55%	
	Traditional-	1,036	208	20.08%	.016*
Math 1315	Adult	36	17	47.22%	
	Traditional-	2,485	638	25.61%	.006*
Math 1319	Adult	17	4	23.53%	
	Traditional-	942	180	19.11%	.549
Math 1329	Adult	14	8	57.14%	
	Traditional-	859	259	30.15%	.040*

This method showed that the most common final mathematics course before adult students left school or changed majors to one requiring a lower level of mathematics was Math 1329-Mathematics for Business and Economics 2. In this analysis, there were three courses that showed a significant difference between adult and traditional-age students. These included Math 1315, Math 1311, and Math 1329. The course that showed the greatest difference in percentages between adult and traditional-age students was Math 1315-College Algebra. A caution in using this method was to acknowledge that students leave school or change their majors for many reasons other than the difficulty of mathematics courses required for graduation. In addition, several students who changed their majors to one requiring a lessor level of mathematics or dropped out of college did so several semesters after taking their last mathematics course. For these students, mathematics may not have influenced their decision. The results of this method only suggested the role mathematics courses might play in the decision to leave school or change majors.

Method 3. In Method 3, the average number of attempts that eventually resulted in success was counted for successful student in each course. Each student who was successful by earning an A, B, or C (or in the cases of developmental mathematics, an E) was included in the analysis. For these students, the number of times the student attempted the course was counted and an average number of attempts per success was calculated. A t-test comparing the means of the adult and traditional-age groups was used to identify any significant differences between the groups for each course. The results are tabulated in Table 9.

Table 9

Results for Method 3: Average Number of Attempts in a Course for Students Who Were Eventually Successful in the Course.

Course		Number of Successful Students	Average Number of Attempts	Standard Deviation	Sig
Math 1300	Adult	25	1.44	.917	
	Traditional-age	75	1.27	.644	.397
Math 1311	Adult	39	1.38	.711	
	Traditional-age	859	1.40	.913	.866
Math 1315	Adult	23	1.57	.843	
	Traditional-age	1,984	1.23	.593	.067
Math 1319	Adult	10	2.20	2.486	
	Traditional-age	733	1.21	.515	.240
Math 1329	Adult	10	1.40	.516	
	Traditional-age	642	1.25	.593	.374

Math 1319-Mathematics for Business and Economics 1, was the course that had the largest average number of attempts for adult students successful in the course. There was no statistical difference at the 0.05 level between adult and traditional-age students in this method of analysis.

Method 4. While Method 3 counted the average number of attempts for each successful student, it omitted students who might have attempted the course several times, but were never successful in the course. In Method 3, all attempts were counted whether the students were successful or not. A ratio was formed, counting the total number of attempts by all students divided by the number of successful students. In this method, because each student may account for several attempts, a statistical significance using traditional statistical tests could not be found. In lieu of traditional methods, empirical probabilities of the observed difference was calculated by forming random groups from students attempting the course with the same number of students as there were adult and traditional-age students. Ratios of total attempts per success were calculated for these randomly formed groups and the difference of the ratios calculated for each random grouping. This procedure was repeated 1,000 times for each course and the empirical probability of the observed difference was calculated and recorded in Table 10 as the significance.

Table 10

Results for Method 4: Ratio of Total Number of Attempts per Success

Course		Total Attempts	Successes	Attempts/ Success	Diff	Sig
Math 1300	Adult	52	25	2.08		
	Traditional-age	129	75	1.72	0.360	.272
Math 1311	Adult	83	39	2.128		
	Traditional-age	1,512	861	1.756	0.372	.093
Math 1315	Adult	52	22	2.364		
	Traditional-age	3,177	1,984	1.601	0.762	.001*
Math 1319	Adult	31	10	3.100		
	Traditional-age	1,175	733	1.603	1.497	.003*
Math1329	Adult	24	10	2.400		
	Traditional-age	1,114	642	1.735	0.665	.079

Note: * The significance recorded is the empirical probability that such a difference between ratios would occur if students attempting the course were randomly assigned to groups of the same size as the adult and traditional-age students attempting the course.

In Method 4, Math 1319-Mathematics for Business and Economics 1, had the largest ratio of number of total attempts per successful student. Math 1315-College Algebra and Math 1319-Mathematics for Business and Economics 1 were both courses in which the adult and traditional-age students performed significantly different. Math 1315 had a slightly greater significant difference in number of attempts per success between adult and traditional-age students.

Method 5. In Method 5, the number of students that repeated each course at least once was counted regardless of whether they were successful in the course. The percentage of these students of the students that repeated the course at least once was calculated. The purpose of this method was to eliminate the effect of the few students who may have repeated a course an unusually high number of times. One adult student attempted Math 1319 nine times. Several traditional-age students also had a high number of repeats in several courses. To counteract the possibility that one or two students might be responsible for the results in Methods 3 or 4, this analysis only counted repeater students only once regardless of the number of times the student repeated the course. These results are listed in Table 11.

Table 11

Results for Method 5: Percentage of Students Repeating a Course at Least Once

Course		Number of Students that Attempted	Number of Students that Repeated	Percentage	Sig
Math 1300	Adult	34	11	32.35%	
	Traditional-age	103	19	18.45%	.099
Math 1311	Adult	55	18	32.72%	
	Traditional-age	1,036	279	26.93%	.353
Math 1315	Adult	36	10	27.78%	
	Traditional-age	2,485	503	20.24%	.295
Math 1319	Adult	17	6	35.29%	
	Traditional-age	942	187	19.85%	.128
Math 1329	Adult	14	6	42.86%	
	Traditional-age	859	193	22.47%	.101

For each course analyzed in Method 5, a greater percentage of adult students repeated each course compared to traditional-age students. The course with the highest percentage of adult repeaters was Math 1329-Mathematics for Business and Economics 2. There was no statistically significant difference between adult and traditional-age students in this analysis.

Summary of roadblock course results. A summary of the results of all five methods of analysis are listed in Table 11. As can be seen in the table, Math 1319-

Mathematics for Business and Economics 1 or Math 1329-Mathematics for Business and Economics 2 was the most difficult course for adult students under each method of analysis. Courses that were most difficult for adult students compared to traditional-age students included Math 1315-College Algebra and Math 1329-Math for Business and Economics 2.

Table 12

Results of the Five Methods of Analysis

Method	Most Difficult Course for Adult Students	Courses with Significant Difference between Adult and Traditional-age Students
Method 1	Math 1319	Math 1315 / Math 1311
Method 2	Math 1329	Math 1315 / Math 1311 / Math 1329
Method 3	Math 1319	-
Method 4	Math 1319	Math 1315 / Math 1319
Method 5	Math 1329	-

As a results of these analyses, Math 1319-Mathematics for Business and Economics 1, was chosen as the mathematics course that acted as the greatest roadblock for adult students. This course, along with its sequel, Math 1329-Mathematics for Business and Economics 2, proved the greatest barrier for adult students in every method of analysis. The success of adult and traditional-age students was shown to be significantly different in only one method of analysis, but because the focus of this study was primarily identifying the mathematics course that posed the greatest difficulty for adults, with a secondary purpose of identifying the course that was most different in difficulty level from traditional-age students, the overwhelming prominence of Math 1319 in the difficulty column overshadowed the several other courses that also proved to be difficult for adults in comparison to traditional-age students. In addition, there is a broad overlap in the curriculums of Math 1315-College Algebra and Math 1319. Both include basic algebra concepts, including solving linear and quadratic equations, logarithmic and exponential functions, and solving systems of linear equations. However, students taking Math 1319 are generally a more homogenous group as the majority is business majors, while students in Math 1315 come from all colleges in the university. Choosing to focus on Math 1319 allowed for a more focused comparison between the behaviors of adult and traditional-age students.

Conclusions and discussion for Part 1: Identifying a roadblock mathematics course for adult students. This section of the research had a two-fold goal. The first was to compare the academic preparedness and the college outcomes of a cohort of adult students entering college in the fall of 1999 to their younger classmates. The second purpose was to identify the mathematics course that served as the greatest roadblock for adult students.

The adult students in this cohort were less academically prepared for college than their traditional-age classmates as shown by their high school records, their college admissions test scores and mathematics placement exam scores, as well as the higher percentage of adult students required to take developmental mathematics courses. These findings support earlier research (Adelman, 2005; Calcagno et al., 2007; Kasworm & Pike, 1994). The adult students had a lower graduation rate than traditional-age students. Adult students who did graduate took longer than traditional-age students with only a few exceptions. These results also support past research (Bryk & Treisman, 2010; Kolajo, 2004).

The analysis showed that the Business Mathematics sequence, Math 1319-Mathematics for Business and Economics 1, and Math 1329-Mathematics for Business and Economics 2, acted as the greatest barriers to adults' original intentions upon entering college. This sequence of courses, and particularly Math 1319, influenced the greatest percentage of students to leave school or change their major, had the highest average number of attempts for successful students, had the highest total attempts per successful student, had the least percentage of success for students attempting the course, and had the greatest percentage of students taking the course more than once.

Part 2: Adult Students' Learning Behaviors in a Roadblock Mathematics Course

In the previous section, Math1319-Mathematics for Business and Economics was identified as being the mathematics course that served as the greatest barrier to the original educational goals of a cohort of adult students at Texas State. The second part of this research focused on the learning behaviors of adult students in this course in hopes of uncovering the factors that make the course difficult for adult students. The college classroom is the focal point of learning for adult students. How the adult student learns and experiences the classroom is mediated by past experiences, psychosocial factors, and adult cognition (Donaldson and Graham, 1999). These factors influence the behavior of the student within the classroom. Graham and Donaldson's model of adult college students and this current research rely on the social constructivist framework of learning which proposes that a student learns more and at a deeper level when he learns within a social environment with the opportunity to discuss and defend his understandings (Cobb, 2000; Palincsar, 2009; Pritchard, 2009). This part of the research involved following four adult students at Texas State who were enrolled in Math 1319 in the fall of 2012, examining their learning behaviors in the course. The learning behaviors specifically targeted included out of class behaviors such as attending office hours, seeking help through tutoring centers, and studying and doing homework with classmates. In class behaviors included responding to instructors questions, asking questions during lecture, and discussing math with classmates. Since learning behaviors could be influenced by past experiences, attitudes towards mathematics, and motivations and goals for the course (psychosocial factors), these were included as areas of interest. In addition, because the current models of adult success may not include all factors that influence success in Math 1319, the adult students' perceptions of the factors that made this course difficult were also explored.

The goal of Math 1319 at Texas State is to "provide the students with the algebra concepts necessary for the business field" (Texas State University-San Marcos, 2012c). The course heavily emphasizes business applications and includes topics such as solving polynomial and rational equations, linear functions and systems of equations, the mathematics of finance, and the fundamentals of sets and probability. The course shares many topics with Math 1315-College Algebra, but does not include topics that do not have a direct business application such as complex numbers. Math 1319 is a freshman level course with the only prerequisite being an appropriate score on the SAT math, ACT math, or math placement test, or credit for the highest level of developmental mathematics, Math 1311. Instructors are free to cover the material in any manner they desire.

In order to understand why Math 1319 is particularly difficult for adult students, the learning behaviors and perceptions of four adult students enrolled in the course in the spring of 2012 were examined. These students were enrolled in three different sections of the course taught by three different instructors. The students were interviewed twice during the semester. The first interview, which took place within the first few weeks of the semester focused on the past mathematical experiences of each student as well as their first impressions of the course and the instructor. The second interview took place near the end of the semester and focused on the learning behaviors the students used in the course and their reflections on the difficulty level of the course and what instructor techniques or campus support facilities were especially helpful for them. Because this research followed a social constructivist model, the interactions of the students with their classmates and their instructors both during and outside of class were closely examined. In addition, every student in each of these three sections participated in two surveys. The first survey was given on the first day of the semester and included items on attitudes towards and confidence to do mathematics. The second survey included items on the learning behaviors of the students in the course. The results of these surveys were both to assess the general attitudes and behaviors of all students in the course and to compare the attitudes and behaviors of the adult students to traditional-age students in the same sections. In addition, each of the three sections was observed three times during the semester in order to verify interview and survey responses. The observation reports can be found in Appendix G.

Selection of participants. During the first week of the semester, the researcher visited five sections of Math 1319. After the researcher introduced herself and gave a brief summary of the study, each student in each of the sections completed a survey on their attitudes towards mathematics. As part of the survey, adult students, those 25 years or older, were invited to be involved more fully in the study by agreeing to participate in two interviews. As a result of this invitation, eight adult students agreed to become participants in the study. Each of these students was contacted, but initial interviews were arranged for only five. Of these five, only four completed the study by completing both classroom surveys and participating in a final interview. These four students became the participants in the study. Table ?? shows the adult students who participated in any way, either filling out one of the classroom surveys or being interviewed at least once.

Table 13

Adult Students Participating in Study in Any Way

Adult Student	Completed First Survey	Agreed to be Interviewed	Second Survey	First Interview	Second Interview
Student 1	X	-			
Student 2	X	X	Dropped Course during First Week		
Student 3	X	X	Dropped Course during First Week		
Student 4	X	X	Dropped Course after First Exam		
Student 5	X	X	-	X	-
Adam	X	X	X	X	X
Belinda	X	X	X	X	X
Carmen	X	X	X	X	X
Dave	X	X	X	X	X

Context of the study. The students selected were enrolled in three different sections of Math 1319. Each section held class at different times of the day and were led by three different types of instructor using very different teaching styles. The first section was taught by a tenured mathematics professor who taught in a traditional lecture style, using the chalkboard to illustrate his lecture. This section met at 9:00 a.m. three days per week with about 25 students enrolled. There was only one adult student in this section. The second section was taught by a graduate student who often used a power-point presentation or document camera in her lessons. This instructor often provided a worksheet with sample problems for the students to practice individually during the lecture. This section had the largest number of students—around 40 students and met twice a week at 12:30. Two adult students and several students between the ages of 22 and 24 attended this class although only one adult student participated in this research. The third section met twice a week at 6:30 p.m. and had only 14 students. Three of these were adult students, two of which participated in this research. The instructor was a non-tenured lecturer who used both the chalkboard and document camera to demonstrate solving problems.

Participants. The four adult student participants who completed both interviews and both surveys ranged in age from 25 to 50 years old. The youngest was a young man who was motivated to go to college by his girlfriend who was working on her master's degree. Two students were women in their late 30's and early 40's pursuing a college degree in order to secure a better life for themselves and their families. The oldest student was a retired Navy veteran who developed a health condition that forced him to change careers. As each of these students was willing to participate in the research, all of them were accepted into the study. The general characteristics of each participant are listed in the table below.

Table 14

Study Participants

Name	Section	Instructor Type	Age	Major	Classification
Adam	Morning	Tenured Professor	50	Accounting	Sophomore
Belinda	Noon	Graduate Student	35	Accounting	Freshman
Carmen	Evening	Lecturer	42	Family & Child Development	Junior
Dave	Evening	Lecturer	25	Business Management	Freshman

Adam was a 50-year-old man enrolled in the morning section of the course taught by the tenured mathematics professor. He dropped out of high school before graduating and spent 20 years in the Navy. He believed that he could have been a good student in high school, but he wasn't interested in school at the time. "If I put forth half an effort, I could have been a pretty good student." Adam completed his high school diploma in the Navy and after retiring, worked in a warehouse distribution center. He was never interested in going to college until health problems kept him from physical labor. Because of past experience volunteering with tax return preparation, he decided, at age 50, to enroll in college in order to become an accountant. At the time of the study, Adam was in his sophomore year and was taking Math 1319 after completing both levels of developmental mathematics at Texas State. Although Adam felt that he was already behind after the first two weeks of class, he was determined to do well in the course. "I can't drop it because I've got to finally get so I can get into the McCoy Business College and if I drop it that means I can't even apply until, not this summer, but next summer at the very earliest." Adam had requested a mathematics tutor form the Veterans Affairs

Office (VA) and although the request was approved, a tutor was never found. Adam dropped the course eight weeks into the semester after failing the first major exam.

Belinda, a 35-year-old mother and wife, was enrolled in the section of Math 1319 that met during the middle of the day with a doctoral graduate student as an instructor. She previously had attended two community colleges in different parts of the state but never completed a degree. “I worked full time and went to school, so that was kind of hard. And I wasn’t really committed to it”. During the time of this study, Belinda worked in a university office where she had been encouraged by her supervisor and co-workers to take advantage of the opportunity afforded university workers to take courses at nominal cost. Belinda was appreciative of the opportunity. “I always felt like I needed my degree.” Belinda was an accounting major and was in her first year of school. She had successfully completed the second level of developmental mathematics at Texas State and because the first several weeks of this course overlapped a lot of material covered in her previous mathematics course, Belinda was confident that she would do well in Math 1319. As the semester progressed, Belinda struggled in the course and barely managed to pass the course with a grade of C.

Dave, 25, was the youngest participant in this study. He graduated from high school and worked for seven years for the school district he graduated from in their distributing center. He reported that he was successful in high school, just not very interested in education. “I was in all AP classes in high school. I was a good student. My grades didn’t reflect it, but I was good in school. I just didn’t go to school.” Dave was motivated to go to college because his new girlfriend was about to get her master’s degree. “It really motivated me to go back to school—I didn’t want to be so far behind her.” At the time of the study, he was a business major because he wanted eventually to own his own business. Dave was enrolled in the evening section of the course taught by the non-tenured lecturer. After some initial anxiety because the material covered was similar to material he had problems with in high school, Dave had no problems in the course. Dave passed the course without any problems.

Carmen, 42 and the only student not aspiring to a business degree, was also enrolled in the evening section of the course. She had just moved to San Marcos after commuting 30 miles to school last semester. Three of her five children still lived at home and while she was single at the beginning of the semester, she had plans to marry a fellow adult student she met through her participation in student government at the community college she recently attended. Carmen had completed several certificate programs at the community college level including computer-assisted design and office management. Carmen hoped to pursue a career in childcare and had briefly owned her own childcare facility. She completed her associate's degree at a local community college with honors and was encouraged by her advisors and teachers to continue her education at Texas State. At the time of this study, she was pursuing a degree in Family and Child Development both because of her love of children and because of the diversity of opportunities that degree would give her. Carmen was classified as a junior and did well in the first few weeks of the course. Unfortunately, Carmen also struggled in the course, failed the first exam, and dropped the course right before the second exam. Carmen had also requested and was approved for a tutor through Student Services, but no tutor was found that matched her schedule.

Factors that might affect classroom behavior. Because this research was done through the lens of a social constructivist framework, the analysis of the interviews, observations and individual responses to classroom surveys were analyzed first in order to determine the levels and types of learning behaviors the adult students used in Math 1319. According to Graham and Donaldson's model of adult student success, adults' experiences in the classroom are influenced by previous experiences, psycho-social factors, and well as adult cognition. Because of this, the participants general experiences as college students—their goals and how they believe they fit into the college culture were explored. Past academic experiences, especially experiences in past mathematics course were examined as past research has shown the influence of high school mathematics on college graduation rates (Adelman, 1999, 2006; Trusty & Niles, 2003). Next, because the focus of this part of the research was the learning behaviors of adult students in this roadblock course, the learning behaviors, both during and outside of class were examined. The information for this part of the analysis came from the two personal interviews, classroom observations, and informal discussions with both the participants and their instructors. After analysis based on these expected influences was complete, the four adult students' views on Math 1319 and why this course was or was not difficult was analyzed. Because only one student, Dave, navigated the course with ease, the difference in his learning behaviors, background, and perceptions were compared to the other three students who struggled in the course.

Motivation to attend college. Adult students often have more focused goals, higher levels of motivation, and more narrow goals for college than traditional-age students (Compton et al., 2006; McGivney, 2004). This was true for each of the adult students in this study who had specific goals and were going to school to fulfill requirements for specific careers. Adam, an accounting major, aspired to become a tax accountant. "The last year that I was in the Navy, I volunteered to do taxes with the VEEP program, in which basically they teach you how to do taxes and you sit and do taxes for people that are in the military—low income people. I fell in love with it." Although Adam was not able to pursue this goal immediately after he retired from the Navy, a severe heart condition forced him to quit a warehouse job which led to him going back to school. "I've got a triple bypass and seven stents. So I went back to the Navy and the VA gave me the opportunity to go back to school."

Belinda, the other accounting major, was encouraged to return to school by her coworkers and supervisor in a university budgeting office in which she worked. "When I took that job, it was kind of like a verbal agreement that I would go back to school." A degree in accounting would dovetail with her present job. "I work in the office of sponsored programs as a proposal coordinator. So I work with faculty and staff basically assisting them to develop their budgets." In addition to the encouragement of her coworkers, Belinda had always felt the need to complete her college degree. "I've always wanted to go back to college because I didn't feel like, I don't know…I don't want to say inadequate or anything, but I didn't think I'd probably ever progress without my college degree."

Dave, the 25 year old business management major, also believed that a college degree was important. "I've always known it's important. I've always known I should go. I never had any motivation to go until…a kick in the pants." Alex's motivation was a new girlfriend that was finishing up her master's degree. "I started dating this girl—she's about to get her master's degree. And it really motivated me to go back to school—I didn't want to be so far behind her. It was really her that motivated me to come back." Dave is pursuing a degree in business management because he hopes one day to own his own business.

Carmen, the only non-business major in the study, also had specific goals for her degree. While she successfully completed several certificate programs and held an associate's degree, she felt that a bachelor's degree would open more opportunities in her field of family and child development. She was very successful at the community college level and her instructors and advisors encouraged her to continue her education at Texas State. Unfortunately, Carmen was not successful in Math 1319 and dropped the course before the second exam. During the course of the semester, after dropping Math 1319, Carmen changed her degree to Occupational Education. "So by going that track, they're giving me my life earning credits and they're picking up way more of my community college classes. If I go that track, I can graduate faster."

Experiences as adult college students. Past researchers have found that adult students often feel different and even alienated from the traditional-age students in their classes (Kasworm, 2003, 2006; McGivney, 2004; Spellman, 2007). This was true of most of the adult students in this study.

Adam, the 50 year old Navy retiree, had very little interaction with younger students on campus and felt he had different goals and attitudes from traditional-age students. He stated, "I know my attitude's a whole lot different than everybody else's." He recounted an episode that happened in his business law class. "It was alright with the rest of the class to drink and drive and I was sitting there saying, 'No, that's not going to happen.' This girl behind me goes, 'Hhhnggh.' That's when I knew." Adam also felt that his goals were different from younger students. He heard other students saying that they would be happy with a C in a course. Adam did not agree. "I guarantee you, every class I walk into, I'm shooting for an A. I'm here for one thing and one thing only—to get a good education and to have a good GPA." In Math 1319, Adam felt like he was invisible. “I think everybody there ignores me. I don’t think that they have a clue that I’m there. And that’s okay.”

Belinda, the 34 year old accounting major, also felt different from the other students in her classes. “I feel old. [laughs] I could almost be their mom. So that makes me feel kind of weird.” Belinda seemed almost embarrassed by her age. “I’ll just be glad when I get past being a freshman. I don’t want to be called a freshman.” Like Adam, Belinda recognized that her attitudes about college were different from younger students. “Why are college students, why are colleges so liberal? Because everyday something happens that I’m just like, ‘my goodness.’ I mean we’ll talk about something in class or somebody will use some language that normally is inappropriate.” She was surprised by the attitudes and especially language of the younger students on campus. “It takes some getting used to.”

Carmen, the 42 year old child development major, had successfully earned an associate’s degree the year before at a community college. In spite of this recent college experience, she was also surprised by the culture at Texas State. She found Texas State “a whole different world.” Carmen felt that younger students “often just run over you.” Another surprise for Carmen was the emphasis on testing that she was not accustomed to at the community college level. “This is all culture shock to me that everything is test, test, test here.” Carmen, similar to Adam, thought that younger students often don’t take their education seriously. Younger students often “act silly in class.” She found this surprising because of the high cost of going to school— “students don’t have time to waste time in class.”

Dave, the youngest participant in this study, was most adept at fitting in socially with his traditional-age classmates. At first, Dave was apprehensive about mixing with younger students. “I definitely didn’t want to be sitting there with a bunch of 18 year olds all day talking about Harry Potter or whatever they like.” He was surprised at the number of adult students on campus. “I didn’t know what to expect. The amount of older people was a lot higher than I thought it would be. In most of my classes, I wasn’t the oldest person.” In addition to not being the only adult student in most of his classes, Dave found that he was accepted socially by the younger students. “The disconnect between them and me wasn’t as big as I thought it would be—it really isn’t that bad. They always think I’m a lot younger than I am.”

In summary, three of the adult students in this study did not feel a social bond with their classmates. This supports past research that adult students rely on family and community for support in their educational goals (McGivney, 2004). For the most part, for the adult students in the study, the social aspects of the classroom were not important. They did not seek out study partners and when other students suggested studying together, they did not find it helpful. Dave, the youngest student in the study and the one whose appearance did not set him apart as different, was the only participant who actively sought out and received social support from his classmates.

Age-related disadvantages. Several of the participants in the study felt that they were at a disadvantage academically because of their age and life situation. Both male participants were full-time students who did not work and did not have dependent children at home. The two female students, in addition to having children at home, held full-time or part-time jobs. Because of this, an issue that was common to the females in the study was time. Belinda, who worked full-time and was married with a young child, stated, “It’s not easy. I’m lucky to have a spouse that supports me but I have a 3-year old, so it is hard—a lot of times I don’t get it done.” Carmen, with three children still at home, recently moved from a nearby town to San Marcos so that she could be closer to school. Before this move, “I spent more time on the road than in class.” She felt that she missed opportunities to get extra help with her classes during office hours or in extra lab times because of her time constraints. Carmen expressed regret that she couldn’t participate in a special program at Texas State that gave extra support to students who had a history of doing poorly in mathematics. Unfortunately, the program required the student to attend class every day of the week. “This will not work for students who have jobs or children to take care of.” The time constraints these two adult students experienced were similar to those documented in past studies that contribute to the difficulties adults have in reaching their educational goals (Kasworm et al., 2002; Sandmann, 2010).

Additionally, all participants except Dave, the youngest, believed they had memory problems that affected their learning and performance on tests that might be related to their age. Adam described it this way, “It was like there’s nothing up here [pointing to his head]; I’ve got a bucket that I carry around with me and I dump my head over and it comes out.” Similar to Adam, Belinda felt that her memory hurt her on exams. “When it comes to taking the test, it’s almost like I go in there and my mind goes blank.” While many traditional-age students complain of going blank during exams, Carmen felt that her memory problems were abnormal. She not only had problems in mathematics, but in all her classes. In Math 1319 this was particularly frustrating. “It was like, I know I’ve done this before. I remember FOIL, I remember this procedure. I remember that procedure, but when it came time to remember that plus the new steps added to that, it was just…it just crunched my memory.” In addition, Carmen could remember doing the problem before, “Sometimes in class, it was the exact same problem and I just blanked out. I was like, 'Oh, my God, I know this." While Belinda thought her memory problems might be just regular mathematics anxiety, both Adam and Carmen attributed their memory lapses to their age.

Past academic experiences. The four adult students in this study had varying experiences in high school. Adam, the 50 year old Navy retiree, dropped out of high school during his junior year. At the time he did not enjoy school and often skipped classes. "If I didn't like the class, I cut it. [laughs]. They kept sending me to remedial school. And I go and do real good in the remedial school and I'd be there and I'd do my homework and I'd do whatever they wanted and I'd be sent back to school and it'd be like, 'I'm not going to do this.' I wouldn't go to class." Dave, the youngest participant, had similar experiences in high school. "I was a good student. My grades didn't reflect it, but I was good in school. I just didn't go to school." Neither Adam nor Dave had interest in getting a college degree until recently. For Adam, "I was never really interested in college or other learning. I knew that I was going to do 20 years in the Navy." Dave, who has aspirations to form his own company, also didn't feel the need for a college degree. "I don't need to go to college to own a business. My parents never went to college and they do very well. So, it didn't seem real important." It took a change in life situations to motivate Adam and Dave to enroll in school. This is supports past research on adult students' reasons to return to school (Compton et al., 2006; Kasworm, 2008; McGivney, 2004).

The two female participants, Belinda and Carmen, had more traditional high school experiences and both enrolled in community college courses directly after high school graduation. Carmen, the 42 year old child development major, was successful in completing several certificate programs and worked in several fields before pursuing a four-year degree, while Belinda, attended two different community college programs but never completed a program. "I had gone to college right after high school, but didn't complete. I wasn't really committed to it." Belinda and Carmen returned to school following relocations (Belinda from north Texas and Carmen from New Jersey) and felt the need to have more education to advance in their careers.

High school mathematics. Past mathematical experiences often play a strong role in how successful students are in college (Adelman, 1999, 2006; Trusty & Niles, 2003). The participants in the study had different experiences in their high school mathematics courses. Adam, the Navy retiree who dropped out of high school, had very little mathematics in high school. "I took the very basics that I needed in order to work towards graduation. Whenever I quit, I'd just gotten into introductory algebra and I was not doing well in it at all. I was confused as hell whenever I had that class." While Adam had serious problems with algebra, he felt that his basic math skills were good. "Up until then [algebra], I was extremely good at math. All of the basic math, I was really good at. But when I got to that point [algebra], it was like I was out in la-la land."

Belinda, the other accounting major, took algebra 1 and geometry in high school. She was never really interested in mathematics. "I really didn't apply myself, or really try, or really care to try. I never, at that time, really liked math." While Belinda felt she was capable of doing mathematics, she felt her disinterest, and more importantly, her anxiety about math, hindered her success in the past. "I think that I could do it if I had really wanted to, but also I have anxiety when it comes to math."

Carmen, the child development major, also had a poor high school mathematics experience. She was never able to pass her high school mathematics classes during the regular school year and was forced to take summer school classes each summer. Carmen was always able to pass the summer school mathematics courses with As and Bs. When asked what the difference was between the school year and the summer, Carmen credited her success in summer classes to the small class sizes in the summer and the narrow focus on skills needed to pass the exams.

Dave, the youngest and most successful student in this study, had a strong high school math background. He took algebra 1, geometry, algebra 2, precalculus, and an Advanced Placement (AP) statistics course while in high school. “I took a geometry class over the summer. I got 100’s in that. I took an AP statistics class; I did really well in that one.” The only minor problem Dave had in his high school mathematics was when he was advanced from a regular algebra 1 course to a pre-AP algebra 2 course. “I don’t know what the disconnect was, but that’s where I hit the wall. I had to go back down to the regular algebra. And then I got As.”

The high school mathematics experiences of these four adult student seemed to forecast their success in Math 1319. Adam and Carmen, who both struggled in high school in algebra were unsuccessful in Math 1319. Belinda, who took only the minimal required mathematics courses in high school, struggled in Math 1319 but was able to pass the course with a C. Dave, who had a strong high school mathematics background, had no trouble passing Math 1319.

Previous college mathematics courses. Three of the study participants started their college mathematics career at the developmental level. Adam, the Navy retiree, started at the lowest level of developmental mathematics at Texas State, Math 1300. “I knew I would need remedial math.” While Adam passed Math 1300 in his first attempt, he took the next level, Math 1311 twice before he was able to pass. The first attempt was during the 5-week summer semester. “I was just overwhelmed. There was just too much, too quickly." Adam still struggled when he repeated the course in the fall semester. "By their [his instructors'] calculations, I was doing a whole lot better than I mentally was looking at. I got a 50, a 60, and a 68 on my tests." Because homework and classwork was counted as part of the final grade, Adam was able to meet the requirement of making a C in the course advancing to college level courses. When asked about his understanding of the concepts taught in the developmental course, "I'm really close to understanding. I can follow the math, but can I do the math? That's the difference." This lack of comfort with the prerequisite material, might have led to his not being successful in Math 1319 which he dropped after he made a 38 on the first exam.

Belinda, the other accounting major, was only required to take the second, final level of developmental mathematics at Texas State—Math 1311. Although she was able to succeed in just one attempt, she had a similar experience to Adam. "Yes, I passed it. [laughs] I think probably, I don't know, I think maybe barely." When asked if she was comfortable with the topics covered in Math 1311, "There were times when I didn't completely understand. But with these classes, it almost seems like you're on one topic and the next day, you're on another." Belinda felt it would be a waste of time spending time on topics that were past, even if she didn't understand them. This continued to be a problem in Math 1319. "We touch on something one day and then we're moving on to the next subject the next class day." She hoped that a misunderstood topic would not reoccur later in the course.

Carmen, the child development major, had passed a developmental mathematics course in one of her early certification programs. "I took it one time in New Jersey when I was at community college and I think I got a C in it. But when I transferred to Austin, since it was like 20 years later, I had to take the TSI test. So when I took that test, I placed into Elementary Algebra." Carmen was never able to pass this developmental course that included material typically covered in a first year high school algebra course (Austin Community College, 2012). She kept dropping it because she was in the honors program at her community college and didn't want to hurt her GPA. "So I took Elementary Algebra and withdrew. And took it again, and withdrew. I would withdraw every time I could see that it was about to hurt my GPA." Carmen was able to get into a statistics course and pass with a C. This enabled her to earn her associate's degree. This inability to master basic algebra skills may have contributed to her lack of success in Math 1319.

In summary, three of the four adult students in this study had weak high school mathematics backgrounds. These were the three students who struggled in Math 1319. While both Adam and Belinda took developmental mathematics immediately preceding enrolling in Math 1319, neither reported having a complete understanding of the concepts taught in those courses and both believed they barely passed. Carmen was unable to pass a developmental mathematics course and used a statistics course as the prerequisite for Math 1319. Dave, the successful of the study participants in Math 1319, had a strong high school mathematics background. The past mathematics experiences of these students seemed to influence both the students' confidence to do mathematics as well as the students' in-class learning behaviors as will be discussed later in the chapter.

Attitudes toward mathematics. Attitudes towards and confidence to do mathematics have been shown to be instrumental to the success of students in mathematics courses (Duffin & Simpson, 2000). Adult students, in particular, do better in classes if they see a practical need for the material taught either in their present life or in their planned career (Galbraith & Jones, 2006; Graham et al., 2000; Knowles et al., 2005). In this section, the attitudes of the four adult students towards mathematics are explored. Then their first impressions of Math 1319 are recorded.

Results of first classroom survey. On the first day of class, a survey was administered to all students in each section. The purpose of this survey was to measure the attitudes of students towards mathematics so that a comparison could be made between adult and traditional-age students. The survey consisted of six items for each of four constructs—the students' perception of the usefulness of mathematics in attaining educational goals, the students' perception of the usefulness of mathematics for future careers, how confident the student was in being successful in mathematics, and how enjoyable mathematics was to the student. The responses to the survey were recorded with a Likert scale ranging from -2 to +2. A positive score indicated a positive attitude towards the construct. Among the students in the combined sections, there was not a statistically significant difference in any of the constructs between adult and traditional-age students (surveys of students aged 20-24 were not considered for this analysis). The greatest difference between the two groups was in the area of confidence, in which the adults were less confident in doing mathematics than younger students and in enjoyment of mathematics, in which adult students responded that they enjoyed doing mathematics more than younger students. The full results of the survey are given below. The individual responses of the study participants are discussed later.

Table 15

Attitudes of Adult and Traditional-Age Students towards Mathematics

Construct	Adult Students n = 9	Traditional-Age Students n = 117	Significance
Usefulness for Educational Goals	**0.9815** **(0.991)**	**1.0632** **(0.587)**	**0.813**
Usefulness for Future Career	0.5000 (0.514)	0.3057 (0.774)	0.318
Confidence to do Mathematics	-0.2667 (0.907)	0.1701 (1.051)	0.200
Enjoyment in doing Mathematics	0.4815 (0.835)	0.0840 (0.875)	0.202

Note: The numbers reported in the table are the average score of each group of students with the standard deviation reported in parenthesis. The significance is the p-value found when performing a t-test.

The individual responses of the participants to the first classroom survey were used, along with the personal interviews were used to assess how useful each participant felt mathematics was to both his educational goals and to his career goals, as well as how confident he felt in doing mathematics and how enjoyable doing mathematics was. Because the survey was administered on the first day of the present course, Math 1319, these views reflected the participants' views on mathematics in general and were not specific to this course. The individual survey responses were tabulated in the following table to compare them with all 133 students (young and old) who took the survey. Each adult student's response is listed as a percentile of the total responses. For example, if a student is at the 79th percentile, that student had a more positive response than 79% of the total students taking the survey.

Table 16

Study Participants' Ranking of Positive Attitudes Relative to All Students

	Adam	Belinda	Carmen	Dave
Usefulness for Career	78th	78th	14th	0th
Usefulness for Education	84th	77th	23rd	0th
Confidence	25th	25th	4th	57th
Enjoyment	89th	22nd	22nd	57th

As can be seen in the table above, the study participants varied in their attitudes towards mathematics. While Adam and Belinda both had relatively positive beliefs that mathematics was useful both to attain their educational goals and in their future work, Dave and Carmen did not. This may be due to the fact that both Adam and Belinda were pursuing degrees in accounting. Belinda expressed the usefulness of mathematics in her present job, "I have to do it every day in my job." Although Dave answered the survey questions in a way that seemed to indicate he did not see how he would use mathematics in his career, in his initial interview, he expressed that mathematics is more useful than most people realize. "As an adult, you use math a lot more than you think you're going to. I like building stuff and use a lot of geometry in that. It ends up a lot more than you think." Carmen, who also rated the usefulness of mathematics low, also expressed pride during her initial interview when she related being able to organize and bring up to standards the accounting methods of a child care facility that received government funding for their care of low-income children. This seemed to contradict her survey response that she would not use mathematics in her future career. This disparity between how the students rated the usefulness of mathematics and their experience with mathematics may be related to their inability to recognize the mathematics used in their everyday life.

The male participants both responded relatively positively in describing their enjoyment doing mathematics, while the female students did not. Adam, in particular, expressed his satisfaction in being able to help others when involved in a volunteer program to help low-income people fill out their income tax forms. "I love doing taxes." Dave's enjoyment of mathematics was clear from observations of his Math 1319 class in which he not only participated in the classroom discussion, but would wave his arms when explaining the shape of different functions. Belinda and Carmen's lack of enjoyment may be a reflection of their lack of confidence and may have influenced their lack of participation in classroom discussions in Math 1319.

Only Dave, the most successful student in the study, expressed even a moderate level of confidence in his ability to do mathematics. This may be the result in being so successful in his high school mathematics classes in which he consistently made A's. The other participants, in addition to rating their confidence to do mathematics low on the survey, expressed this in their interviews. Adam expressed this succinctly, "Me and math don't get along." Belinda related that, "I've never excelled at math." Carmen related an experience in this course, Math 1319, that illustrated her lack of confidence in mathematics when she was the last to finish a quiz during class, "Why is it taking me so long to finish. I must be doing it wrong."

These students' attitudes towards mathematics may have affected both their behaviors in the Math 1319 classroom and their success in the course. Confidence to do mathematics, in particular, seemed to be a factor influencing participation in classroom discussions.

First impressions of the course. Math 1319 is a critical course for business majors. Business majors who are not accepted into the business school based on their high school record and college entrance exams must complete two English courses and both Math 1319 and its sequel, Math 1329-Mathematics for Business and Economics 2 before they can be apply to the business school. Adam, the Navy retiree, expressed it this way, "1319 and 1329 are extremely important because to get into business college, you have to have a certain GPA. If you don't have that GPA, then they start looking at the math. If you don't have an A in the math, you might as well just say, 'I need to do another major." Carmen, the one student in the study who was not a business major, had a choice between taking Math 1319 and Math 1315, the regular college algebra. She chose Math 1319 based on advice from her teachers at the community college she transferred from. "They were saying a business math is more practical. So that's what you should take versus college math which is lots of memorization."

Each of the adult students in this study started the semester confident that they would do well in Math 1319. Ironically, the only student that expressed any apprehension during the first interview was Dave, who became the most successful student. In high school, Dave was promoted to an advanced algebra 2 class but had trouble at the beginning of the semester when the teacher expected students to be familiar with the fundamentals of set theory. Dave could not keep up and had to move down to the regular algebra 2 class. In Math 1319, his first college mathematics course, Dave's instructor started the semester with a discussion of sets. "I felt anxiety when we started talking about it. I thought, 'Oh, no, this is what did it last time." By the end of the second week of class, Dave was no longer anxious about his prospects in the course, "I think I'm getting it this time. It's not implied that you already know this stuff."

Belinda, the accounting major in the noon class, was confident at the onset of the semester. “So far it seems like it’s just a review of 1311 (developmental math).” When asked if this was a disappointment and if she was bored in the class, she responded, “I’m relieved. I’m not bored because there are problems that I’m not real comfortable with.” Belinda was confident that she would be successful in the course. “I’m not worried about this class.”

Carmen, the child-development major in the evening class, was also confident during the first few weeks of the course. She had been able to do her homework and her first two quizzes went well. In spite of this, because she believed that she had memory problems, she contacted the student services department which promised to find a tutor for her. Unfortunately, as the semester went on, a tutor that could meet her during the limited time she was available (she worked in a nearby city on Mondays, Wednesdays, and Fridays) was never found and Carmen dropped the course.

Adam, the Navy retiree in the morning class, recognized that he was behind by the second week of class. In spite of this, and because the VA promised to provide him with a tutor, Adam was determined to succeed. “I can’t drop it because I’ve got to finally get so I can get into the McCoy Business College. If I drop it that means I can’t even apply until next summer at the very earliest.” Unfortunately, the VA never provided Adam a tutor and Adam dropped the course.

General learning behaviors in Math 1319. Because the research was conducted through a social constructivist lens, there was particular interest in how students behaved in the classroom and interacted with both the instructor and classmates both during and outside of class. Social constructivism places emphasis on the social exchanges and discussion that occur while students learn. This social exchange is beneficial not only to the student trying to understand new material but also to the student explaining the material (Michael, 2006). This part of the analysis relied on a class survey focusing on learning behaviors, classroom observations recording the behaviors of all students in the class, and individual interviews with the study participants to undercover reasons for their behavior.

Overall results of learning behavior survey. As the first step in analyzing the learning behaviors of the adult participants in this study, the responses to the survey addressing learning behaviors was examined. The survey was given six weeks into the semester to all students in each class that the study participants were enrolled in. There were three sections of Math 1319 that had adult participants enrolled. At the time of the survey, there were a total of six adult students enrolled in one of the three sections, one of whom was absent on the day the survey was given. This survey addressed the frequency of participating in classroom discussions, the frequency of seeking help outside of class either during the instructor's office hours or at tutoring labs on campus, and the frequency of meeting other classmates outside of class to collaborate on homework assignments or studying for exams. First, the responses of adult students were compared to traditional-age students. Secondly, the responses were compared between the three sections of Math 1319 that the study participants were enrolled in. Finally, the individual participant responses were compared to the total response.

Comparison of adult and traditional-age student behaviors. One of the purposes of this study was to identify reasons Math 1319 was particularly difficult for adult students. Because adult students often enter college unsure of their place on campus and in the classroom (Bourgeois et al., 1999; Kasworm, 2010), this insecurity might affect their full participation in classroom discussions and their seeking the assistance they need in the course. The following table summarizes the results of the learning behavior survey, comparing adult student responses traditional-age student responses. As with the first survey students aged 22—24 were excluded from the comparison to provide a clearer distinction between adult and traditional-age students.

Table 17

Comparison of Adult and Traditional-Age Student Behaviors

	Adult Students n = 5			Traditional-Age Students n = 50		
	Rarely	Sometimes	Often	Rarely	Sometimes	Often
Attended Office Hours	4	0	1	49	1	0
Stayed after Class to Speak w/ Instructor	4	0	1	39	8	3
Sought Help at Tutoring Center	4	0	1	36	5	8
Did Homework w/ Classmate	2	1	2	26	11	13
Asked Instructor a Question during Class	3	2	0	24	14	11
Answered a Question posed by Instructor	3	2	0	19	15	16
Asked a Classmate a Question during Class	2	2	1	14	20	14
Answered a Classmate's Question during Class	2	2	1	27	10	13
Missed Class	3	2	0	37	12	1

Note: For this tabulation, the categories of Never and Rarely were combined within Rarely, and the categories of Often and Always were combined within Often.

Because of the low number of adult students a statistical comparison between the adult and traditional-age students could not be done. The graphs below give a visual comparison of the two groups. Each graph shows the percentage of students in each group responding with *rarely* (red), *sometimes* (blue), and *often* (green).

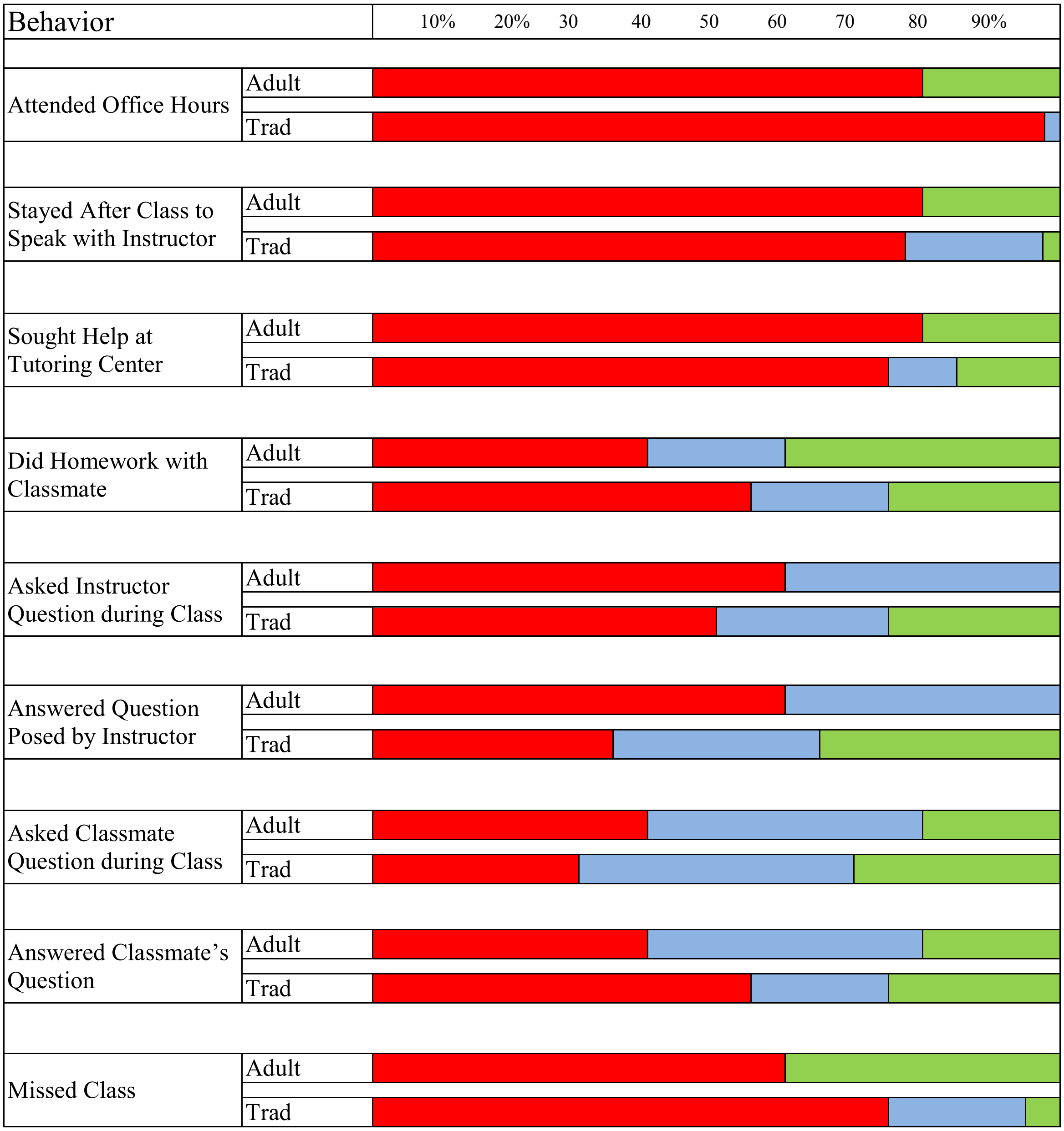

Figure 9. Comparison of adult and traditional-age student learning behaviors.

As can be seen in the graphs in Figure 9, there is only a little difference between the reported learning behaviors of adult students and traditional-age students. The differences that do occur seem to stem from the setting in which students seek assistance. Adult students who responded to the survey were more likely to report seeking help in private settings such as attending office hours, staying after class to ask the instructor a question, and seeking help at tutoring centers; while traditional-age students were more likely to participate in the public classroom by asking and responding to questions during class.

Classroom context. Realizing that social behavior in the classroom is influenced by the unique culture each classroom develops (Fritschner, 2000; Howard & Baird, 2000; Karp & Yoels, 1976), the survey was next analyzed comparing the three different sections of Math 1319. A summary of the results of the survey are displayed in the table below.

Table 18

Behavior Differences Between Classroom

Item	Morning Class n = 16			Noon Class n = 34			Evening Class n = 10		
	Rarel y	So meti mes	Often	Rarely	So meti mes	Often	Rarel y	So meti mes	Often
Attended Instructor's Office Hours	16	0	0	32	2	0	9	0	1
Stayed after Class to speak w/ Instructor	14	1	1	24	7	3	8	1	1
Sought Help at Tutoring Center	11	2	1	23	3	7	9	0	0
Did Homework or Studied with Classmate	8	3	5	16	8	9	6	1	3
Asked a Question of the Instructor during Class	7	5	4	17	9	7	6	2	2
Answered a Question posed by Instructor	8	5	2	12	12	10	2	3	5
Asked a Classmate a Question during Class	3	8	5	11	12	9	4	3	3
Offered Explanation to Classmate during Class	10	1	5	12	13	9	6	2	2
Missed Class	12	4	0	24	9	1	8	2	0

Note: For this table, the categories of never and rarely are combined within rarely, and the categories of often and always are combined within often.

To better understand the differences between classes, ribbon graphs were made to compare the behaviors in each class. Each ribbon indicates the percentage of each class that responded *ofen* (green), *sometimes* (blue), or *rarely* (red).

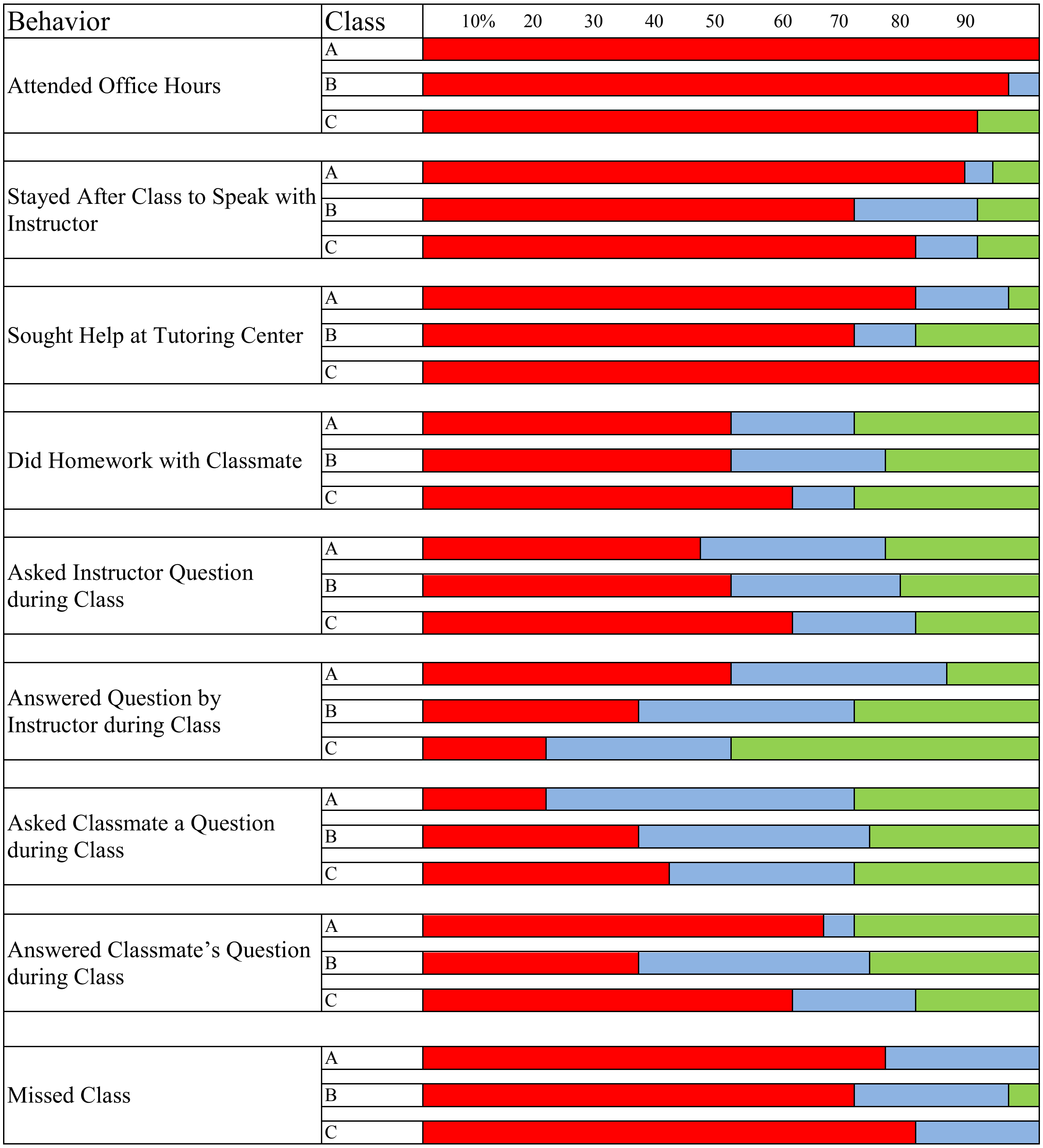

Figure 10. Behavior differences between classrooms

By the ribbon graphs above, it can be seen that the survey did not reveal any striking differences between the classes. The greatest differences were in the percentage of students who reported answering a question posed by the instructor and the frequency of seeking help at the tutoring center. However, as seen in the results of past research, surveys are not always accurate records of classroom behavior (Fritschner, 2000; Karp & Yoels, 1976). The classroom observations revealed different student behaviors between the classrooms. This disparity between survey results and observed behavior was similar to the results Karp and Yoels (1976) found in the results of their study on classroom behavior.

The expectations of the instructors for student participation in each class were very different. The morning class, taught by a tenured mathematics professor was very traditional in that the instructor lectured and the students, for the most part, listened and took notes. While the instructor began each observed class by asking for questions about previous material, the students rarely had questions and the instructor quickly moved on to new material. During the first observation, the only three questions posed by the students were to clarify the homework assignment. During the third observation, there were more questions from the students, but these were in the context of going over an exam, during which the instructor was prodding the students to ask questions about exam questions that they missed. During several observations of this class, the majority of the students did not seem to be taking notes and many were not even watching the board where the instructor was demonstrating new concepts.

In contrast to this, the noon class, taught by the graduate student was more interactive. The instructor either had a power point presentation or a handout displayed on the document camera that not only went step by step through sample problems, but also had examples for the students to work on their own. The instructor then expected students to supply solutions to the example problems. While there was more interaction with the instructor in this class than the morning class, only a few students seemed to be participating. This is typical of many classrooms in which a few students participate in classroom discussion and the other students come to rely on these select few (Karp & Yoels, 1976). While there were not a large percentage of students participating in the class discussions, there seemed to be pockets of students who knew each other outside of class and had quiet social conversations during and before class that did not involve mathematics.

The evening class seemed to be the most interactive. This class was small with only 14 students on the first day and dwindling to around 10 by the end of the semester. The instructor used the chalkboard and the document camera to instruct the class and not only asked for volunteers to supply the next step in solving problems, but also called on individual students to answer questions. Although there was not a high level of discussion among the students in this class, the atmosphere of the class seemed relaxed with the instructor often joking with the students and small groups of students conversing before class.

As a way to verify the impressions of the researcher, during the classroom observations, the number of times students asked questions of the instructor, the number of times students answered questions posed by the instructor, and the number of times students talked among themselves about the topics in the class were tabulated. These tabulations are displayed below. The results include the total number of interactions in the whole class discussion during the observation, the total number of students present in the class that day, and the average number of interactions per student. The observation forms with more detailed information on the types of interaction, interaction among students, and the number of students contributing to the interactions are found in the observation charts in Appendix H.

Table 19

Total Interactions during Classroom Observations

Class	Observation 1			Observation 2			Observation 3		
	Total Student Remarks	Number of Students	Average Per student	Total Student Remarks	Number of Students	Average per Student	Total Student Remarks	Number of Students	Average per student
Morning	3	23	0.130	5	22	0.227	9	16	0.56
Noon	14	34	0.412	55	27	2.04	41	36	1.14
Evening	39	11	3.55	69	11	6.27	88	8	11.0

As can be seen in the table, the average number of interactions per student is very different between the different classes.

Study participants' individual behaviors. The focus of this study is the learning behaviors of adult students in a multi-age mathematics course with the view that the behaviors of the adults may contribute to their difficulty in succeeding in the course. While each of the adult students started the course confident and determined that they would succeed, their behaviors in the course were very different and their levels of success in course were also different. In this section, first the adult students' learning behaviors outside of the classroom, including office hour visits, visits to tutoring centers, and homework habits are explored. Then, the in-class behavior of these students is examined.

Learning behaviors outside of class. Time spent studying outside of class time is important for success in a mathematics course (Cerrito & Levi, 1999). For a course that has been identified as particularly difficult for adult students, this becomes crucial. Doing homework and studying with classmates or discussing problems with the instructor may be beneficial for students (Hsu et al., 2008; Treisman, 1992). The adult students in this study used different strategies to complete homework and study for exams outside of class.

Seeking help from the instructor outside of class. Attending the instructor's office hours was one of the least used strategies among all students in all three of the sections. As can be seen in Table 15, only 3 of the 60 total students ever sought help from their instructor outside of class time. Carmen, the child development major, was one of these. By the third week of the semester, Carmen reported that she had been to office hours three times. In addition, during one of the classroom observations, when Carmen was confused about how to find some information in the e-textbook, the instructor invited her to his office after class so that he could demonstrate how to access the information. Carmen expressed that it was important to her that her instructors know something about her, "I want my professor to know who I am. And I usually refer to myself as their problem child, because I'm the one that's emailing them. I'm the one that's asking them questions." Carmen was reluctant to ask questions during class and used office hours as a more private way to get her questions answered.

None of the other three study participants ever used their instructor's office hours as a way to seek help outside of class. At the beginning of the semester, Adam, with the tenured math professor as an instructor, believed he would eventually go to office hours, "I have not talked to the man yet. I probably should go talk to him and I'm quite sure that sometime during the year I will be talking to him." This did not happen. When asked why, especially in light of the struggle he had with the course and his determination to succeed, Adam explained that he did not think that the instructor could explain in a way that Adam would be able to understand. "He did not come across, even when I did ask him questions in class." This was very different from Adam's use of office hours while he was taking developmental mathematics. "I was in her [the instructor's] office once or twice a week for about an hour, or two hours having her explain stuff that I just wasn't catching on." In Math 1319, Adam felt that going to office hours would be a waste of time.

Belinda also never went to office hours until the last week of the semester. During an informal conversation after a class observation, Belinda related that she was having trouble in the class and had done very poorly on the first exam. She knew that she should go speak with her instructor, but didn't know where the instructor's office was. At the time of the last interview, Belinda said she planned to see her instructor before taking the final exam. "I plan on coming to see her [to prepare for the final]." This was similar to Belinda's use of office hours in her previous mathematics courses. Belinda did attend office hours twice while studying for her final exam, in which she needed at least a 70 to pass the course with the C needed to progress to the next mathematics course.

Dave, the youngest student in the study, never experienced trouble in the course and never had a need to go to office hours. When asked if he felt he needed extra help with any of the material covered in class, he replied, "I really haven't and that's just the way I am. When I have everything in front of me, it's so clear and it makes so much sense, I get it". Dave also remarked that most of the material covered in Math 1319, he had seen in high school. "There's very little I've never seen before in some form or fashion."

Seeking help at tutoring centers. Texas State provides two tutoring centers for mathematics courses. One, the Student Learning Assistance Center (SLAC) takes up half of a floor in the university library and provides tutoring in all subjects. The Math Lab, found in the mathematics classroom building, provides specialized tutoring for mathematics courses. Both centers are open Monday through Friday from 8 am to 7 pm or later, and SLAC has limited hours during the weekends. Three of the adult students in this study used, or tried to use, these resources at least once during the semester. Dave, who had no trouble in the course, did not use either of the tutoring centers.

Adam, the Navy retiree, spent most of his study time at SLAC. He had started the habit of using SLAC while taking developmental mathematics. "I've been to SLAC so much that one girl knows my name." For Math 1319, Adam spent hours at SLAC. "I would be there for hours and hours and hours—working on nothing but math." In spite of all this time spent studying and working with tutors, Adam had trouble in the course. While Adam acknowledged that there were many excellent tutors at SLAC, "some of them were just amazing," he was often frustrated at the number of students seeking help at SLAC and the limited number of tutors. "They have so many people up there trying to get help and so few people that know what they're doing [some tutors only have experience in specific mathematics courses]. You're talking 10 or 15 students per tutor." Adam was especially frustrated that the VA never provided the tutor he was promised. He felt that he needed individual tutoring. "Every time I went to class and I didn't understand what was going on, I would see in my mind, that I wouldn't have to worry about it that much if I know that after this class, in a couple of hours, I was going to talk to somebody that I could sit down and say, 'talk to me about this, explain this, work with me on this."

Belinda was also frustrated when trying to get help at SLAC. She had never used SLAC until this semester and she was not successful getting the help she needed. “I just sat there waiting for someone to help me and I eventually left and worked on it myself.” When asked if the tutoring center was busy that day, “I don’t think it was very busy at all. The set up to me was different, because I sat down at the table and there was just one other person there and a girl came and checked on her, but she never said anything to me—I just kept sitting there, waiting.” Belinda also tried the Math Lab, but wasn’t able to get help there either. “I thought it would be quiet in there, but it’s not.” Like Adam, Belinda felt like she needed individual help and that a tutoring center would not work for her.

Carmen, because of her busy schedule, just used the Math Lab once as a meeting place to study for an exam with another adult student in her class. She did not take advantage of the tutors, but used the available computers to review the online homework.

Homework behavior. Homework is an integral part of any mathematics course (Cerrito & Levi, 1999). None of the instructors in this study collected written homework. Both the tenured mathematics professor (morning class) and the graduate student instructor (noon class) assigned homework each class meeting and gave quizzes over the homework problems. The third instructor (evening class) used online homework and the grades were included as part of the final course grade. Research has shown that students who study together and discuss material covered in class develop a deeper understanding of the material as they explain and justify their answers to problems (Hsu et al., 2008; Treisman, 1992). Only two of the adult students in this study collaborated with classmates while doing homework.

At the beginning of the course, Adam, the Navy retiree, had expectations about the time needed to complete homework that were unrealistic. "I would hope that I would be able to get done with my math homework in a couple hours. What it actually takes is much more than that." Because Adam was determined to succeed in the course, "If your homework's taking up too much of your time, you need to make more time." Adam did his homework in the tutoring center. "Homework is just taking hour upon hours—four, five, six hours just to get done each day." In spite of doing the homework, Adam did not do well on the homework quizzes which were taken straight from the homework assignments. By the fourth week of the semester, Adam reported that he had made a 10 out of 15 points on the first quiz, a 5 out of 15 on the second, and had done poorly on the third although he had not gotten it back yet. Although Adam spent a great amount of time discussing homework problems with the tutors at SLAC, he never met with other classmates outside of class.

Belinda, in the noon class, did not spend much time on the homework and because it wasn't collected, often did not complete it. "To be honest, I haven't done all of it. And that's probably going to hurt me." When asked how much time she spent on homework. "I spent some, but not a lot. I would spend about an hour the night before or the day of class." Belinda often did her homework during her lunch hour at her full-time job. "I would sometimes just stay at my desk and put up a sign that says I'm at lunch and work on it." Belinda reported that she managed to have about a C average on her daily homework quizzes. Belinda, similar to Adam, never met with other students outside of class to work on homework together. She did meet one time with a classmate to study for an exam.

Dave, in the evening class with online homework, also did not spend much time on homework assignments. He did acknowledge that homework was important. "I'm doing all the homework. I was allergic to homework in high school." Dave reported that he spent maybe an hour a week doing homework. "On some of them, it started taking a lot longer, but I'd say on average, it's pretty close to 30 minutes a class day." Dave also appreciated the amount of homework assigned. "It's not a lot, but it's enough." Dave did develop a relationship with a traditional-age student in the class. They often did homework together and studied for exams together. "We've become friends outside of class—that's my math buddy." They met about once a week outside of class.

Carmen, also in the evening class with online homework, appreciated the built-in help features of the online homework. "They have 'try me,' they have 'try an example.' I would write down the steps." Carmen developed several unique strategies in doing her homework. First, her 8th grade daughter was very helpful in assisting with her homework. "She is in 8th grade and when I was talking to her about my homework, she was great. She's a great tutor." Carmen also did her homework over the phone with another adult student in the class. "The trick to that is that when you're on MyMathLab, so there's no cheating, you do not have the same problem. So she (the other student) had a problem and I had a problem and we would talk through the problem and even though our numbers were different, it was the same problem." This arrangement did not work out very well because of the different styles of studying the two students had. "I did my homework in sequence. She did her homework jumping all around. I was like, 'What are you doing?' 'I'm trying to find the easy ones first.' So for a lot of the problems, when she was jumping all around, I had finished them already." When asked if she felt doing homework and discussing the problems was helpful, Carmen replied, "It was

50/50. When I did so many problems before her, I wanted to keep going. I was on a roll." When helping her study mate, "I had to stop, slow down or go backwards."

Other outside of class behaviors. The four students in this study used different strategies when studying for exams. Adam, the Navy retiree, seemed at a loss on how to study. In an informal conversation with Adam, the researcher advised Adam to concentrate on the past quizzes when preparing for the upcoming exam. He replied that he hadn't considered that. Adam made a 38 on the first exam. Although the instructor gave an "add-on" quiz the next week that could add 20 points to the exam grade, Adam calculated that even if he earned all 20 extra points and did well on the next exams, the best he could hope for was a D in the course. As that was not high enough to go on to the next course, Math 1329, and would only hurt his GPA, Adam decided to drop the course.

Belinda, the other accounting major, also did poorly on her exams, always scoring in the bottom quarter of the class. For the first exam, she admitted not spending much time studying. "I really didn't spend much time at all." For the second exam, Belinda met with another adult student in the class. "It didn't help much grade-wise. We only met for a couple of hours. She tried to help me. I felt kind of bad about that because I knew she needed to be doing her own review." When reflecting on why she had done so poorly on both exams, "I think part of it was remembering those formulas. I should have probably memorized those. I should have probably studied more." In an informal conversation with Belinda's instructor, the researcher discovered that there were no formulas needed for the exam. Belinda may have been talking about her lack of understanding of the concepts covered on the exam. In spite of her poor exam grades, Belinda was able to pass the course with a C because of her high grades on two class projects and the C average on her quizzes.

Dave, the youngest student, also did not spend very much time studying for exams. He had a better outcome than Belinda and Adam. Dave made an 89 on the first exam, but the second exam was longer and more difficult. "Most of the test was about the business models that we went over, which in my opinion was a very small portion of what we had to know for the test. I studied more for the other things because I thought I was weaker in those areas." Part of the problem Dave had in studying for the second exam was that the instructor had suggested they do the online review provided by the online homework publisher. "In MyMathLab, there's two practice tests and he had strongly recommended you do that, but the program was really frustrating me so I didn't do it." Although Dave did not do as well as he had hoped on the second exam, he had no problem passing the course with a B.

Carmen, the child development major, did very poorly on the one exam she took. Her study strategy was to go through the online homework problems and repeat them until she could do them. Carmen met with another adult student in the class to study, but the other student had missed several classes and Carmen didn't feel like she benefitted from the collaboration. "I really didn't want to go backwards because I was trying to understand the new stuff." Carmen believed her main problem on exams was her memory. She practiced problems before the exam, but, "when it came time to come in class, it was the exact same problem and I just blanked out. I was like, 'Oh my God, I know this." Because of her poor exam grades, the pace of the course, and a health problem that caused her to miss class occasionally, Carmen dropped the course before the second exam.

According to the social constructivist theory that served as the framework for this study, collaboration among students and between students and faculty enhance learning.

Dave, the only student in the study who collaborated regularly with a classmate on homework assignments and preparing for exams, was the most successful student in Math 1319. Adam, who spent considerable time working with tutors in the SLAC lab was not successful in the course. Carmen, who took advantage of office hours often, also was not successful in the course. Clearly there are factors other than collaboration outside of class that influence adult student success in Math 1319.

Learning behaviors during class. Donaldson and Graham's model of adult student success emphasizes the importance of the college classroom as the focal point of learning for adult students (Donaldson and Graham, 2000). During the first few weeks of class, the social norms of the class are set which influence how students participate in classroom discussions and what behaviors are expected of the students and instructor. These norms are influenced by both the instructor's expectations and the students' expectations (Cesar, 1998). This study, through classroom observations and the second classroom survey, examined the four adult students' learning behaviors in the Math 1319 classroom.

Adam, the Navy retiree, was enrolled in the morning section of the course. Despite the results of the classroom behavior survey, this class was observed to be very traditional in style with the instructor lecturing and working example problems on the board while the students took notes. Usually, the only questions from the students arose at the beginning of class when the instructor would ask if there were any questions on the homework. Only occasionally would the instructor ask the students a question about the topic being learned. Adam was well within the norms of this quiet classroom. Both by Adam's response to the survey and by classroom observation, Adam answered a question posed by the instructor to the class only rarely. According to his survey response, Adam did not participate in classroom discussion because he didn't feel he knew enough. The one time Adam answered an instructor-posed question during an observation, Adam responded incorrectly. While Adam didn't seem flustered by this and with the instructor's guidance was able to correct his response, Adam was never observed either answering or asking any questions during class after that incident. Although not observed, by his response to the survey, and later during interviews, Adam reported asking questions of the instructor two to three times per week. During the second interview, Adam related that he never received a satisfactory answer to his questions, so he stopped asking. "He did not come across, even when I did ask him questions in class." Adam also never took notes during class. While he was not alone in not taking notes (by classroom observations), this seemed odd behavior for a student determined to pass the course. When asked about this, Adam explained, "When I first started taking the class, I had a tape recorder. He [the instructor] would move through problems quickly enough so where trying to copy down what he was doing, sometimes I would get lost. I made a conscious decision—'okay, pay attention to what he's doing. Hopefully, you'll be able to follow." Adam hoped that when his tutor was provided, Adam would be able to go over the material with the tutor to cement his understanding. Adam always sat on the back row by himself. He made no effort to get to know any other student in the class. "I never talked to anybody, to be honest." These behaviors are something he plans to change when he retakes the course this summer. Because many students in this section were never observed asking questions or consulting with classmates during class, Adam's level of participation in classroom discussion was typical for this section.

Belinda, in the noon class, was the most quiet of all the participants in this study. According to her responses on the learning behavior survey and later confirmed by the classroom observations, Belinda never said anything during class. This section of the course was more active than the morning section, with the instructor regularly asking the class questions about the examples being worked together and always having the students working examples on their own. But, during the classroom observations, only about five of the approximately 35 students regularly participated in classroom discussions, so Belinda's behavior was not unusual. The reasons Belinda gave for her non-participation included not knowing enough and the fear of appearing ignorant to her classmates. "I don't want to ask questions. I might say the wrong thing or it might be a dumb question. I just listen and take notes on the questions that everyone else asks." There was one student in the class that seemed to dominate the classroom discussion. When asked about this student, Belinda responded, "I think it's good that she asks questions. I think other people benefit from her asking questions." Belinda rarely spoke with the students sitting next to her. Belinda chose a seat at the edge of the classroom. Only during one of the three classroom observations did another student sit next to her. During the very last few weeks of the semester Belinda did develop a relationship with one of the other students in the class. Another adult student started sitting next to her and they occasionally spoke. "She's asked me questions and I've asked her questions. I think we tend to help each other." Most often these discussions occurred immediately after class.

The evening section of the course was the most active of all the sections observed for this study. Because it was so small with only about eleven students attending regularly, the instructor not only asked the whole class to respond to questions but often called on individual students to respond. While there was one dominant student who asked and answered most of the questions, all of the students were forced to participate. Also, when the instructor gave a problem for the students to try on their own, he would often walk around the class to make sure everybody understood how to work the problem. Dave described the class this way, "It's pretty interactive. It's a very small class, so it's easy to be interactive."

While not the most active student, Dave participated at a high level. "I think I participate because I don't get embarrassed. I don't care if I'm right or wrong. I'm just trying to understand, so I'll just blurt out whatever I think it is." When asked his opinion of a student that often dominated the class discussion, "That's what it seems like to most of us. It seems like he [dominant student] and him [the instructor] are the class and we're just taking notes on that interaction." When asked if this inhibited his participation, Dave replied, "It doesn't discourage me but I could see how it would discourage the others." In addition to "blurting out the answers," Dave was observed gesturing with arm waving to respond to questions about the shapes of functions. Surprisingly in this small class, there was very little interaction among the students. Although, before class several of the students would talk, once class started, the students each sat separated from each other and didn't speak to each other. Dave was the exception to this. Dave always sat next to a traditional-age female student in class, "I always sit next to the prettiest person in class," and they compared answers to problems and talked throughout the class. Contrary to Dave's perception of how much he liked the class, "Well I don't know about enjoy, but I don't NOT enjoy it," Dave clearly was an active, engaged participant.

Carmen, the child development major, while not the quietest student in the evening class, was reluctant to join in classroom discussion for two reasons. First, Carmen felt that it took a long time for her to absorb new material. "One of the reasons I was quiet was that I was trying to process the information. I'm writing down my notes and I'm processing." The second reason for her low participation in classroom discussions was her fear of embarrassing herself. "If I were more confident with myself, I probably would have answered more. But I was afraid that I was going to give out that wrong answer and be embarrassed." During one classroom observation, the instructor approached Carmen while the whole class was working on a problem to ask her questions on how she was working the problem. "I'm quiet, very quiet. And he [the instructor] would pick on me. [laughs]." When asked if the instructor selecting her individually to respond to questions bothered her, "I didn't not appreciate it. I know I'm supposed to participate. I kind of found it a little bit challenging but at the same time, I'm like, 'He's going to put me on the spot." While Carmen was reluctant to participate in front of the class, she often stayed after class to ask the instructor questions. "We talked. After class, I would tell him what I liked and what I learned and what I didn't understand." Carmen was not embarrassed to reveal her ignorance to the instructor. "Not to him, I mean, he's the teacher. There're no stupid questions. But to students…" Carmen missed several classes before she dropped and only was present for one classroom observation.

Because what happens in the college classroom is so important to the learning and success of adult students (Donaldson & Graham, 1999; Faust & Courtenay, 2002; Graham et al., 2000), student behaviors during class are especially important. Dave, the most active participant in classroom discussions among the four adult students in this study, was the most successful in Math 1319. Adam, who did ask questions occasionally in class, became frustrated with not understanding the instructor's answers, and quit participating. While his behavior was not atypical for his section, Adam was not successful in the course. Both Belinda and Carmen avoided participating during class. Both attributed their lack of participation to embarrassment over their lack of understanding. While both struggled in the course, Belinda was able to pass with a C. Carmen dropped the course.

Summary of learning behaviors. Each of the adult students in this study exhibited varying levels and types of learning behaviors. The out-of-class behaviors included going to the instructor's office hours, seeking help at tutoring centers, and doing homework and studying both alone and with a classmate. The in class behaviors included responding to questions asked by the instructor, asking the instructor to clarify a topic, and discussing a problem with a classmate. The levels of these behaviors, especially the in class behaviors were mediated by the social norms developed in the individual classrooms and influenced by the instructor's teaching style and the class size. The table below summarizes the level of each adult participant's behaviors along with the success of the student in the class.

Table 20

Levels of Learning Behaviors

	Office Hrs	Tutoring	Studying with Classmates	Class Discussion		Success
				Overall	In Context	
Adam	Low	High	Low	Low	Average	No
Belinda	Low	Med	Low	Low	Average	Struggled
Carmen	High	Low	Med	Med	Low	No
Dave	Low	Low	High	High	High	Yes

Note: The class discussion levels reflect both the level of participation in comparison with all students in all classes (overall) as well as in comparison with students in their individual classes (in context).

Because this study was based on a social constructivist theory of learning, particular emphasis was placed on students collaborating both during and outside of class as well as meeting with tutors or the instructor to discuss the mathematics introduced in class. While most of the students in this study collaborated at some level, there were very different outcomes.

Dave, who was most regular in studying and doing homework with a "math buddy" was very successful. Belinda and Carmen rarely and occasionally studied with a partner and neither was satisfied that the partnership benefitted them to a great extent. In addition, Carmen met often with the instructor during office hours. Again, this did not seem to influence her performance in the course. Adam, while never meeting with other students from his class, spent hours in the tutoring center. This did not benefit him.

The level of participation in classroom discussions for these students also varied greatly. The individual levels of participation seemed to depend both on the classroom expectations and on the level of confidence of the adult students. Dave, the most successful student, was the most active of the participants in classroom discussion. In addition, he was the one that formed social relationships within the classroom and studied regularly with a classmate. Adam had limited participation in class discussion. He never tried to develop a partnership with other classmates, and although he actively sought help in the tutoring center, dropped the course after failing the first exam. Carmen, while she did participate in classroom discussion, did so only when called on by name. She also attempted to form a partnership with a classmate to do homework, but she felt this was not beneficial for her. Carmen, after failing the first exam, dropped the course right before the second exam. Belinda also was very quiet in class. Like Carmen, she tried to form a partnership with a classmate, but only during the last few weeks of the semester. Similar to Carmen, Belinda did not feel like this was beneficial to her. Unlike Carmen, Belinda did not drop the course after failing two exams and was able to do well enough on the final to pass the course with a C.

Another factor that may have influenced the level of participation in class was the gender of the adult students. Both female participants expressed a fear of appearing ignorant in front of their classmates. The male participants did not express this concern. Even though Adam refrained from participating in class, his reasons had more to do with his perception of the lack of helpful explanations he received from the instructor, not fear of embarrassment.

In addition, the depth of high school mathematics background may have played a role in the degree to which the adult students participated during classroom discussions. Dave, with the strongest high school background, participated at the highest level, while the others, with weaker backgrounds, participated less. It was unclear whether the high school mathematics background affected the confidence of the students which then affected participation, or whether the high school mathematics background directly influenced participation. The levels of in class and out of class behaviors as well as the factors that were thought to be possible influences for these behaviors are summarized in the table below.

Table 21

Factors that Possibly Influenced Participation and Success in Math 1319

	Adam	Belinda	Carmen	Dave
Attitude about Usefulness of Math	High	High	Low	Low
Confidence to do Math	Low	Low	Low	Med
Enjoyment doing Math	High	Low	Low	Med
High School Math Background	Low	Med	Low	High
Developmental Math Background	2 levels	1 level	Unsuccessful	N/A
Initial Confidence to succeed in course	High	High	High	Med
Out of class levels of behavior	High	Med	High	High
In class Participation	Low	Low	Med	High
Success in Course	Dropped	Struggled but passed	Dropped	Easily passed

Student perceptions of the difficulty of Math 1319. The previous analysis used a priori themes to analyze the data collected in the second part of this research. While including the academic background of the students and the student's attitudes about mathematics, special emphasis was given the role of classroom discussions and study partnerships formed with classmates in the course. This section of the analysis focuses on the students' perceptions of why Math 1319 was difficult without any preconceptions on the part of the researcher. The recurring themes that evolved included the role of the instructor, the lack of adequate academic preparation, the fast pace of the course, and the perception of the usefulness of the material included in the course.

Role of the instructor. Three of the four adult students in this study felt that the instructor played a large role in making Math 1319 more or less difficult. Only Belinda, taught by the graduate student, did not have strong feelings about her instructor.

Belinda, the accounting student in the noon class, felt that her instructor did a good job, but didn't have the strong feelings that the other students had. "She's nice; you know willing to help." Belinda appreciated that the instructor used other means of assessment besides exams, but wished that exams did not count as much as they did. When asked what she wished the instructor would change, Belinda replied, "Maybe not so much tests counting towards our grades. Because I think that other people have test anxiety too." Overall, Belinda liked the instructor. "One thing about Ms. B. is she's always very positive. She's always very encouraging. So that's nice."

Adam, the Navy retiree, had strong but ambivalent feeling about his tenured mathematics professor. After an initial negative impression about the instructor, Adam was willing to adapt his own study strategies to meet the expectations of the instructor. "He's got a teaching style and I think I've learned that you have to adapt to them [the instructor's]. Hopefully you can. I think I can with him." Before Adam dropped the course, while Adam was not successful on quizzes and exams, he did not hold the instructor to blame. "I believe he truly wants to instruct you. I truly believe he wants you to pick up the concepts. He gives us the information. If you can't retain it, that isn't his fault." In addition, Adam felt that his instructor was fair. Even though Adam did poorly on the exam, he did not believe it was the instructor's fault. In an informal conversation with Adam after one of the classroom observations, and confirmed by the instructor, the exam questions were taken directly from the homework. Adam just couldn't remember how to do them.

After Adam dropped the course, and had an opportunity to reflect on his performance in the course and the role that the instructor played in his failure, Adam placed more responsibility on the instructor. Adam was often confused by his teaching style. "He [the instructor] would start talking about a concept with real numbers and then he would switch to 'a,' 'b,' and it would be like, 'Hold on, whoa, whoa, whoa. Go back to the numbers in the original problem." Adam felt like the instructor was better suited to teaching upper division mathematics courses. "My personal opinion is that he really doesn't have a good personality for teaching the lower level classes. I believe that his mind is racing at 2,000 miles per hour and sometimes he needs to talk at ten miles per hour." In addition, Adam felt that the instructor did not adequately answer questions that the students' posed. This was confirmed in a classroom observation. When a traditional-age student asked a question during the observation, the instructor was very adept in understanding what the student asked, but could not explain the concept in a way that the student could understand. The question was asked and answered twice and finally, the student resorted to asking the student next to him to explain it. Another source of confusion for Adam was the instructor's expectations about the use of a calculator on the exams. "The last test that I took with him, there were two points; you could take the raw formula and get a certain amount of the points. If you gave him the right answer along with that, then you got credit for the whole thing. He had said don't use calculators, so I didn't bring a calculator." Then, during the exam, the other students did use calculators to get the final answer for full credit. While Adam said that he would not take Math 1319 from that same instructor, the blame did not lay solely on the instructor. "I don't totally blame Dr. A—he had 50 minutes in order to teach us a concept. I think a 50 minute class is just ludicrous."

Dave and Carmen, both in the evening class, felt that their instructor was a major factor in making Math 1319 accessible, interesting, and relevant. When asked what role the instructor played in his success, Dave responded, “I would say he would get a pretty good portion of the credit. He’s pretty entertaining and the things he says, the little witticisms, this is hilarious.” Dave especially appreciated the interactive nature of the course. “That’s the kind of person I usually respond to instead of the get up and lecture and take notes like most math classes seem to be. Yeah, the interactivity keeps people interested.” Dave believed that the instructor, in asking the class to come up with the next step in working out examples, was effective having the students understand the concepts being taught. “That’s how you learn math.”

Although Carmen was not successful in the course, she agreed with Dave that the instructor played a large role in her learning. “I credit the instructor a lot because he did give those concrete examples. He was animated. You could tell he was passionate about math, but you could also tell that he really wanted us to get this.” Both Carmen and Dave felt that the instructor’s ability to be entertaining and to present the practical applications of the material played a big role in their interest in the course.

Inadequate preparation for the course. By the end of the semester, several of the students in this study felt that they had not had an adequate mathematics background to be successful in Math 1319. Dave, the most successful student had seen all of the material “in some form or fashion” in high school. The other adult students in the study did not have the same mathematics background that Dave, and possibly the majority of the younger students in the class, had.

Adam, the Navy retiree, was particularly frustrated by his lack of background. “The information was way over my head. There was a bunch of stuff, for whatever reason, I'm assuming, we were supposed to know, that just kept getting in my way." Exponential and logarithmic functions were particularly difficult for Adam. "I'm not strong in math anyway, but those two concepts really killed me and it was right there at the beginning of class and, you know, I don't know where I was supposed to get that kind of information." While Adam had taken and passed both levels of developmental mathematics immediately preceding taking Math 1319, he felt that he barely passed these courses and that the developmental courses did not give him the background necessary to do well in Math 1319.

While Belinda appreciated that the developmental course she took prior to this course helped her re-familiarize herself with mathematics in general, when asked if it was adequate in preparing her for Math 1319, "No, I don't think so. I think it was good to have 1311 just to kind of get back into…you know, familiarize yourself with things. I think that helped." During an informal conversation with Belinda after one classroom observation, Belinda was extremely frustrated. The idea of matrices was completely foreign to her. Based on the responses of the other students during the observation, a majority of the students were familiar enough with the concept to know that there was a way to use a calculator to solve matrix problems. Belinda said she was frustrated by trying to take notes and understand the material at the same time. During the first interview, Belinda remarked that Venn diagrams were also completely new to her. "I don't ever remember doing anything like that." She felt that some topics that were brand new to her were familiar to the other students in the class. "They're familiar with it, based on what I overhear. So I think that too is hard. And plus, I think times change on what they teach [in high school]." Overall, Belinda felt that many other students in the class had better mathematics backgrounds than she did.

Carmen also had a poorer mathematics background than the other students in her class. "I've totally forgotten a lot of the background stuff." She had attempted a developmental mathematics course twice at the community college level that included topics from the first high school algebra course, but was never able to pass the course. Since a level of proficiency at the level of the final developmental mathematics course was a prerequisite for the course, Carmen may not have met the prerequisite, but was able to enroll in the course nonetheless. Carmen felt that she was familiar with about half the material she encountered in the course. "It was kind of like half and half." Even the material Carmen was familiar with, gave her trouble. "It was like I know I've done this before."

Dave, the student with the strongest high school mathematics background was the most successful of the adult students in this study. Those with poor high school mathematics preparation struggled. This supports research that emphasizes the importance of high school mathematics in success in college (Adelman 1999, 2006; Trusty & Niles, 2003). While the developmental courses were seen by the students as helpful, they did not make up for a poor high school background either in terms of confidence or ability to succeed on exams.

Pace of the course. All three of the adult students who struggled in Math 1319 reported that one of the major issues for them was the pace of the course. Dave, who was successful in the course, had no problem keeping up. For Dave, "it seems the pace is a little bit slower [than high school]."

Adam, the Navy retiree, felt that trying to present a topic in the 50 minutes allotted for his class was very difficult. "I wish there was a little slower pace. I wish that we had an hour and 20 minutes instead of the 50 minutes we've got." By the third week of class, Adam felt that the pace of the course was affecting his learning, but didn't blame the instructor for this. "He needed to move from point A to point B by this amount of time." Ultimately, Adam could not keep up and dropped the course.

Belinda, in the noon class, described the course, "You know it's like a roller coaster. I feel like we're going too fast." A particular issue for Belinda was the skipping from topic to topic. "We touch on something one day and then we're moving on to the next subject the next class day. I think that's hard for me." This moving on to new topics also kept Belinda from seeking help about topics she was unsure of. "With the pace, with us moving on to something new, then I thought, 'well, why go back." Like Adam, though, Belinda did not blame the instructor for the pace of the course. "I don't know if it'd even be possible [to slow down] with so much you've got to get in the semester."

From the beginning of the semester, the pace of the course was too fast for Carmen, the child development major. Even within a single class session, Carmen felt that she was still "painting the picture in her head" about one topic while the instructor would move on to the next topic. Like both Adam and Belinda, Carmen had trouble taking notes while trying to understand new concepts. "I was writing down the notes so when he did that [instructor asked her a question], he stopped me from writing it down and I'd lose my train of thought." Carmen especially appreciated when a student would ask a question in class because that would give her time to catch up on her notes. "That was helpful because I was able to take more detailed notes." Overall, Carmen was not able to keep up in the course. "For me, it was too fast."

The perceived fast pace of the course may be related to the students' poor background in mathematics. Two of the instructors for this course reported that they assume no prior mathematics knowledge beyond high school mathematics and present each topic as if it were new material. However, because many of the topics are covered in high school (Dave had seen all of the topics before), little time is spent on each topic. This may pose particular problems for students for whom the material is genuinely new material.

Summary of Part 2: Adult Students' Learning Behaviors in a Roadblock Mathematics Course. This portion of the research involved following four adult students through a semester. These students were enrolled in three sections of Math 1319, the course identified in Part 1 as the mathematics course that served as the greatest roadblock for adult students. The purpose of this was to examine the four students' learning behaviors, including in class and out of class behaviors, to explore their role in the adult students' success in the course.

Social constructivism places an emphasis on peer collaboration and discussion as well as student-faculty discussion. Therefore, factors that were expected to influence adult students' success in Math 1319 included meeting with classmates outside of class and active participation in classroom discussion.

The adult students in this study exhibited varying levels of collaboration outside of class and participation during class. The most successful student was the most active of the adult students during class and the only student that had regular collaboration with a classmate outside of class. The other adult students in the study, while not atypical from their classmates, had much lower levels of collaboration and participation. These students all struggled in the course.

A contributing factor that may have influenced the level of classroom participation that emerged from the analysis was the differing levels of high school mathematics backgrounds the adult students in this study possessed. Dave, the student with the strongest high school mathematics background was the most successful of all the students in the study. This was the same student that had the highest level of confidence to do mathematics and the highest level of participation during class and collaboration outside of class. The three other adult students in this study related that among the reasons for their low level of participation was their lack of confidence in asking an intelligent question or supplying a correct answer. Because of this, both Belinda and Carmen expressed that they were reluctant to participate for fear of revealing their ignorance and being embarrassed in front of their classmates. Even taking developmental mathematics courses directly preceding enrollment in Math 1319 did not relieve this lack of confidence. Other factors that emerged as influencing success in Math 1319 included the pace of the course and the role of theFigure 11. Factors that Influenced Success in Math 1319.

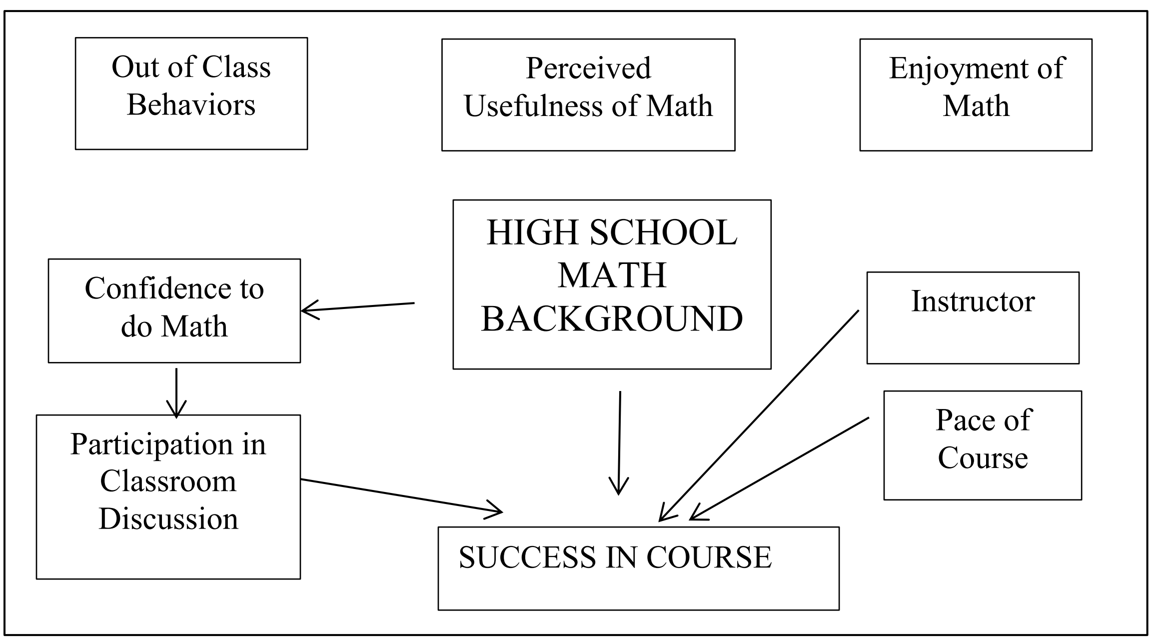

Figure 11. Factors that influenced success in a roadblock mathematics course.

CHAPTER 5

DISCUSSION

Adult college students have lower graduation rates than traditional-age students. The ability of adult students to succeed in mathematics courses plays a major role in the success of adult students. This research identified Math 1319-Mathematics for Business and Economics 1 as the mathematics course that acted as the greatest roadblock to the original educational goals of adult students in a cohort of students who were freshmen in the fall of 1999 at a large university in central Texas. In order to understand adult students' difficulty in the course, the learning behaviors of four adult students enrolled in the Math 1319 during the spring of 2012 were investigated. A social constructivist framework was used in this study and particular attention was paid to the adult students' participation in classroom discussions and activities as well as collaboration with classmates outside of class, meeting with the instructor during office hours, and seeking help at tutoring centers. While the most successful of the four students had a high level of participation during class and a high level of collaboration with a classmate outside of class, other students struggled in spite of actively seeking assistance during instructors' office hours and at tutoring centers. In addition to their observed and reported learning behaviors, the adult students were asked for their perceptions about the difficulty of the course. Common themes that emerged as factors that made Math 1319 particularly difficult were the lack of an adequate mathematics background, a lack of confidence to do mathematics, and the fast pace of the course. These contributed to the students' lack of participation in classroom discussions which, according to the social constructivist model, enhances learning and promotes success in the college classroom.

In this chapter, conclusions and implications of the results will be discussed along with the results that invite further research. First, the research questions will be addressed along with the implication of the results. Next, the current study is compared to past, similar research and the differences in results are explored. Finally, limitations of this research study are acknowledged.

A Roadblock Mathematics Course

One of the main purposes of this research was to identify the mathematics course that acted as the greatest roadblock for a cohort of adult students. Math 1319-Mathematics for Business and Economics served as the greatest roadblock for this cohort of adult students at Texas State. This course had the lowest success rate for adult students, had the greatest number of attempts per success for successful students in the course, and had the greatest ratio of attempts per success overall.

In past research, several mathematics courses have been identified as acting as roadblocks for all college students. These included developmental mathematics, college algebra, and calculus (Bryk & Treisman, 2010; Burton, 1987; Reyes, 2010; Small, 2010; Suresh, 2006; Treisman, 1992). This research extended past research in that Math 1319-Mathematics for Business and Economics, which is similar to college algebra, was identified as the greatest roadblock mathematics course for the adult students in the cohort analyzed. The five mathematics courses that had less than a 75% success rate for adult students in this study included two developmental courses, college algebra and the two business mathematics courses. These are all considered pre-college or freshman level courses. The few adult students who continued their mathematics coursework beyond the freshman level were generally successful in their advanced courses. While the second business mathematics course which focuses on calculus business applications had only a 71% success rate for adult students, other calculus courses, including calculus for life sciences and the two-part regular calculus course had a 100% success rate for the five adult students enrolled in these courses. While the success rates for all students in the five pre-college and freshman level courses were low, the success rates for adult students were consistently lower than traditional-age students (with the exception of the lower level of developmental mathematics), and for two of the five courses, significantly lower. While regular calculus courses did not seem to pose an obstacle for adult students, this study demonstrated that courses that act as roadblocks for traditional-age students also act as barriers for adult students.

As a result of analyzing the interviews and observations of adult students enrolled in Math 1319-Mathematics for Business and Economics 1, several trends common to the adult students who struggled in the course emerged. First, it became apparent that the adult students who struggled in the course had different high school mathematics preparation for the course from many of the younger students in the course. The strength (or weakness) of adult students' high school mathematics background was a major factor in their success in the course.

Because each mathematics course at Texas State has prerequisites or qualifying placement exam scores for enrollment, instructors may assume that all students enroll in each course equally prepared to succeed. Through classroom observations and student interviews, it became clear that several of the adult students in Math 1319 had never encountered some of the topics that the younger students in the class were familiar with. These topics included logarithms, Venn diagrams, and matrices. While many traditional-age students in the course may not have had mastery over these topics, their familiarity with the topics seemed to give the younger students an advantage over the adult students who had never seen these before.

When it became apparent that the adult students lacked experience with specific topics included in the curriculum of Math 1319, the researcher contacted the instructors of the sections in which adult students in the study were enrolled. Two of the three instructors participating in the study assured the researcher that they approached each new topic as if no student had seen it before. In spite of this assertion, the length of time spent on each topic in a class is, in part, dependent on how quickly the students seem to understand the material. One instructor reported that he assumed a high school level of mathematics knowledge. Unfortunately, Adam, who dropped out of high school before completing the first year of high school algebra; Belinda, who took the minimal amount of high school mathematics almost 20 years before; and Carmen, who failed her high school mathematics courses each school year; may not have had a current high school level of mathematics knowledge. While both Adam and Belinda successfully passed courses in developmental mathematics designed to make up these deficiencies, this was not enough to fully prepare them for more rigorous college level mathematics courses such as Math 1319.

While two semesters of developmental mathematics can never be expected to adequately replace four years of high school mathematics, changes might be suggested to adapt developmental mathematics to better serve adult students. There is continuing debate over the need for and effectiveness of developmental mathematics in universities today. Some experts point out that the extra time needed to complete their course of study may lower the graduation rates for students requiring developmental courses (Bryk

& Treisman, 2010). Others point out that developmental courses are helpful not only for preparing students for topics in a specific discipline but also in changing attitudes and instilling other college readiness skills that help students succeed in all their courses (McCabe, 2003). Designing developmental mathematics courses for the specific college level mathematics course included in a student's degree plan may be one approach to alleviate the time versus scope issue. For those students planning to enroll in Math 1319, a specialized developmental course might include some of the topics listed above that the adult students in this study were completely unfamiliar with.

Another solution that might ameliorate the poor high school mathematics background may adult students have would be to provide extra support for adults who report having these deficiencies. Adult students like Adam, who need, not to refresh forgotten mathematics skills, but to learn new skills. Even though Adam was able to progress through his developmental mathematics courses, he still felt unprepared for Math 1319. The need for continuing support for adult students who enroll with poor high school mathematics backgrounds was demonstrated by the transcript analysis completed in the first part of this study. Adult students who were required to begin at the lower level of developmental mathematics had much lower graduation rates than traditional-age students starting at the same level.

One aspect of the kind of support that may be needed is demonstrated by both Adam and Carmen in this study. Adam was proactive in seeking help at the university tutoring center. In spite of hours spent at the center, he wasn't able to succeed in Math 1319. The semester after this study was completed, Adam repeated the course. Before the semester began, Adam secured the services with a private tutor that he met with twice a week. Getting individualized help and support with the particular topics he was weak in made it possible for Adam to pass the course with a C. Adam, while acknowledging the helpfulness of most of the student tutors at the tutoring center, needed much more assistance than could be provided by one tutor helping many students.

Carmen was also proactive in seeking help during her instructor's office hours. In spite of this, Carmen was unable to succeed in the course. Carmen decided that the best option for her would be to go back to the lowest level of developmental mathematics. Individualize tutoring might have helped Carmen succeed in the course.

Because Math 1319-Mathematics for Business and Economics 1 is a difficult course for younger students as well as adult students, another option might be to provide specialized assistance for all students in this course. Other mathematics courses that have a history of low passing rates such as calculus have added a laboratory component to the course that meets several times a week. The purpose of these lab meetings is to provide students an opportunity for guided practice in working examples and homework problems that cannot be done in the lecture component of the course because of time constraints. Adding an opportunity for guided practice to reinforce topics covered in class might provide the extra support all students need to succeed in the course. This extra assistance could also be provided less formally with a supplemental instruction (SI) component which involves a student who was successful in passing the course in a recent semester acting as a discussion leader for a voluntary homework practice session that meets once a week.

Adult Student Learning Behaviors

The second purpose of this study was to examine the learning behaviors of adult students in Math 1319, the identified roadblock mathematics course. Exploring to what extent adult students participate in classroom discussions and collaborate with classmates outside of class could lead to a better understanding as to why this course is difficult for adult students. This study found that adult students attributed their lack of participation to a fear of being embarrassed in front of their classmates for their poor understanding of mathematics and to their lack of confidence in providing a reasonable response to questions posed by the instructor. This low level of confidence to do mathematics seemed to stem from a weak high school mathematics background. A low level of confidence to do mathematics led to a reluctance of adult students to participate in classroom discussions. Dave, with the strongest high school mathematics background, had the highest level of confidence to do mathematics and subsequently the highest level of participation in the classroom. The adult students with poor or minimal high school mathematics backgrounds reported low levels of confidence to do mathematics and were reluctant to participate in classroom discussions. The level of high school mathematics background seemed to be a major, if indirect, factor in the level of classroom participation.

A past study that supports the conclusion about the role of high school mathematics in the success of adult students in college mathematics courses is Le's qualitative dissertation on the learning approaches of five adult students in a college algebra course (Le, 1997). Like the current study, Le gathered data in the form of classroom observations and interviews while following five adult students through a college algebra course. While each of the five adult students attended class regularly, took good class notes, completed all assignments, and sought assistance when needed; only one of the five was successful in earning a C in the course. Le attributed the students' difficulty to the students' inability to adapt to the new learning strategies necessary to succeed in algebra. In their past developmental courses, the students were able to use memorization and repeated practice to earn good grades on mathematics exams. In college algebra, the students were expected to have conceptual knowledge and to be able to apply learned concepts to new situations. Instead of adapting their study styles, the unsuccessful students spent more time redoing homework problems and repeating past study strategies. The one adult student who did well in the course had a strong previous mathematics background.

The four adult participants in the current study had traits similar to the students in Le's study. The one student in this study who did not struggle in the course had a strong high school mathematics background. Two of the other students passed one or two semesters of developmental mathematics in the semesters before taking Math 1319. Both of these students were successful in the developmental courses but both also acknowledged that they did not fully understand the concepts they had been taught. During their initial interviews, these two students reported that they were surprised that they had passed their developmental courses. Both students related that their test scores in the developmental courses were low and that there was information presented in their developmental classes that they did not fully understand. Their success in the developmental courses did not increase these adult students' confidence in their mathematics ability. These students, like the students in Le's study, might have depended on memorization and repeated practice to succeed in their developmental courses. This lack of fully understanding the concepts they had been taught may have added to their struggle in Math 1319.

Like Le's students, the adult students who struggled in Math 1319 seemed to lack effective study strategies. Adam, who dropped the course, spent hours in the university tutoring center. He attempted to do all the homework, but was frustrated that the time he spent on the course did not help him to pass the biweekly quizzes. Although the quizzes were made up from the homework questions, he could not remember the correct procedures when it came time to take the quizzes. During several conversations, Adam referred to his head as a bucket that could be filled with knowledge, but just as easily emptied if tipped over.

Belinda also made poor grades on exams. After one exam, she remarked that she should have memorized the formulas better. While there were no specific formulas on the exam, there were set procedures necessary to solve the problems. Belinda, like Le's students, may have relied on memorization rather than an underlying understanding of the topics being taught.

Carmen also faulted her memory for doing poorly on exams. She attributed her poor memory on her age and the need for her to create visual images to stimulate her recollection of facts and procedures. While Carmen credited her instructor for his skill in presenting clear, practical examples to illustrate the topics presented in class which assisted her in creating visual images, Carmen felt that her poor memorization skills hindered her success in Math 1319.

The propensity to memorize formulas and procedures in lieu of understanding the underlying concepts of mathematics may be a contributing factor for these adults' struggle in mathematics courses. It is unknown if the traditional-age classmates of these students used memorization to prepare for exams or whether because of their more recent experience with high school mathematics, had a better understanding of the underlying principles of the mathematics being studied. While this question was beyond the scope of this study, in light of the adult students' perception of their poor memory, it would be worthwhile to investigate the difference between the memory capability of adult and traditional-age students and what role this plays in success in mathematics courses.

Graduation Rates

Another finding of this study was that adult students had lower graduation rates than traditional-age students. Only 27% of the adult students in the 1999 cohort graduated while over 57% of the traditional-age students graduated. This part of the research was designed to mirror Calcagno et al.'s 2007 study exploring the effect of age on graduation rates at community colleges in Florida. Using information from the transcripts of over 42,000 first time community college students, Calcagno et al. found that adult students graduated at lower rates than traditional-age students but the researchers concluded that this was only because the adults had rusty mathematics skills that needed refreshing. When comparing groups of students with comparable incoming mathematics ability, Calcagno et al. found that adult students actually had higher rates of completion than younger students.

The results of the current study do not support Calcagno et al.'s findings. While the graduation rates of the Texas State adult cohort was less than traditional-age students overall, comparing only adult and traditional-age students who were required to start in each of the two levels of developmental mathematics did not result in a higher graduation rate for adult students. This is directly contrary to Calcagno et al.'s findings.

There are several possible explanations for the difference in results between this study and Calcagno et al.'s study. First, Calcagno et al. had access to mathematics placement scores for all students in his study. In the current study, mathematics placement scores were only available for less than a quarter of adult students and a smaller percentage of traditional-age students. The students who did not have mathematics placement scores either used college entrance exams to place them into their first mathematics course or transferred in mathematics credit from other colleges. Because of this incomplete data, the current study used the requirement to take some level of developmental mathematics in order to compare students entering Texas State with similar mathematics ability. Because students are placed into one of the two levels of developmental mathematics or into a college level mathematics course based on their incoming mathematics ability, this was a reasonable method to group students. However, this method may not have been as precise as Calcagno et al.'s procedure.

Secondly, Calcagno et al. compared adult and traditional-age students in two year community colleges. The current study took place in a four year institution. Past research has demonstrated that adult students often need to "stop out' for a semester or two and often adult students can only attend college part-time (Pusser et al., 2007; Sandmann, 2010). The shorter time needed to complete an educational program at a community college may encourage adult students to finish their program whereas in a four-year institution, adult students may get discouraged at the long time frame needed to complete their degree. This frustration at the length of time to complete their programs was expressed by two of the four participants in the current study. Adam was discouraged by not being successful in Math 1319. Because of his failure to pass the course, Adam would have to postpone applying to the business college for a whole year. Carmen, upon dropping out of Math 1319, decided to change her major to one that, even though she decided to restart her mathematics college work at the lowest level of developmental mathematics, would allow her to graduate in the same time as her original degree plan. Carmen was willing to change her original educational goals in order to graduate in a shorter length of time.

In this study, the level of developmental mathematics into which an adult student was originally placed affected adult student graduation rates differently from traditional-age student graduation rates. This is in contrast Calcagno et al.'s results. Calcagno et al. concluded that adults only needed to refresh past mathematics knowledge. Once these skills were refreshed, adults were more likely to graduate than younger students with comparable incoming mathematics ability. In addition, Calcagno et al. concluded that adult students' completion rates were less affected by the need to take developmental mathematics than the rates of younger students. In the current study, the graduation rates of adult students were strongly influenced by their incoming mathematics ability. For adult students, being placed in the lower level of developmental mathematics greatly lowered their graduation rates. Even though adult students were as successful as traditional-age students in passing the lower level of developmental mathematics, adults still significantly lagged behind the traditional-age students in graduation rates. Being able to begin at the higher level of developmental mathematics almost doubled the graduation rate of adult students compared to those adults placed into the lower level of developmental mathematics. In addition, while the graduation rates of adults beginning at the upper level of developmental mathematics were lower than the younger students starting at the same level, this difference was not statistically significant. There was a significant difference between the graduation rates of adult and traditional-age students starting at the lower level. These findings seem to suggest that Calcagno et al. were correct in concluding that if adults merely needed to refresh their mathematics skills, their graduation rates would be similar to traditional-age students with the same incoming mathematics ability. However, the current study demonstrated that if an adult never learned basic mathematics skills in high school and had to begin his college mathematics at the lowest level of developmental mathematics, even two semesters of developmental mathematics was often not enough to make up for this deficiency. This is shown by the low graduation rate (22%) of adults beginning mathematics at the lower level of developmental mathematics. In addition, of the adult students in this study who started in Math 1300, only 31% were subsequently able to be successful in a college level mathematics course. This compares to almost 60% of adult students who start in Math 1311, the higher level of developmental mathematics.

The results discussed above point to the importance of high school mathematics in influencing the graduation rates of college students. While past researchers have demonstrated the effect of high school mathematics on college graduation rates for traditional-age students (Adelman, 2006; Trusty & Niles, 2003), the importance of high school mathematics also seems applicable to adult students. In this study, Adam, who dropped out of high school before completing algebra 1, struggled in and eventually dropped his first college level mathematics course, Math 1319. Carmen, who struggled in high school mathematics, was not able to succeed in this college level mathematics course.

In addition to many adult students' struggles in high school mathematics, adult students' exposure to specific mathematics topics in high school is very different from the experience of high school students today. The high school mathematics curriculum has become more sophisticated than when many adult students attended high school. Not only are current high school students required to take more mathematics courses in order to graduate (Texas Education Agency, 2011b), but are also subject to more rigorous mathematics in the required high school exit exams (Texas Education Agency, 2011a). Belinda remarked on this when she encountered several topics in Math 1319 that the other students seemed to be familiar with. She believed that current high schools teach different topics than when she went to school. Dave, who had a strong high school mathematics background and the most recent high school experience, had no trouble in Math 1319.

The Diversity of Adult Students

Past research has developed an ambiguous portrait of the typical adult student. While some researchers emphasis the insecurity and lack of confidence, especially in mathematics courses, of adult students (Coben, 2000; Kasworm, 2010), others point to the high level of motivation and sense of purpose that adult students exhibit (Ross-Gordon, 2003). The four students in this study demonstrated the diversity of adult undergraduates.

Past researchers have commented on the high level of motivation and sense of purpose that many adult college students possess (McClenney, 2005; McGivney, 2004; Ross-Gordon, 2003). The students in this study support past research in this aspect. Each of the four students was determined to succeed in the course and, in fact, all were confident at the beginning of the course that they would succeed. At the beginning of the semester, Adam, who dropped the course in the middle of the semester, expressed his willingness to devote as much time as needed to succeed in Math 1319. However, in spite of spending hours in the tutoring center, he was not successful. One of Adam's frustrations was that the VA had promised to supply him with a tutor which never materialized. Even after dropping the course, Adam continued to be optimistic and pro-active in achieving his educational goals. Before the summer session in which he was going to repeat Math 1319, he found a tutor on his own and contracted with the VA to hire that tutor. During the summer, Adam met with his tutor twice a week and was able to pass the course with a C. Carmen also was determined to succeed and visited her instructor during office hours very frequently. Like Adam, in spite of her high level of motivation and a willingness to seek help outside of class, Carmen was unable to succeed in the course.

In other aspects, the adult students in the current study did not conform to the image of adult students set in past research. Other researchers have pointed out that adult students often have family and work obligations that limit both their study time and their time on campus (Kasworm et al., 2002; Sandmann, 2010). Two of the four students in the current study had no limitations on their time. Neither Adam nor Dave held jobs or had dependent children at home. While both lived in towns outside of the university campus, both had unrestricted time on campus. Adam's education was being funded by the VA while Dave was using student loans to pay for college. The two female students fit the image of adult college students better in that they both had dependent children and both held jobs. The four students in this study illustrate the great diversity of adult students.

Past researchers have also reported that adult students often take some time to find their place in the academic life of college. Adult students often enroll in college unsure of themselves and their academic abilities (Kasworm, 2010; Spellman, 2007). As adult students continue their education, they become more sure of themselves and their place on campus and are more outspoken in class. The changing self-image of adult undergraduates might explain the relatively low success rate of adult students in freshman level mathematics courses and the high rate of success in upper division mathematics courses.

An equally valid explanation for the high rate of success of adult students in upper division mathematics courses is the mathematics background adult students bring to mathematics courses. As seen in the current study, three of the four adult students were encountering many of the topics covered in Math 1319 for the first time. Adam and Belinda especially noted that topics that were new to them seemed familiar to other students in the course. Even with hours spent on homework these struggling adult students had trouble keeping up with the rest of the class. Dave, who had attended high school most recently and had a strong high school mathematics background, reported being familiar with all of the topics covered in the course. It might be assumed that for the majority of the traditional-age students, these topics were not new to them. For many of the adult students, this material was brand new. In freshman level courses, whose material is often an extension of high school mathematics, adult students have lower success rates than younger students as shown in the first part of the current research. The lack of exposure to topics that many of the younger students are familiar with place these adult students at a disadvantage. Once students reach a level where the material is new to all students, the motivation and work habits of adult students may give them a distinct advantage. The higher level of success in upper level mathematics courses for adult students may be explained by the more equal familiarity of topics covered in these courses.

The Effectiveness of a Social Constructivist Model to Explain Adult Student Success

The current research was framed by the social constructivist theory of mathematics education. A greater level of interaction between student and instructor and student and student was predicted to lead to a deeper understanding and greater level of learning by the student. Supporting this, Dave, the student who was most successful in

Math 1319, was also the adult student who formed a relationship with a classmate and participated in classroom discussion at a high level. However, it is not clear whether his success stemmed from his active participation in class and collaboration with classmates, or was more influenced by his strong background in mathematics prior to taking Math 1319. Dave also reported that he had a high level of confidence in his ability to do mathematics and was the one adult student that was not required to take developmental mathematics. Even without his active participation in class, Dave might have been successful in the course.

For several of the adult students in this study, forming relationships with their classmates was not perceived as important. Two of the adult students made no effort to form relationships with other students in their class. Adam, although he acknowledged that he might try to find a study partner when he repeated the course, expressed impatience with younger students. He felt it would be a waste of time to form a study group with younger students because the younger students were often not serious about their studies. Belinda also made no effort to get to know other students in her class. Belinda never spoke up in class and although another adult student approached her to study together once, Belinda did not feel she benefitted from the association. Carmen also did not believe she benefitted when she occasionally studied with another adult student in her class.

What seemed more important to the adult students in this study than relationships with peers were their relationships with their instructors. Three of the four adult students credited their instructors as a major influence in both their success in the course (or lack of success) and their enjoyment of the course. The importance the adult students in this study placed on forming relationships with faculty instead of classmates supports past research that adult students tend to value relationships with their instructors more than relationships with their younger classmates (Lundberg, 2003). Carmen reported that she made an effort in every class she took to form a relationship with her instructor. In Math 1319, Carmen attended her instructor's office hours more than any other student in the three sections. Both Carmen and Dave reported that the animated teaching style of their instructor and the concrete examples he used made the class enjoyable as well as practical. Adam, though he had attended his previous, developmental mathematics instructors' office hours frequently, did not try to form a relationship with his Math 1319 instructor. He was discouraged from doing so because Adam perceived that his Math 1319 instructor was not approachable and that Adam's questions would not be answered in a way that he could understand. Belinda, while appreciating her instructor's willingness to help, never attempted to form a personal relationship with her instructor or attend office hours until the end of the semester because of her tight work schedule.

The level of participation in classroom discussions varied greatly among the adult students in this study. Only Dave, the most successful of the four adult students in this study, had a high level of participation in classroom discussions. Dave's willingness to participate in the classroom at a high level might be attributed to his not feeling different from the other students in the class. Even though he was initially apprehensive that he would be much older than the other students, Dave found that in every class he attended, there were students older than he was. Also, Dave commented that the younger students often thought that he was younger than he actually was. The presence of other adult students in the classroom, as well as not appearing different from the younger students in class allowed Dave to feel more comfortable in the classroom. The three other students in the study felt very different from the other students in class. They felt that, because of their age, the other students either ignored them or thought them strange. Feeling isolated from their classmates may have discouraged their participation. Carmen and to some extent, Belinda, sought help in more private venues than the classroom by either staying after class to talk to the instructor in private or by attending office hours.

Another factor that influenced classroom participation was fear of being embarrassed by asking an inappropriate question or providing an incorrect answer to a question posed by the instructor. While Dave reported that he wasn't embarrassed if he answered incorrectly, he was also one of the better students in the class and had a relatively high level of confidence in his ability to do mathematics. Belinda, who never spoke in class, was afraid that she would embarrass herself by asking the wrong thing. Carmen was afraid the other students would think she was not smart. Carmen reported that if she had more confidence in her ability, she would have spoken up more. Both Belinda and Carmen had low levels of confidence in their ability to do mathematics and were hesitant to display their ignorance in the public setting of the classroom.

Social constructivism was used as a model in this study to explain adult success in a roadblock mathematics course. The model was somewhat useful in explaining adult student success but did not provide a complete explanation for the differing success levels of the adult students in the study. The students who struggled in the course did not participate in the classroom discussion or collaborate with their classmates outside of class to any great extent. The most successful student displayed both of these behaviors to a high level. Two of the students who struggled, however, had high levels of interaction with tutors or the instructor outside of class which did not lead to success in the course. The differing levels of success of these adult students might emphasize the importance of in-class participation over interactions outside of class. Also peer-interaction as experienced by Dave might be more influential than expert-student interaction for success in mathematics courses.

In addition to high levels of in-class participation and high levels of peer interaction outside of class, Dave, the most successful student had the strongest high school mathematics background, the highest level of confidence in his ability, as well as feeling most comfortable with his classmates. The adult students' high school mathematics experiences seemed to influence both their confidence to do mathematics as well as their participation in the classroom. The strength of the students' high school mathematics background might be another factor in explaining adult student success in a difficult mathematics course. For adult students with strong mathematics background, participation in classroom discussion may not be as important in their success as for other students.

Based on a social constructivist framework, it was expected that a high level of participation in classroom discussions and collaboration with classmates and the instructor outside of class would lead to success in Math 1319. While attitudes towards mathematics and past experiences as an adult student and in mathematics were expected to influence the level of participation, this study did not confirm the order and extent of these influences for the four adult students in this study. Dave, who did not perceive mathematics to be important to his education or to his future career, had the highest level of participation in classroom discussions and was most successful in Math 1319. Adam and Belinda, who both perceived a high level of importance of mathematics for their education and careers, did not participate at high levels in the classroom. Past experiences in mathematics seemed to be a more important influence in how the adult students participated in the classroom. Dave, with a strong high school background, had high levels of participation in the classroom, while Adam, Belinda, and Carmen, who struggled with mathematics in the past, had low levels of classroom participation.

The past mathematics experiences of adult students, especially their high school mathematics background, seemed to be the major explanation of adult students' participation in classroom discussion as well as success in Math 1319. It is unclear from the results of this study which was more important—the high school background or in-class participation. Dave's success in the course might be attributed solely to his mathematics background and he might have been successful even without his high level of participation in class. For the adult students who struggled, it is unclear whether higher levels of in-class participation would have led to greater success in the course. Finding a way to enable the struggling students to overcome their reluctance to participate in classroom discussion and allow them to participate more fully might have enhanced their learning, but it is unclear whether a high level of participation alone could have made up for the deficiencies in their mathematics background. While the current study looked at four students and showed that a stronger high school mathematics background may have led to a higher level of participation in classroom discussion, it would be beneficial to extend this study to a larger population in order to see if this trend is generally true for both adult and traditional-age students. Also, teaching methods that enhance students' participation in classroom activities should be explored and the learning outcomes compared.

The Differences Between Adult and Traditional-Age Students

This study focused on the success of adult students, a growing population on college campuses. While many of the findings of this research may be valid for students of all ages, there are a few results that distinguish the needs of adult students from traditional-age students. The main difference found between adult and traditional-age students was the effect of having to take the lower level of developmental mathematics. As discussed above, the need to take Math 1300 affected adult students to a much greater extent than traditional-age students. Adam, one of the students who had a very poor high school mathematics background, although he was able to succeed in his developmental courses, had trouble in his first college level mathematics course. This struggle was not relieved by his time spent at the university tutoring center. Only when Adam received personal assistance from a private tutor was he able to pass the course. Adult students and their instructors need to realize that successfully passing the lower level of developmental mathematics might not put adult students on equal footing with their younger classmates. Adult students may need continuing support through their first college level course.

A second difference between the adult and traditional-age students in this study was how the adult students perceived themselves in the college classroom. While all students might experience some degree of nervousness and insecurity upon enrolling in college, three of the four adult students in this study never felt they were similar to the other students in the classroom even though several of them had been enrolled for several semesters. Two of the students chose seats in the classroom that exhibited and prolonged this feeling of differentness. Adam chose to sit in the back row of the class and believed that the younger students in his class didn't even realize he was there. Belinda chose a seat at the edge of the classroom with an aisle on one side and a single empty seat on the other. Near the end of the semester, another adult student started sitting in the one seat next to Belinda, and while they met outside of class once, they didn't continue the partnership. These students did not make any attempt to integrate themselves into the social structure of the class. Carmen, on the other hand, while reluctant to answer questions in class, sat in the front row. There were no students sitting beside her and she didn't speak to other students during the classroom observations. According to her interviews, Carmen sat on the front row to encourage a relationship with the instructor, not the other students. Dave, the youngest student, reported that he was able to relate to the younger students more than he had originally thought possible and that he did not see a lot of differences between himself and the other students. He made a point to sit next to an interesting looking student in the class specifically to form a friendly relationship. Dave was often observed before class engaging in conversations with two other students in the class.

How much the self-concept of the adult students influenced their participation in the classroom is not known. Dave, who felt similar to the younger students, participated to a large extent; the other adult students, who felt different from the younger students participated little, if at all. More research would be needed to determine if this was a typical response for adult students in general.

Summary of Results Discussion

Overall, it seemed that the greatest influence in the success of adult students in Math 1319 was the strength of the students' high school mathematics background. The strength of this background then seemed to influence adult students' confidence to do mathematics, which subsequently influenced their participation in classroom discussions. All these factors together led to success in the course. Those students with weak high school mathematics background were shown to need greater support and assistance than could be provided by the usual support services such as tutoring centers and office hours.

Adult students with minimal high school mathematics may need individualized tutoring even after being successful in developmental courses.

Limitations of the Study

The major limitations of this study occur in the first part of this research. The greatest limitation is the inability to track students who transfer out of Texas State to complete their studies elsewhere. Because the student transcripts only included courses taken at Texas State, students who did graduate elsewhere were recorded in this study as not graduating. There was no way to determine if this affected the graduation rates of adult students differently from traditional-age students.

Another limitation was the sparse high school information from adult students. While most of the traditional-age student transcripts included high school GPA, high school rank in class, and college aptitude scores; these were lacking for many of the adult students. This made comparisons of academic preparedness for college not totally reliable. This deficiency was addressed in the area of mathematics preparation by looking at the numbers of adult and traditional-age students required to take developmental mathematics courses.

Last Thoughts

The Center for Educational Statistics predicts a continuing increase in the number and percentage of adult students in 4-year educational programs. How institutions respond to these students will affect not only the futures of the adult students, but also the effectiveness of the educational institutions as well as the viability of the American workforce.

Mathematics will continue to play an important role in the success of adult students. Identifying mathematics courses that act as roadblocks to adult students reaching their education goals will alert students, instructors, and mathematics departments to the need to make individual and institutional changes to ensure the proper support for adult students to succeed in their goals. More important, though, is the need to understand the factors that influence adult success in difficult mathematics courses. While this study uncovered some factors such as the importance of adults' high school mathematics background, adult students' lack of confidence, and adult students' inability to keep pace with students already familiar with the material in freshman level courses, this research only begins to explain the lower graduation rates of adult students in postsecondary education. I hope this study will encourage more research in identifying factors that influence the success of the growing population of adult students on university campuses.

APPENDIX A

CLASSIFICATION OF MAJORS OFFERED AT TEXAS STATE

Level 1 – Needs math at college algebra level only

- All majors in College of Applied Arts
- Elementary Education
- Health and Human Performance
- All majors in College of Fine Arts
- All majors in College of Liberal Arts
- College of Health Professions

Level 2 – needs some calculus but no mathematics beyond 2nd semester calculus

- All majors in College of Business
- Middle School education – math/science specialist
- Biology
- Chemistry
- Engineering Technology
- Construction Science – needs pre-calculus and stats* (to be treated as a special case)

Level 3 – needs courses beyond calculus

- Mathematics
- Physics
- Electrical Engineering
- Computer Science

APPENDIX B

CONSENT FORM

You are being asked to participate in a research study. This form provides you with information about the study. The person in charge of the study will describe the study to you and answer all of your questions. Your participation is voluntary. You can refuse to participate at any time. You may choose not to answer any questions posed to you.

Title of Research Study: Adult Student Learning Behaviors in a Roadblock Mathematics Course

Investigator: Aimee Tennant (at1188@txstate.edu)

Purpose of the Research Study: The purpose of this research is to investigate the learning behaviors used by adult students in a college level mathematics course focusing on learning behaviors during and outside of class.

Participation: If you agree to participate, you will be asked to participate in a 30 minute interview twice during the semester concerning your math background and current participation in the math course you are enrolled in. The interview will be recorded for later transcription.

Confidentiality: The participant will not be identified by name in any report or publication. He or she will be referred to by a pseudonym.

Signatures: By signing this document, you are indicating that you fully understand the consent form and its contents. You have been given the opportunity to ask questions and have been told that participation in this study is voluntary.

____

Printed Name of Participant

____

Signature of Participant and Date

____

Signature of Principle Investigator and Date

APPENDIX C

INITIAL CLASS SURVEY

This is a preliminary survey to determine the demographic make-up of this mathematics class as the basis for a study on adult students' learning behaviors in mathematics courses. Please fill out the requested information.

Age: _____18 – 22 ______23 – 24 _____25 or older

Gender: ____Male ____Female

Major: __________

Classification: ____Freshman ____Sophomore ____Junior ____Senior

Have you already earned a bachelor's degree? ____No ____Yes

What other mathematics courses have you taken since graduation from high school (include any developmental math courses)?

____

If you are 25 or older, would you be willing to participate in a study concerning adult students' learning behaviors in mathematics courses? This would entail filling out a form about your attitudes towards mathematics and 20 - 30 minute interviews to be arranged at your convenience at the beginning and near the end of the semester. The interviews would focus on your goals for this course and the strategies you use to meet these goals.

If you are willing, please include your Texas State email here:

____

If you would like more information about this study, please contact Aimee Tennant at at1188@txstate.edu

Initial Class Survey p. 2

	Disagree Strongly	Mildlv Disagree	Not Sure	Mildly Agree	Agree Strongly
1. Mathematics is useful for me because I need it to attain my college degree.					
2. Mathematics is enjoyable and stimulating to me.					
3. Using mathematical knowledge will not be essential to me in my life's work.					
4. A mathematics course is beneficial to me because it is a necessary part of my educational program.					
5. I'll need to use mathematics a lot in my future work.					
6. Mathematics has always been one of my most difficult courses.					
7. When a math problem arises that I cannot immediately solve, I stick with it until I get the solution.					
8. In my math course, I will probably learn a lot that I will not actually use in my career.					
9. I'm sure of myself when I do math.					
10. Passing my math course is important in achieving my career goal.					
11. I study as little math as possible.					
12. I think I can handle more difficult mathematics.					
13. The challenge of math problems does not appeal to me.					
14. Most subjects I can handle, but I just don't seem to be able to do a good job in math.					
15. Mathematics is important to me because it is necessary to being an educated person.					
16. I don't understand how some people can spend so much time on math and enjoy it.					
17. Most of my mathematical knowledge I attain will be used in my future work.					
18. Failing my mathematics course will not affect me reaching my educational goals.					
19. Once I start working on a math puzzle, I find it hard to stop.					
20. I am challenged by math problems I can't solve immediately.					
21. I can be an educated person without knowing mathematics.					
22. I would rather have someone give me the solution to a difficult math problem than to have to work it out myself.					
23. I plan to use mathematics frequently after completing my education.					

APPENDIX D

INITIAL INTERVIEW PROTOCOL

Interview Subject: ____

Time and Place of Interview: ____

This purpose of this research project is to examine the learning behaviors of adult students in college mathematics courses. This data collected for this study includes classroom observations, surveys, and interviews.

Interview Questions:

1) Tell me a little about yourself – your major, your reasons for going to college, demands on your time outside of college.

2) What are your past experiences with mathematics – both in high school and in college?

3) How would you rate your math anxiety level? Has this affected your achievement in math courses in the past? Do you have any particular anxiety as you enter this class?

4) What are your goals for this course? Do you have any particular strategies to ensure you meet these goals?

5) How do you define participation in class? How would you rate the level of your participation in past math classes? Is this the same as in your non-math courses? What level of participation do you expect to have in this class?

6) What do you believe is the responsibility of the instructor in a math course?

7) What do you believe is your responsibility as a student in a math course?

8) What are your general impressions of this course so far?

APPENDIX E

CLASSROOM OBSERVATION CHART

Date:____________________ Observer:_____________________ Time: ___________________

Number of Students: ___________________ Topic of Class: _______________________________
Tabulations of Comments made in class:

	Instructor Initiated	Student Initiated	Direct Question	Offhand Remarks	Remarks Per Student
Class Totals					
Adult student in this study					

Front of class

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

Codes: T = traditional age studentA = adult studentX = empty seat
S = Student initiated remark I = Instructor initiated remark D = Direct question O = Off-hand remark
<--> = talking with neighbor

Observation Instrument: Page 2

TIME	OBSERVATIONS	REFLECTIONS
BEFORE CLASS		
8:00		
8:10		
8:20		
8:30		
8:40		
8:50		
AFTER CLASS		

(Note: This is designed for a 50 minute class. Adjustments would be made for longer class time.)

APPENDIX F

LEARNING BEHAVIOR SURVEY

This survey is being conducted as part of a study to compare the learning behaviors of students 25 years and older with traditional-age students in mathematics courses. Please mark the answer that best describes your own behavior in this class so far this semester. If you have any questions or concerns about this study, you may contact the research, Aimee Tennant (at1188@txstate.edu).

Age at the beginning of the semester: 18-21 _______ 22-24_________ over 25___________

Gender: ________

	NEVER 0 times	RARELY Once or twice total	SOMETIMES Once/ month	OFTEN 2-3times/ month	ALWAYS Once/ week
1) How often have you contacted your instructor outside of class time either by e-mail or in person?					
2) How often have you gone to your instructor's office?					
3) How often have you stayed after class to ask a question or clarify something covered in class?					
4) How often have you gone to the SLAC lab or math tutoring lab?					
5) How often do you study or do homework for this class with a classmate?					
6) How often do you ask a question in class during class a class discussion?					
7) How often do you answer a question posed by the instructor during a class discussion?					
8) How often do you ask a classmate a question about a topic in class (include questions asked during group activities)?					
9) How many times have you explained something to another student in class?					

Survey-page 2

10) Do you know the name of your instructor in this class?

Yes_______ No_______

11) Does the instructor know your name?

Yes_______ No_______

12) Do you know the names of 2 classmates who sit near you?

Yes_______ No_______

CIRCLE ALL THE RESPONSES THAT APPLY:

1) My responsibilities as a student include:
   a) To complete assigned tasks d) To pay attention in class
   b) To attend class e) To ask for help when I need it
   c) To learn the material f) To participate in class discussion
   Other: ____

2) In this class, I participate in the class discussion because:
   a) I have something to share e) I need clarification
   b) I learn more when I participate f) The instructor calls on me
   c) I disagree with something said in class g) I like to talk
   d) I don't participate in class h) I am trying to help other students
   Other: ____

3) In this class, when I choose NOT to participate in discussion, it is because:
   a) Of the feeling that I do not know enough g) My ideas are not well formulated
   b) Of appearing unintelligent to classmates h) I have nothing to contribute
   c) I am shy i) Of appearing unintelligent to the instructor
   d) The class is too large j) I always participate
   e) The course is not interesting to me k) The instructor does not want participation
   f) Someone else will participate, so I don't need to
   Other: ____

4) The instructor's responsibilities to me as a student include:
   a) Be knowledgeable of the subject matter e) Make the class interesting
   b) Help me think critically about the material f) Follow the syllabus
   c) Motivate me to participate in discussion g) Know me by name
   d) Call on me to participate in class
   Other: ____

APPENDIX G

FINAL INTERVIEW PROTOCOL

Time and date of interview: Place:

Interviewer: Interviewee:

This purpose of this research project is to examine the learning behaviors of adult students in college mathematics courses. This data collected for this study includes classroom observations, surveys, and interviews.

1) What are your general impressions of the course?

2) At the beginning of the semester, you said that your learning strategies would be to ……. Were you able to practice these strategies? Why or why not?

3) Were these strategies successful?

4) Was there anything that made this course particularly difficult for you?

5) Was your anxiety level higher or lower than in other math courses? Can you explain why?

6) To what extent do you feel you participated in this class?

7) What made it easy (hard) for you to participate in class?

8) How do you feel about students who behave differently than you?

9) In class, I saw you ……. Can you explain what you were thinking (feeling) at that time?

REFERENCES

Adelman, C. (1990). *A college course map: Taxonomy and transcript data*. Washington, DC: U.S. Department of Education.

Adelman, C. (1995). *The new college course map and transcript files: Changes in course-taking and achievement, 1972-1993: Based on the post secondary records from two longitudinal studies*. Washington DC: U.S. Department of Education. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED460653

Adelman, C. (1999). *Answers in the toolbox: Academic intensity, attendance patterns, and bachelor's degree attainment*. Washington, DC: U.S. Department of Education. Retrieved from http://www.ed.gov/pubs/Toolbox/index.html

Adelman, C. (2006). *The toolbax revisited: Paths to degree completion from high school through colleg*e. Washington, DC: U.S. Department of Education. Retrieved from http:// http://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/index.html

Affective. (n.d.). In Merriam-Webster's online dictionary. Retrieved from http://www.merriam-webster.com/dictionary/affective

Alfonso, M. (2006). The impact of community college attendance on baccalaureate attainment. *Research in Higher Education, 47*, 873-903. doi:10.1007/s1162-006-9019-2

Ashcraft, M., & Moore, A. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment, 27*, 197-205. doi:10.1177/0734282908330580

Astin, A. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development, 40*, 518-529.

Bandura, A. (1994). Self-efficacy. In V. Ranachaudran (Ed.), *Encyclopedia of human behavior* (pp. 71-81). New York, NY: Academic Press.

Battista, M. (1999). The mathematical miseducation of America's youth: Ignoring research and scientific study in education. *Phi Delta Kappan, 80*, 424-433.

Bauersfeld, H. (1988). Interaction, construction, and knoweldege: Alternative perspectives for mathematics education. In D. Grouws, T. Cooney & D. Jones (Eds.), *Perspectives on research on effective mathematics teaching* (pp. 27-46). Reston, VA: National Council of Teachers of Mathematics.

Bauersfeld, H. (1994). Theoretical perspectives on interaction in the mathematics classroom. In R. Biehler, R. Scholz, R. Straber, & B. Winkelmann (Eds.), *Didactics of mathematics as a scientific discipline* (pp. 133-146). Dordrecht, Netherlands: Kluwer.

Bean, J., & Metzner, B. (1985). A conceptual model of nontraditional undergraduate student attrition. *Review of Educational Research, 55*, 485-540. doi:10.3102/00346543055004485

Belief. (n.d.). In Merriam-Webster's online dictionary. Retrieved from http://www.merriam-webster.com/dictionary/belief

Bell, N., Grossen, M., & Perret-Clermont, A. (1985). Sociocognitive conflict and intellectual growth. In M. Berkowitz (Ed.), *Peer conflict and psychological growth* (pp. 41-54). San Francisco, CA: Jossey-Bass.

Bishop, A. (1985). The social construction of meaning--a significant development for mathematics education? *For the Learning of Mathematics, 5*, 24-28.

Blumner, H., & Richards, H. (1997). Study habits and academic achievement of engineering students. *Journal of Engineering Education, 86*, 125-132.

Boaler, J. (1998). Open and closed mathematics: Student experiences and understandings. *Journal for Research in Mathematics Education, 29*, 41-62. doi:10.2307/749717

Bozick, R., & DeLuca, S. (2005). Better late than never? Delayed enrollment in the high school to college transition. *Social Forces, 84,* 531-554. doi:10.1353/sof.2005.0089

Bourgeois, E., Duke, C., Guyot, J., & Merrill, B. (1999). *The Adult University.* Buckingham, Great Britain: Society for Research into Higher Education & Open University Press.

Boylan, H., & Saxon, D. (1998). The origin, scope, and outcomes of developmental education in the 20th century. In J. Higbee & P. Dwinell (Eds.) *Developmental education : Preparing successful college students*. Columbia, SC: National Resource Center for the First Year Experience and Students in Transition, University of South Carolina.

Bradburn, E. (2002). *Short-term enrollment in postsecondary education: Student background and institutional differences in reasons for early departure, 1996-98* (NCES 2003-153). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Bryk, A., & Treisman, U. (2010, April). Make math a gateway, not a gatekeeper. *Chronicle of Higher Education,* B19-B20.

Burton, L. (1987). From failure to success: Changing the experience of adult learners of mathematics. *Educational Studies in Mathematics, 18*, 305-316. doi:10.1007/bf00386200

Bussi, M. (1994). Theoretical and empirical approaches to classroom interaction. In R. Biehler, R. Scholz, R. Staber, & B. Winkelmann (Eds), *Didactics of mathematics as a scientific discipline* (pp. 121-132). Dordrecht, Netherlands: Kluwer.

Calcagno, J. C., Crosta, P., Bailey, T., & Jenkins, D. (2007). Does age of entrance affect community college completion probabilities? Evidence from a discrete-time hazard model. *Educational Evaluation and Policy Analysis, 29*, 218-235. doi:10.3102/0162373707306026

Callahan, K. (2008). Academic-centered peer interactions and retention in undergraduate mathematics programs. *Journal of College Student Retention, 10*, 361-389. doi:10.2190/CS.10.3.3.f

Carmichael, C., & Taylor, J. (2005). Analysis of student beliefs in a tertiary preparatory mathematics course. *International Journal of Mathematical Education in Science and Technology, 36*, 713-719. doi:10.1080/00207390500271065

Carnegie Foundation for the Advancement of Teaching. (2010). Five foundations fund initiative to improve student success in community colleges. Retrieved from http://www.carnegiefoundation.org/print/7413

Cerrito, P., & Levi, I. (1999). An investigation of student habits in mathematics courses. *College Student Journal, 33*, 584-589.

Cesar, M. (1998, September) *Social interactions and mathematics learning.* Paper presented at the Annual Meeting of International Mathematics Education and Society Conference, Nottingham, UK. Retrieved from http://www.nottingham.ac.uk/csme/meas/papers/cesar.html.

Choy, S. (2002). Nontraditional undergraduates: Findings from "The Condition of Education, 2002." Washington DC: National Center for Education Statistics. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED471077

Cipra, B. (1988). Calculus: Crisis looms in mathematics' future. *Science, 239*, 1491. doi:10.1126/science.239.4847.1491

Civil, M. (2003). Adult learners of mathematics: A look at issues of class and culture. In J. Evans, P. Healy, K. Kaye, V. Seabright, & A. Tomlin (Eds.), *Policies and practices for adults learning mathematics: Opportunities and risks. Proceedings of the 9th International Conference of Adults Learning Mathematics* (pp. 13-23). London: Adults Learning Mathematics.

Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematical development. *Educational Researcher, 23*(7), 13-20. doi:10.2307/1176934

Cobb, P. (2000). Constructivism in social context. In L. Steffe & P. Thompson (Eds.), *Radical constructivism in action* (pp. 152-178). London, England: Routledge.

Coben, D. (2000). Mathematics or common sense? researching "invisible" mathematics through adults' mathematics life histories. In D. Coben, J. O'Donoghue & G. FitzSimons (Eds.), *Perspectives on adults learning mathematics* (pp. 53-66). Dordrecht, The Netherlands: Kluwer Academic Publishers.

College Portrait of Undergraduate Education (2012). Texas State University-San Marcos College Portrait. Retrieved from http://www.collegeportraits.org/TX/Texas-State

Compton, J., Cox, E., & Laanan, F. (2006). Adult learners in transition. *New Directions for Student Services, 114*, 73-80. doi:10.1002/ss.208

Crede, M., & Kuncel, N. (2008). Study habits, skills, and attitudes: The third pillar supporting collegiate academic performance. *Perspectives on Psychological Science, 3,* 425-453. doi:10.1111/j.1745-6924.2008.00089.x

Creswell, J. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Crombie, G., Pyke, S., Silverthorn, N., Jones, A., & Piccinin, S. (2003). Students' perceptions of their classroom participation and instructor as a function of gender and context. *The Journal of Higher Education, 74*, 41-76.

Cross, K. P. (1981). *Adults as learners: Increasing participation and facilitating learning.* San Francisco, CA: Jossey-Bass.

Damlamian, A., & Straber, R. (2009). ICMI study 20: Educational interfaces between mathematics and industry. *Mathematics Education, 41,* 525-533. doi:10.1007/s11858-009-0194-4

Diamond, J. (2001, July). *Math is in the eye of the beholder*. Paper presented at the Adults Learning Mathematics-7, Medford, MA. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED478896

DiRamio, D., Ackerman, R., & Mitchell, R. (2008). From combat to campus: Voices of student-veterans. *Journal of Student Affairs Research and Practice, 45*, 73-102.

Donaldson, J., & Graham, S. (1999). A model of college outcomes for adults. *Adult Education Quarterly, 50*, 24-40. doi:10.1177/07417139922086894

Donaldson, J., & Townsend, B. (2007). Higher education journals' discourse about adult undergraduate students. *The Journal of Higher Education, 78*, 27-50. doi:10.1353/jhe.2007.0001

Duffin, J., & Simpson, A. (2000). Understanding their thinking: The tension between the cognitive and the affective. In D. Coben, J. O'Donogue & F. FitzSimons (Eds.), *Perpectives on Adults Learning Mathematics* (pp. 83-99). Dordrecht, Netherlands: Kluwer.

Eagan, M., & Jaeger, A. (2008). Closing the gate: Part-time faculty instruction in gatekeeper courses and first-year persistence. *New Directions for Teaching and Learning, 2008*(115), 39-53. doi:10.1002/tl.324

Elliott, J. (1986). *Causal attribution, confidence, perceived usefulness, and mathematics achievement of nontraditional female and male college students* (Doctoral dissertation). Available from Proquest Dissertations and Theses. (UMI No. 8620883)

Elliott, J. (1990). Affect and mathematics achievement of nontraditional college students. *Journal for Research in Mathematics Education, 21*(2), 160-165. doi:10.2307/749143

Ernest, P. (1999). What is social constructivism in the psychology of mathematics education? *Philosophy of Mathematics Education Journal, 12*. Retrieved from http://people.exeter.ac.uk/PErnest/pome12/article8.htm

Faust, D., & Courtenay, B. (2002). Interaction in the intergenerational freshman class: What matters. *Educational Gerontology, 28*, 401-422. doi:10.1080/03601270290081362-2038

Forman, E., & Kraker, M. (1985). The social origins of logic: The contributions of Piaget and Vygotsky. *New Directions for Child and Adolescent Development, 1985*, 23-39. doi:10.1002/cd.23219852904

Fritschner, L. (2000). Inside the undergraduate college classroom: Faculty and students differ on the meaning of student participation. *Journal of Higher Education, 71*, 342-362. doi:10.2307/2649294

Galbraith, M., & Jones, M. (2006). The art and science of teaching developmental mathematics: Building perspective through dialogue. *Journal of Developmental Education, 30*(2), 20-27.

Galligan, L., & Taylor, J. (2008). Adults returning to study mathematics. In H. Forgasz, A. Barkatsas, A. Bishop, B. Clarke, S. Keast, W. Seah, & P. Sullivan (Eds.), *Research in Mathematics Education in Australasia 2004-2007* (pp. 99-118). Rotterdam: Sense.

Gerhardt, J., Vogel, J., & Wu, C. (2006). Why do I have to take calculus? Information Systems Education Journal, 4(65). Retrieved from http://isedu.org/4/65

Goldin, G. (2003). Affect, meta-affect, and mathematical belief structures. In G. Leder, E. Pehkonen, & Torner, G. (Eds.), *Beliefs: A hidden variable in mathematics education* (pp. 37-42). doi:10.1007/0-306-47958-3

Graham, S., Donaldson, J., Kasworm, C., & Dirkx, J. (2000, April). *The experiences of adult undergraduate students: What shapes their learning?* Paper presented at the American Educational Research Association, New Orlean, LA. Retrieved from http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED440275

Graham, S., & Gisi, S. (2000). Adult undergraduate students: What role does college involvement play? *Journal of Student Affairs Research and Practice, 38*, 99-121.

Gregoryk, K., & Eighmy, M. (2009). Interaction among undergraduate students: Does age matter? *College Student Journal, 43*, 1125-1136.

Grootenboer, P., & Hemmings, B. (2007). Mathematics performance and the role played by affective and background factors. *Mathematics Education Research Journal, 19*(3), 3-20.

Gupta, S., Harris, D., Carrier, N., & Caron, P. (2006). Predictors of student success in entry-level mathematics courses. *College Student Journal, 40*, 97-108.

Hagedorn, L., & Kress, A. (2008). Using transcripts in analyses: Directions and opportunities. *New Directions for Community Colleges, 2008*(143), 7-17. doi:10.1002/cc.331

Hall, M., & Ponton, M. (2005). Mathematics self-efficacy of college freshman. *Journal of Developmental Education, 28*(3), 26-32.

Hand, B., Treagust, D., & Vance, K. (1997). Student perceptions of the social constructivist classroom. *Science Education, 81*, 561-575. doi:10.1002/(sici)1098-237x(199709)81:5<561::aid-sce4>3.0.co;2-8

Hansman, C. & Mott, V. (2010) Adult learners. In C. Kasworm, A. Rose, & J. Ross-Gordon (Eds.), *Handbook af adult and continuing education* (pp. 13-24). Los Angeles, CA: Sage.

Herriott, S., & Dunbar, S. (2009). Who takes college algebra? *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies, 19*, 74-87. doi:10.1080/10511970701573441

Horn, L., Cataldi, E., & Sikora, A. (2005). *Waiting to attend college: Undergraduates who delay their postsecondary enrollment*. (NCES 2005-152). Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005152.

Howard, J., & Baird, R. (2000). The consolidation of responsibility and students' definitions of situation in the mixed-age college classroom. *The Journal of Higher Education, 71*, 700-721. doi:10.2307/2649159

Howard, J., & Henney, A. (1998). Student participation and instructor gender in the mixed-age college classroom. *The Journal of Higher Education, 69*, 384-405. doi:10.2307/2649271

Howard, J., Short, L., & Clark, S. (1996). Students' participation in the mixed-age classroom. *Teaching Sociology, 24*, 8-24. doi:10.2307/1318894

Howell, K. (2006). *An examination of the relationship between participation in academic-centered peer interactions and students' achievement and retention in mathematics-based majors* (Doctoral dissertation). Available from Proquest Dissertations and Theses. (UMI No. 3212029)

Hsu, E., Murphy, T., & Treisman, U. (2008). Supporting high achievement in introductory mathematics courses: What we have learned from 30 years of the Emerging Scholars Program. In M. Carlson & C. Rasmussen (Eds.), *Making the connection: Research and teaching in undergraduate mathematics* (pp. 205-227). Washington DC: Mathematical Association of America.

Ishitani, T. (2006). Studying attrition and degree completion behavior among first-generation college students in the United States. *The Journal of Higher Education, 77,* 861-885. doi:10.1353/jhe.2006.0042

Jacobs, F., & Hundley, S. (2010). *Understanding and supporting adult learners: A guide for colleges and universities*. San Francisco, CA: Jossey-Bass.

Johnson, D., Johnson, R., & Smith, K. (1998). Cooperative learning returns to college: What evidence is there that it works? *The Magazine of Higher Learning, 30*(4), 26-35. doi:10.1080/00091389809602629

Justice, E., & Dornan, T. (2001). Metacognitive differences between between traditional-age and nontraditional-age college students. *Adult Education Quarterly, 51*, 236-249.

Karp, D., & Yoels, W. (1976). The college classroom: Some observations on the meanings of student participation. *Sociology and Social Research, 60*, 521-439.

Kasworm, C. (2003). Adult meaning making in the undergraduate classroom. *Adult Education Quarterly, 53*(2), 81-98. doi:10.1177/0741713602238905

Kasworm, C. (2006, June). *Being invisible and a minority: Adult undergraduates in the university classroom*. Paper presented at the Adult Education Research Conference, Minneapolis, MN. Retrieved from http://www.adulterc.org/Proceedings/2006/Proceedings/Kasworm.pdf

Kasworm, C. (2008). Emotional challenges of adult learners in higher education. *New Directions for Adult and Continuing Education, 2008*, 27-34. doi:10.1002/ace.313

Kasworm, C. (2010). Adult learners in a research university: Negotiating undergraduate student identity. *Adult Education Quarterly, 60*, 143-160 doi:10.1177/0741713609336110

Kasworm, C., & Pike, G. (1994). Adult undergraduate students: Evaluating the appropriateness of a traditional model of academic performance. *Research in Higher Education, 35*, 689-710. doi:10.1007/BF02497082

Kasworm, C., Polson, C. J., & Fishback, S. J. (2002). *Responding to adult learners in higher education*. Malabar, FL: Krieger.

Knowles, M., Holton, E., & Swanson, R. (2005). *The adult learner* (6 ed.). San Diego, CA: Elsevier.

Kolajo, E. (2004). From developmental education to graduation: A community college experience. *Community College Journal of kResearch and Practice*, 28, 365-371. doi:10.1080/10668920490424078

Lawrence, B. (1988, October). *Mathematical myths and adult learners*. Paper presented at the Adult Education Conference, Cincinnati, OH.

Le, X. (1997). *An investigation of learning approaches of nontraditional students in mathematics.* (Doctoral dissertation). Available from Proquest Dissertations and Theses. (UMI No. 9719649)

Lehmann, C. (1987, April). *The adult mathmatics learner: Attitudes, expectations, attributions.* Paper presented at the Annual Meeting of the American Educational Research Association, Washington, DC. Retrieved from http://eric.ed.gov.libproxy.txstate.edu/PDFS/ED283680.pdf

Leonelli, E. (1999). Teaching to the math standards with adult learners. *Focus on Basics, 3*. Retrieved from http://www.ncsall.net/?id=348

Lock, A. & Strong, T. (2010). *Social constructionism: Sources and stirring in theory and practice.* Cambridge, England: Cambridge University Press.

Lundberg, C. (2003). The influence of time-limitations, faculty, and peer relationships on adult student learning: A causal model. The Journal of Higher Education, 74, 665-688. doi:10.1353/jhe.2003.0045

Maralani, V. (2011). From GED to college: Age trajectories of nontraditional educational paths. *American Educational Research Journal, 48*, 1058-1090. doi:10.3102/0028312114058366

McCabe, R. (2003). *Yes, we can! A community college guide for developing America's Underprepared*. Phoenix, AZ: League for Innovation in the Community College.

McClenney, K. (2005). Engaging students, challenging the odds. Community College Survey of Student Engagement: 2005 Findings. Retrieved from http://www.ccsse.org/center/resources/docs/publications/CCSSE_reportfinal2005.pdf

McGivney, V. (2004). Understanding persistence in adult learning. J*ournal of Open and Distance Learning, 19*, 33-46. doi:10.1080/0268051042000177836

McLeod, D. (1994). Research on affect and mathematics learning in the JRME: 1970 to the present. *Journal for Research in Mathematics Education, 25*, 637-647. doi:10.2307/749576

Meader, P. (2000). The effects of continuing goal-setting on persistence in a math classroom. *Focus on Basics, 4*. Retrieved from http://www.marshalladulteducation.org/pdf/pdf_files/Persist_math.pdf

Merriam, S. (2001). Andragogy and self-directed learning: Pillars of adult learning theory. *New Directions for Adult and Continuing Education, 2001*(89), 3-14. doi:10.1002/ace.3

Mezirow, J., Darkenwald, G., & Knox, A. (1975). *Last gamble on education: Dynamics of adult basic education*. Washington, DC: Adult Education Association.

Michael, J. (2006). Where's the evidence that active learning works? *Advanced Physiological Education, 30*(4), 159-167. doi:10.1152/advan.00053.2006

Miglietti, C., & Strange, C. (1998). Learning styles, classroom environment preferences, teaching styles, and remedial course outcomes for underprepared adults at a two-year college. *Community College Review, 26*, 1-19. doi:10.1177/009155219802600101

Milesi, C. (2010). Do all roads lead to Rome? Effect of educational trajectories on educational transitions. Research in Social Stratification and Mobility, 28, 23-44. doi:10.1016/j.rssm.2009.12.002

Miller-Reilly, B. (2002). Exploration and modelling in a university mathematics course: Perceptions of adult students. In D. Coben, J. O'Donoghue & G. E. Fitzsimons (Eds.), *Perspectives on Adults Learning Mathematics* (pp. 257-269). Netherlands: Springer.

Miller-Reilly, B. (2006). *Affective change in adult students in second chance mathemtics courses: Three different teaching approaches* (Unpublished doctoral thesis). University of Auckland, Aukland, New Zealand.

National Center for Education Statistics (NCES). (2009). *Digest of Education Statistics, 2008.* Retrieved from http://nces.ed.gov/pubsinfo.asp?pubid=2009020

Neer, M., & Kircher, F. (1989). Apprehensives perception of classroom factors influencing their class participation. *Communication Research Reports, 6*, 70-77. doi:10.1080/08824098909359836

Nolting, P. (2007). *Winning at math: Your guide to learning mathematics through successful study skills*. Bradenton, FL: Academic Success.

Nonesuch, K. (2006). *More complicated than it seems*. Retrieved from: http://www.nald.ca/library/research/morecomp/cover.htm

Palincsar, A. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology, 49*, 345-375. doi:10.1146/annurev.psych.49.1.345

Paulson, K. & Boeke, M. (2006). *Adult learners in the United States: A national profile*. Washington, DC: American Council on Education, Centers for Policy Analysis and Lifelong Learning.

Peters, M., & Kortecamp, K. (2010). Rethinking undergraduate mathematics education: The importance of classroom climate and self-efficacy on mathematics achievement. *Current Issues in Education, 13*(4), 1-33.

Pritchard, A. (2009). *Ways of learning*. New York, NY: Routledge.

Pusser, B., Breneman, D., Gansneder, B., Kohl, K., Levin, J., Milam, J., & Turner, S. (2007). Returning to learning: Adults' success in college is key to America's future. Retrieved from Lumina Foundation for Education website: https://folio.iupui.edu/bitstream/handle/10244/270/ReturntolearningApril2007.pdf?sequence=1

Quinnan, T. (1997). *Adult students "at risk": Culture bias in higher education*. Westport, CT: Bergin & Garvey.

Rau, W., & Heyl, B. (1990). Humanizing the college classroom: Collaborative learning and social organization among students. *Teaching Sociology, 18*, 141-155. doi:10.2307/1318484

Reyes, C. (2010). Success in algebra among community college students. *Community College Journal of Research and Practice, 34*, 256-266. doi:10.1080/10668920802505538

Ross-Gordon, J. (2003). Adult learners in the classroom. *New Directions for Student Services, 2003,* 43-52. doi:10.1002/ss.88

Safford, K. (2002). Algebra for adult students: The student voices. In D. Coben, J. O’Donoghue & G. E. Fitzsimons (Eds.), *Perspectives on Adults Learning Mathematics* (235-255) Mathematics Education Library (21). doi:10.1007/0-306-47221-X_13

Sandmann, L. (2010). Adults in 4-year colleges and universities: Moving from the margin to the mainstream. In C. Kasworm, A. Rose & J. Ross-Gordon (Eds.), *Handbook of adult and continuing education* (pp. 221-230). Los Angeles, CA: Sage.

Saxon, D., Levine-Brown, P., & Boylan, H. (2008). Affective assessment for developmental students, part 1. *Research in Developmental Education, 22*, 1-4.

Schatzel, K,. Callahan, T., Scott, C., & Davis, T. (2011). Reaching the non-traditional stopout population: A segmentation approach. *Journal of Marketing for Higher Education, 21*, 47-60. doi:10.1080/08841241.2011.569590

Schloglmann, W. (2006). Lifelong mathematics learning--A threat or an opportunity? Some remarks on affective conditions in mathematics courses. *Adults Learning Mathematics: An International Journal, 2*, 6-17.

Schoenfeld, A. (2002). Making mathematics work for all children. *Educational Researcher, 31*, 13-25. doi:10.3102/0013189X031001013

Slotnick, H., Pelton, M., Fuller, M., & Tabor, L. (1993). *Adult learners on campus*. Washington, DC: Falmer.

Small, D. (2010). *An urgent call to improve traditional college algebra programs.* Retrieved from: http://www.maa.org/t_and_l/urgent_call.html

Smith, R. (2010). Facilitation and design of learning. In C. Kaworm, A. Rose & J. Ross-Gordon (Eds.), *Handbook of adult and continuing education* (pp. 147-156). Los Angeles, CA: Sage.

Spellman, N. (2007). Enrollment and retention barriers adult students encounter. *Community College Enterprise, 13*, 63-79.

Stinebrickner, R., & Stinebrickner, T. (2003). Understanding educational outcomes of students from low-income families: Evidence from a liberal arts college with a full tuition subsidy program. *The Journal of Human Resources, 38*, 591-617. doi:10.2307/1558769

Stone, C. (2008). Listening to individual voices and stories--the mature-age student experience. *Australian Journal of Adult Learning, 48*, 263-290.

Suresh, R. (2006). The relationship between barrier courses and persistence in engineering. *Journal of College Student Retention: Research, Theory, and Practice, 8*, 215-239. doi:10.2910/3QTU-6EEL-HQHF-XYF0

Swain, J., Baker, E., Holder, D., Newmarch, B., & Coben, D. (2005). *Beyond the daily application: Making numeracy teaching meaningful to adult learners*. Retrieved from: http://www.nrdc.org.uk/publications_details.asp?ID=29

Taniguchi, H., & Kaufman, G. (2005). Degree completion among nontraditional college students. *Social Science Quarterly, 86*, 912-927. doi:10.1111/j.0038-4941.2005.00363.x

Texas Education Agency. (2011a). *State graduation requirements*. Retrieved from http://www.tea.state.tx.us/graduation.aspx

Texas Education Agency. (2011b). *Technical Digest 2010-2011.* Retrieved from http://www.tea.state.ts.us/studentassessment/techdigest/yr1011.aspx

Texas Higher Education Coordinating Board (2011). *College for all Texans--Engagement*. Retrieved from http://www.thecb.state.tx.us/index.cfm?objectid=71E19AE4-0CB7-3F7F-0FBC4FBF4CBDEAD3

Texas State University-San Marcos (2012a). *Undergraduate courses*. Retrieved from http://www.math.txstate.edu/degrees-programs/undergrad/ucourses.html

Texas State University-San Marcos (2012b). *Institutional research fact book.* Retrieved from http://www.ir.txstate.edu/Facts/xfacts.html

Texas State University-San Marcos (2012c). *Department of Mathematics: Undergraduate Courses*. Retrieved from http://www.math.txstate.ude/degrees-programs/undergrad/ucourses.html

Texas State University-San Marcos (2012d). *College of Applied Arts: Bachelor of Applied Arts and Sciences.* Retrieved from http://www.ocid.txstate.edu/undergraduate-degrees/applied-arts-sciences.html

Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition*. Chicago, IL: University of Chicago.

Treisman, U. (1992). Studying students studying calculus: A look at the lives of minority mathematics students in college. *The College Mathematics Journal, 23*, 362-372. doi:10.2307/2686410

Trueman, M., & Hartley, J. (1996). A comparison between the time-management skills and academic performance of mature and traditional-entry university students. *Higher Education, 32*, 199-215. doi:10.1007/BF00138396

Trusty, J., & Niles, S. (2003). High-school math courses and completion of the bachelor's degree. *Professional School Counseling, 7*(2), 99-107.

Ulrich, M. (1988). *A study of adult participation in mathematics courses as a function of mathematics anxiety and other variables* (Doctoral dissertation). Available from Proquest Dissertations and Theses. (UMI No. 8907679)

Van Der Werf, M., & Sabatier, G. (2009). *The college of 2020: Students*. North Hollywood, CA: Chronicle Research Services. Retrieved from http://www.warren-wilson.edu/~adcommittee/Tuition_Study/2020Students.pdf

Walsh, J. (1987). Why is calculus such a hurdle? *Science, New Series, 238,* 749. doi:10.1126/science.238.4828.749

Weaver, R., & Qi, J. (2005). Classroom organization and participation: College students' perceptions. *Journal of Higher Education, 76*, 570-601. doi:10.1353/jhe.2005.0038

Wedege, T., & Evans, J. (2006). Adults' resistance to learning in school versus adults' competence in work: The case of mathematics. *Adults Learning Mathematics: An International Journal*, 1, 28-43.

Zopp, M. (1999). *Math anxiety, the adult student, and the community college* (Doctoral dissertation). Available from Proquest Dissertations and Theses. (UMI No. 9946578)

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