

Cooperative Learning in a Community College Setting:
Developmental Coursework in Mathematics

by

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ABSTRACT

This action research study, set in a community college in the southwestern United States, was designed to investigate the effects of implementing cooperative learning strategies in a developmental mathematics course. Introductory algebra was formerly taught in a lecture based format, and as such regularly had a low course completion rate. To create a more engaging learning environment, formal and informal cooperative learning activities were integrated into the curriculum. Bandura's self-efficacy theory, Vygotsky's constructivist theory, and Deutsch's social interdependence theory guided this study. Qualitative and quantitative data were collected through pre and post self-efficacy surveys, semi-structured student interviews, student journal entries, class observations, focus groups, and pre and post mathematics assessments. Data were analyzed using a mixed methods approach. As a result of implementing cooperative learning practices as a part of my teaching, there was an increase in student attendance as well as a decrease in student withdrawal rates. Students were also more motivated to work with each other on mathematics homework outside of class sessions. There was a strong sense of community that I had not witnessed in previous courses that I have taught. Use of cooperative learning practices served as a vehicle to motivate students to work on their mathematics coursework with their peers.

Keywords: cooperative learning, developmental mathematics, constructivism, social interdependence theory, self-efficacy, community college

DEDICATION

This dissertation is dedicated to my parents. They both valued education and encouraged me to pursue my goals. Their support has helped me throughout my academic career.

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Chapter 1

INTRODUCTION

“In the coming years, jobs requiring at least an associate degree are projected to grow twice as fast as jobs requiring no college experience. We will not fill those jobs – or keep those jobs on our shores – without the training offered by community colleges” (President Barack Obama, July 14, 2009).

Enrollment at community colleges has grown at the national level for a number of years (Mullin & Phillippe, 2011). One reason for this continual enrollment growth is the affordability of community colleges tuition in comparison to four-year academic institutions (Crawford & Jervis, 2011; Fonte, 2011; Zeindenber, 2008; College Board, 2009; Rowh, 2006). Community colleges are regionally accredited two-year academic institutions that award associate degrees as the highest credential (Horn, Nevill, & Griffith, 2006). Community colleges are academic institutions that provide individuals with lower economic means an opportunity to further their education. They prepare students for transferring to universities and offer certificates for entering the workforce. These institutions provide an opportunity for individuals to upgrade current skills and prepare displaced workers for employment (Boggs, 2010).

On July 14, 2009, President Barack Obama introduced the American Graduation Initiative. This financial initiative provides support for individuals interested in attending college as well as financial resources for colleges. According to the President, an additional five million students will earn degrees and certificates by 2020 (Obama, 2009). With the status of the current economy and budget cuts across academic institutions, the attainment of this goal appears questionable. Providing for five million individuals to

complete an education seems unlikely considering that the educational factory model is ineffective.

Linda Darling-Hammond (2010) suggests that the current education system in the United States follows a factory model and that changes must be made in our education system so that knowledge is no longer solely based on basic skills. There is a need for students to interact with course content and each other. The purpose of this action research study is to transform the lecture based learning environment in a developmental algebra class to one that is learner-centered and potentially more meaningful for students. Developmental course credits are not transferrable toward a college degree. Developmental courses are intended to bring students' skills to a level that will enable them to succeed in college level courses. This developmental algebra course includes topics in linear equations.

Learner-centered instruction, also known as student-centered instruction, is the process of guiding students in the construction of their own knowledge (Walczyk & Ramsey, 2003). Instruction that is student centered is effective with adults and students enrolled in developmental courses (Schwartz & Jenkins, 2007). There are seven principles for learner-centered undergraduate instruction according to Chickering and Gamson (1987). Three of the seven principles, (a) interaction between faculty and students, (b) use of active learning strategies and (c) implementation of cooperative learning techniques, were emphasized in this study. This study investigated the effect active learning strategies through the use of cooperative learning had on student efficacy and mathematics learning.

While access to higher education has increased, student completion rates in degree and certificate programs have decreased, especially for community college students (Tinto, 2011). Tinto (2011) proposes that efforts have been made to improve student completion rates at the institution and program levels, but often changes are not implemented at the classroom level. In his words, “Most innovations fail to substantially improve the classroom experience – the one place where students connect with faculty and engage in learning” (p. 2). The more students are academically and socially engaged in classroom activities, the more likely it is that they will be successful in the classroom (Tinto, 2010). Educators must create engaging learning environments that will make mathematics relevant for their students in hopes of increasing completion rates.

To support learning in an engaging classroom environment, social constructivist theory was used to guide my innovation. Social constructivist theory proposes that learning is supported by students’ active involvement in social interactions regarding knowledge, not in the isolation of a lecture format. I argue that students will retain more content through social interaction, thus establishing deeper learning and understanding within my algebra course.

As a college mathematics instructor at a community college in the southwestern United States, part of my teaching assignment is introductory algebra, a developmental mathematics course. Courses in developmental mathematics are for individuals who are not ready for college level coursework and serves as a gateway for mathematics courses at the college level. I have taught at the community college level for 13 years with five years of experience teaching introductory algebra. My teaching has emphasized skills and rote memorization, which may not be preparing students for the future. I taught this way

not knowing an alternative, because I did not take education courses on teaching methods. Research has shown that drill-and-practice methods are not effective for developing higher levels of mathematical thinking. (Darling-Hammond, 2010).

Listening to student comments and observing student behavior over previous semesters has made it clear to me that students considered mathematics irrelevant to their future goals and their lives. They express boredom through body language and many demonstrate no inclination to engage in problem solving or other classroom activities.

The goal for this action research is the implementation of active learning strategies using cooperative learning techniques to promote interest and student involvement in learning. My classroom, which has been primarily lecture based, was transformed into a classroom where students became involved with, and were engaged in, the learning process through the use of informal and formal cooperative learning activities.

The research questions for this study were: (a) How and to what extent does the integration of cooperative learning strategies in a developmental algebra course affect student learning? (b) Will changing from lecture-based instruction to learner-centered cooperative learning activities create an environment that improves student self-efficacy? and (c) What are student perceptions of cooperative learning?

I examined these research questions using a mixed methods approach incorporating pre and post survey instruments, pre and post mathematical knowledge assessments, observations and student interviews to collect relevant data.

Chapter 2

REVIEW OF SUPPORTING SCHOLARSHIP

In this chapter I will present a review of the literature that supports the implementation of cooperative learning in an introductory algebra course; including Bandura's self-efficacy theory, Vygotsky's constructivist theory, and Morton Deutsch's social interdependence theory. Students learning together offers more benefits to student learning through personal and active student engagement in comparison to traditional instruction (Barkley, Cross & Major, 2005). I propose that cooperative learning can increase student learning and student self-efficacy as well as promote successful course completion in developmental mathematics courses.

Cooperative Learning

Active learning with cooperative learning experiences has been recommended as an effective strategy for college level courses. Evidence that cooperative learning is beneficial can be found at Patrick Henry Community College (PHCC) in Martinsville, Virginia. Through collaboration with faculty, PHCC implemented cooperative learning strategies to increase retention among first-year college students. The college emphasized positive interdependence and individual accountability within the cooperative learning program using three strategies (a) base groups, (b) informal groups, and (c) formal cooperative learning groups. (Achieving the Dream, n.d.). Results demonstrated that students were more apt to persist academically if they participated in courses that involved cooperative learning. Ninety-five percent of students who completed at least two courses with cooperative learning strategies continued their studies the second year

compared to 75% of the students enrolled in courses that did not involve cooperative learning (Achieving the Dream, n.d.).

Cooperative learning involves groups of students who work together to accomplish a common goal. Each individual accomplishes their own learning goal only when other members of the group accomplish their own learning goals. (Johnson, Johnson, & Smith, 1991). For a small group to be cooperative, certain components must exist. Cooperative learning groups must have (a) positive interdependence, (b) the promotion of members' learning and successes of members within the group, (c) group accountability among members, (d) the use of interpersonal skills for success and (e) group processing regarding members working together effectively (Johnson, Johnson, & Smith, 1991; Barkley, Cross, & Major, 2005). Research demonstrates that both underprepared and well-prepared students benefit from learning in groups (Barkley, Cross, & Major, 2005). Contrary to individualistic and competitive learning, cooperative learning does not involve success for only one individual; in cooperative learning the entire group achieves success or failure. In competitive learning environments, students work against each other to achieve a goal that not everyone can achieve (Johnson, Johnson & Smith, 1991). I propose that cooperative learning teaching strategies are beneficial in improving the self-efficacy and course completion rates of students enrolled in developmental mathematics courses.

It is important for instructors to monitor and understand the learning environment and experience of students, especially students in developmental mathematics courses. Students enrolled in these courses often lack the mathematical foundation and confidence required to be successful in mathematics. Through the social interdependence in

constructivist cooperative learning groups, students will gain support from peers, thus increasing their self-efficacy.

Theoretical Framework

Theoretical perspectives relevant to my action research are Bandura's self-efficacy theory, Vygotsky's constructivist theory, and Morton Deutsch's social interdependence theory. These theories will inform my use of cooperative learning strategies to offer students an engaging atmosphere for learning, as well as guide the interpretation of results.

Bandura's Self Efficacy

Self-efficacy is a person's perception regarding their ability to complete a task. It is the judgment of a person's aptitude to organize and complete specified types of accomplishments (Bandura, 1997). Self-efficacy is a personal judgment of one's capabilities; not a comparison of self to others (Young, and Ley, 2002). An individual's beliefs in their capability to "organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3) determines success or failure in completing a goal. Self-efficacy beliefs influence motivation by intensifying aspirations and the anticipated results of one's efforts. These beliefs not only affect thought processes, but contribute to the level and persistence of motivation (Bandura, 1997). Waddill and Marquardt refer to Knowles' observation that adults have internal motivators that guide them through the learning process. These motivators include, "self-esteem, better quality of life, self-confidence and self-actualization" (2003, p.408). These motivators may influence the self-efficacy of individuals.

Two interrelated factors that can influence student success in mathematics courses are previous mathematics experience and self-efficacy. The acquisition of mathematical knowledge is correlated with motivation and achievement. (Kim and Keller, 2010). Because mathematical knowledge develops over time, low self-efficacy and the correlated low levels of motivation and persistence, may prevent the development of mathematical knowledge. Students may possess problem-solving skills, but if they do not believe that they can accomplish a task, they will not attempt to problem solve. This suggests that improving self-efficacy is crucial to the successful completion of a course. Basic skills alone will not ensure academic success.

For students enrolled in developmental mathematics courses their personal belief regarding their capabilities related to mathematics is a potential obstacle (Hall & Ponton, 2005). Students accept their lack of success in mathematics and believe that there is nothing they can do to be successful in mathematics courses. Given the importance of self-efficacy to student motivation, it is important for instructors to create a supportive learning environment which has the potential to improve self-efficacy. Creating a positive, active classroom atmosphere is essential to learning and to the increase of student self-efficacy beliefs.

A study conducted by Hall & Ponton (2002), compared self-efficacy of freshman developmental mathematics students to freshman first semester calculus students. Findings indicate that the calculus students had higher self-efficacy compared to the developmental mathematics students. For the purpose of my action research study, I suggest that many students enrolled in developmental mathematics courses tend to have low self-efficacy in regard to mathematics.

One strategy to increase student self-efficacy is the integration of active learning experiences and peer collaboration into classroom sessions. “People do not live their lives in isolation; they work together to produce results they desire” (Bandura, 1997, p. 7). Through the careful design of cooperative learning activities, which will encourage and support positive interdependence among group members, students will benefit from collective knowledge between group members.

In cooperative learning, all members of a team are expected to be responsible for contributing to the attainment of a common goal. “The active learning environment will not flourish if students do not accept responsibility for their own learning and participate in the learning environment in an appropriate way”(Michael & Modell, 2003, p. 63).

“As relationships within the class or college become more positive, absenteeism decreases and students’ commitment to learning, feeling, or personal responsibility to complete the assigned work, willingness to take on difficult tasks, motivation and persistence in working on tasks, satisfaction and morale, willingness to endure pain and frustration to succeed, willingness to defend the college against external criticism or attack, willingness to listen and to be influenced by peers, commitment to peers’ success and growth and productivity and achievement can be expected to increase” (Johnson, Johnson, & Smith, 1991, p. 43).

The sense of community that can develop as a result of participating in cooperative learning experiences can decrease the likelihood of withdrawal from the course due to academic reasons. Hall & Ponton (2005) indicate that an increase in mathematics self-efficacy results from positive experiences, whereas decreased self-efficacy results from

negative experiences. In order to assist students in improving their perception of their actual ability, educators must acknowledge factors that are necessary for students to be successful in mathematics as well as college.

Research shows that there are specific strategies that can assist in the improvement of self-efficacy in students; these strategies include, planning tasks that are moderately challenging, using peer models, and teaching specific learning strategies (Margolis & McCabe, 2006). By providing moderately challenging tasks students may be more apt to work together to accomplish a goal. Through cooperative learning groups, students are more likely to demonstrate problem solving models amongst peers. With students involved in peer modeling during problem solving activities, there is opportunity for growth in self-efficacy. Those offering peer instruction as well as those asking questions of their peers regarding specific problem solving strategies can promote growth in mathematics knowledge and self-efficacy. Self-efficacy in a mathematics classroom may be improved by encouraging students within their cooperative groups to attempt a problem solving strategy, stressing recent successes among members of the group, and providing frequent and focused feedback on specific activities on an individual and group level.

Vygotsky's Constructivist Theory

Vygotsky proposed that individuals create knowledge through social interaction and engagement encountered through activity and dialogue about a shared task or problem (Driver, et al., 1994). Social constructivism proposes that ideas are constructed through student-teacher and student-student interactions (Powell & Kalina, 2009).

According to constructivist theory, "learning is an active contextualized process

of constructing knowledge rather than acquiring it” (“Constructivism,” 2010). Lecture-based practices that dispense information to students do not stimulate the construction of knowledge nor take into account the prior knowledge of the learner. According to the tenets of constructivist theory, the learner creates new knowledge through consideration of their prior knowledge in a given situation (Powell & Kalina, 2009; Merriam, Caffarella, & Baumgartner, 2007). Meaning is constructed by creating multiple associations between current and newly acquired information (Michael, 2006).

Constructivism deems it imperative for students to assume an active role in their own learning; this is essential for deep, long lasting learning that is also enjoyable and transferable outside of the classroom (Walczyk & Ramsey, 2003). Six principles describe learning with a constructivist viewpoint: (1) Material being learned is important to students. (2) Students have a deep level of interaction with content. (3) Students must be able to relate new information to what they already know. (4) Students must continuously update understanding as a result of new experiences. (5) New learning does not automatically transfer to new contexts to which it is relevant. (6) Students become independent learners if they are aware of the process of learning (Walczyk & Ramsey, 2003). It is important for instructors to understand how to embrace the knowledge students bring to the classroom in order to enrich the learning environment. Each student contributes personal experiences and prior knowledge to an academic setting. Cooperative learning activities will be designed to include all six principles in each activity.

The construction of new mathematical knowledge can be understood, and facilitated, through Vygotsky’s Zone of Proximal Development (ZPD). In the words of

Vygotsky (1978) (the ZPD is) “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 (p 86).” The ZPD involves the amount of problem solving accomplished by an individual and what can be accomplished as a result of guidance from another individual (Rieber & Robinson, 2004). The ZPD is dependent upon the social interaction between individuals who are more experienced and those who are less experienced (Doolittle, 1997). “Exposing all students to concepts and understandings that are within their ability to grasp, but not yet part of their personal understanding, enables each to learn from other students those concepts that are just beyond their current level of development” (Barkley, Cross, & Major, 2002, p. 14). Maximizing the potential of the ZPD relies on complete social interaction; through guidance by peer relationships, the development of skills is greater than what is achieved alone (Fani & Farid, 2011).

Vygotsky’s views indicate that people have two levels of learning, social and internal (Rieber & Robinson, 2004; Doolittle, 1995; Doolittle, 1997). Mental functions as described by Vygotsky, include higher and lower levels. Lower mental functions are internal; examples of this type of mental function involve perceptions and involuntary attention. Examples of higher mental functions include language, problem solving skills, and voluntary attention (Doolittle, 1995). Through the use of cooperative learning groups, the two levels of learning are can be utilized. Internalization occurs when an individual first encounters a concept, behavior or attitude in a social environment with the social experience resulting in part of the person’s knowledge (Doolittle, 1997). Group members bring their existing knowledge (internal) and construct new knowledge based on social

interactions with other group members. Vygotsky emphasized the need for social interaction in learning. Social interaction between less experienced and more experienced students is an important factor of the ZPD (Doolittle, 1997).

Good cooperative learning practices promote the possibility of engagement among students; such practices include intentional and significant exchanges of ideas that are an essential form of constructivism (Vermette & Foote, 2001). The exchange of ideas among students allows for a greater perspective on course content. Different perspectives on content may provide novel and stimulating learning opportunities for a student (Powell & Kalina, 2009). Through a collection of perspectives, students are able to increase their content knowledge base in comparison to acquiring a limited view when working alone.

Social Interdependence Theory

Social interdependence, the basis of cooperative learning, is a theory that describes how individuals are affected by one another's actions. For example, social interdependence is present when the goal achievement of a particular individual influences the goal achievement of another (Johnson & Johnson, 2005). This type of dynamic determines the success or failure of goal achievement.

There have been several theorists who have made contributions to the theory of social interdependence. Gestalt psychologist Kurt Koffka first noted the dynamics of group interdependence in the early 1900's, which was refined by Kurt Lewin (Morgan, Rosenberg, & Wells, 2010). Morton Deutsch later expanded Kurt Lewin's philosophy of interdependence among group members and he was the first to articulate social

interdependence theory during the 1940s and make distinctions between interdependence types (Johnson, Johnson, & Smith, 1991).

Social interdependence is a characteristic existing in cooperative learning experiences and is an essential component in any cooperative learning activity. Cooperative learning has not only been one of the most successful teaching strategies for the past 60 years, but is commonly used internationally in various academic institutions ranging from preschool to adult education. (Johnson, & Johnson, 2005). Substantial evidence exists that indicates that cooperative efforts cultivate greater determination to achieve, more encouraging relationships, and better psychological health than individualistic or competitive efforts (Johnson, 2003).

Social interdependence is present when the actions of individuals and others affect outcomes; either positive or negative social interdependence exists within cooperative groups. Through positive interdependence, individual actions yield the achievement of group goals; negative interdependence prevents the achievement of group goals. Those with positive goal interdependence gain higher achievement than those who work alone and have the opportunity to interact with others (Johnson & Johnson, 2005). Students enrolled in developmental mathematics courses will benefit from positive interdependence because promotive interaction can be achieved. Examples of promotive interaction are encouragement and assistance among group members to complete tasks in order to achieve a group goal (Johnson, Johnson, & Smith, 1991).

These theories are essential in promoting meaningful learning in a classroom that involves cooperative learning. Through a positive cooperative learning experience,

students will ultimately improve their mathematics self-efficacy, and encourage self-regulated learning, thus reducing the likelihood of withdrawing from class.

My innovation is transforming my teaching in developmental mathematics courses from lecture based to a learner-centered environment. Through personal observations as an instructor I have come to realize that if students are not intellectually stimulated, they will not actively participate in their learning. “Learner-centered approaches to science and mathematics instruction assume that only when students are active participants will learning be deep, enduring and enjoyable, and transfer to contexts beyond the classroom” (Walczyk & Ramsey, 2003, p. 566). The authors also suggest that learner-centered practices are not commonly used in college classrooms. I intend to integrate learner-centered cooperative learning activities in my instruction with the intention of making mathematics meaningful and having students retain content in long-term memory.

As a college instructor, it is important for me to establish a more rewarding learning environment so that students will attend class on a regular basis, have an enjoyable learning experience, gain meaningful learning and establish a good foundation in the course content. As an instructor, I believe it necessary for me to empower students by showing them how they can remain in control of their own learning and also work with others. Having the social skill of collaborating with peers will assist students in their future employment. Employees with a strong foundation in problem-solving, critical thinking, math skills and the aptitude to work well in teams have a greater likelihood of success.

Chapter 3

METHOD

Setting and Participants

The study occurred during the fall 2012 semester at a community college in the southwestern United States. The participants were diverse in age, ethnicity and educational background. The community college is a designated Hispanic Serving Institution (HSI). According to the Hispanic Association of Colleges and Universities (HACU), a HSI is defined as an academic institution with a minimum of 25% Hispanic enrollment that includes both full-time and part-time students. During the spring semester of 2010, enrollment was 7,269 with 34% Hispanic, 10% African American, 5% Asian, 1% American Indian, 40% White and 10% students identified as Other.

The participants were 22 out of 30 students enrolled in a sixteen-week introductory algebra course. Although all thirty students enrolled in the course participated in the activities related to the innovation, data presented represents only 20 who agreed to participate in the study and were present during pre and post data collection. The course was scheduled twice a week for one hour and forty minutes. The age distribution of the participants was split with fifty percent of the participants between the ages of 15 and 24 and the remaining half older than 24 years of age. Gender was predominantly female with 77.3 percent female and 22.7 percent male. Five different ethnic categories were identified with 9.1 percent American Indian, 9.1 percent Black, 40.9 percent Hispanic, 27.3 percent White and 13.6 percent other. Participants had various academic backgrounds ranging from recent high school graduates to those who have been away from an academic environment for more than one year.

Initially, students in the course were randomly divided into eight groups. Six of the groups had four members and two groups had three members. During the semester, the groups were re-arranged twice into heterogeneous groups based on ethnicity, gender and mathematical ability in order for students to have the opportunity to interact with other members of the class.

Data Collection Instruments.

A mixed methods approach was used for this action research study. Through mixed methods, a better understanding of the research environment was achieved in comparison to strictly using only one research method (Greene, 2007; Leech & Ownegbuzie, 2007). Quantitative and qualitative data were collected and analyzed for the purposes of triangulation. Through triangulation, the goal of multiple methods is to reach convergence, corroboration or correspondence when analyzing data (Greene, 2007).

Two quantitative instruments and four qualitative data collection methods were used. The quantitative instruments were the Mathematics Content Assessment and the Self-Efficacy Survey. The four qualitative instruments were Math Reflections, Student Interviews, Focus Groups and one Observation. These instruments were integrated in a sequential design; data collection instruments and methods were implemented in the study individually at specific points in time (Greene, 2007). The instruments and a description of the data collection plan follow.

Mathematics Content Assessment

To measure mathematics learning 15 multiple-choice items were used to assess students' algebraic knowledge (See Appendix A). Items for this assessment were taken from Martin-Gay's, *Beginning & Intermediate Algebra, 4th edition* (2009), which is the

textbook for the course. The items were scored 1 = correct answer and 0 = incorrect answer, with one correct answer available out of four possible choices. The items measured eight course competencies: (a) solving two-step equations, (b) solving equations with variables on both sides of the equation, (c) solving multi-step equations involving the distributive property, (d) solving ordered pair solutions, (e) graphing linear equations, (f) calculating slope (g) finding the equation of the line and (h) solving problems modeled by a system of two linear equations. This assessment was administered twice during the semester in the first and last class periods. Descriptive statistics were computed and paired samples t-test were conducted to note possible growth in algebraic learning from pre to post assessments.

Self-Efficacy Survey

To measure student self-efficacy, 20 items adapted from the Mathematics Motivated Strategies for Learning Questionnaire (MMSLQ) were used (Liu & Lin, 2010). The items were rated using a five point Likert scale from 1 = Strongly Disagree to 5 = Strongly Agree. The survey measured four constructs: (a) self-efficacy, (b) self-regulation, (c) peer learning and (d) help seeking. In addition, nine items for demographic classification were included. This survey was administered twice during the semester during the third and last class periods. Descriptive statistics and a correlation matrix will be presented. Paired samples t-tests were conducted to note possible growth on each of the constructs from pre to post. The complete survey is provided in Appendix B.

Math Reflections

To measure student self-efficacy and attitudes toward mathematics, participants completed two reflective mathematics journal entries (See Appendix C). The first journal entry was assigned as homework after the second class meeting. Participants wrote both their mathematics autobiography and a description of their most recent math experience. The goal of this journal entry was to gather information regarding previous mathematics classroom pedagogy, current attitude towards mathematics, and self-reflection of mathematical ability.

The second journal entry was assigned as homework during the last week of the semester. This entry included information regarding current mathematical experience, attitude towards mathematics and self-reflection on mathematical ability. The purpose of the pre and post math reflections was to note any changes in attitudes and mathematics self-efficacy during the semester. Journal entries were analyzed. Grounded Theory was used to determine themes and warranted assertions (Strauss & Corbin, 1998). While coding, themes emerged. The journal entries were read for a general impression on contents of responses. A second reading was completed to note words describing attitudes toward mathematics as well as mathematical ability; these words were highlighted in order to note any patterns within the data. Words were then arranged in categories. The categories were reviewed and rearranged in order to identify themes. Through the comparison of themes, assertions were identified that provided information that answered my research questions.

Student Interviews

Three students were interviewed at the end of the semester to capture student reactions to cooperative learning groups, perceptions of mathematics problem solving ability and help seeking strategies. These three were selected on the basis of academic grades with the selection of one high achieving student, one average student and one lower achieving student. The purpose of selecting students at different levels was to determine whether different themes would arise depending on achievement level. Interviews were analyzed using qualitative measures. Student responses were coded using grounded theory.

Each interview was audio recorded and transcribed. Interviews were listened to three times in order to ensure accuracy of statements. Transcriptions were read for each interview to compile specific statements that were related to each other. Each statement was coded with a word or phrase related to a category. Once statements were in specific categories, all statements were read again and collapsing of categories occurred for those statements that could be combined into a single category. The categories became themes and warranted assertions were determined by supporting statements. Student interview questions are provided in Appendix D.

Focus Group

Twelve students were selected randomly to participate in two separate focus groups at the end of the semester. Due to scheduling conflicts, only nine students participated. Students were selected on the basis of high and low academic ability; one focus group contained five students and the other focus group contained four students. Students responded to prompts regarding their experiences in the course. Focus group

prompts relating to experience working in cooperative groups, impact on learning and help seeking strategies were discussed with participants. External facilitators conducted the focus groups in order to ensure student anonymity. The focus group facilitators were English faculty members. The services of facilitators provided a safe environment for students. Participating in a safe environment allows students to be comfortable speaking honestly regarding their opinions of the course. Focus group sessions were audio taped and had an external recorder write down student responses for data collection purposes. Focus group responses were analyzed through qualitative measures. Student responses were reviewed and coded using grounded theory. Student focus group questions are provided in Appendix E.

Observation

One classroom observation was videotaped to observe student to student interaction in cooperative learning groups. Only students who agreed to participate in the study were included in the video. The purpose of the observation was to note whether students demonstrate the five elements of cooperative learning groups as indicated by Johnson & Johnson (1999). The observation allowed me to record student behavior and compare the level of student class participation to behavior demonstrated at the beginning of the semester. Beginning semester student behaviors were recorded as personal notes through self-reflective journal entries. The classroom observation took place during the eighth week of the semester as a mid-semester check. The observation was performed to note whether any changes were needed in the structure of cooperative learning activities.

The classroom observation instrument was a mixed methods data collection tool; qualitative and quantitative data were captured through observer notes as well as

documented frequencies of the five cooperative learning elements. Through observations, student frequency of the five elements of cooperative learning was recorded. Two external observers with experience in cooperative learning strategies viewed the videotapes individually and recorded individual student behavior in five minute intervals using the observation instrument. The observers were experienced in implementing cooperative learning techniques in their own teaching. The purpose for external observers was to validate the study through the use of inter-rater reliability and to control for experimenter bias. A post-observation meeting was held with the observers in order to discuss their impressions of the cooperative learning activity as well as student behaviors. The instrument has been adapted from The Cooperative Learning Observation Protocol created by Kern, Moore, and Akillioglu (2007). The observation was analyzed using quantitative and qualitative methods. The cooperative learning observation guide (CLOG) is provided in Appendix F.

For all data collection instruments, student confidentiality was ensured through student generated identification numbers. Students were instructed to create their own ID by using the first three letters of their mother's first name and first two numbers of their home address.

Innovation

The innovation of integrating active learning strategies through cooperative learning techniques during a sixteen-week semester was the focus of my action research. At the beginning of the semester, students were randomly assigned base groups. A base group was a group of participants that were seated together for five weeks. Each base group developed ground rules for members' expectations. Expectations from each group

were shared with the entire class and general rules of group behavior were established. After the second exam, students were assigned heterogeneous groups according to mathematical achievement in the course with a mixture of high achievers with low achievers. There was one low achiever in each group. Groups were also created to ensure diversity between gender and ethnicity.

At the beginning of each class session, students were asked to complete their Member Grid for their base group. The grid contained every member's name and a specific question for the day. Questions selected were intended to have a positive response and serve as an ice-breaker for every member in the group. The purpose of completing the Member Grid was for students to become familiar with members of their base group and to have students communicate with each other. This was also a mechanism to help create a foundation of trust between group members. What was also useful about the Member Grid was that it gave me an opportunity as the instructor to get to know something about each student. At times students would not speak much until I came around and asked them questions about their response. I would also talk about commonalities between members at the table and this usually caused students to interact with each other a little more. By midterm, students were very comfortable when talking to each other and often asked me what the question of the day was when I forgot.

During a typical class session, a brief lecture segment as well as various formal and informal cooperative activities were implemented. A lecture segment consisted of a five to ten minute lecture regarding information on a particular topic. Information covered included definitions of key terms, modeling examples, and applications. After the lecture segment, students participated in activities in informal and formal cooperative

groups. One example of an informal cooperative group is participating in paired discussions with a member at their table or a randomly assigned individual; this type of activity is known as think-pair-share. Students also participated in formal cooperative groups during the class period. Formal cooperative groups involved student roles to ensure accountability from each group member. One example of a formal cooperative group is a jigsaw. A jigsaw activity requires each member of a group to be an expert in a specific area. Each expert is responsible for explaining their concept to others in their base group. A jigsaw activity that was used on the first day of class was the syllabus jigsaw. In this activity, each group member had a particular section of the syllabus; everyone who had the same page sat together and answered questions regarding that particular section of the syllabus. Once individuals worked with others on their section, they returned to their base groups and taught syllabus content to others.

After students worked with one another in their groups, I facilitated a focused class discussion on the content. The purpose of the class discussion was to note student understanding regarding the content they experienced. This also gave students the opportunity to ask questions and discover any misconceptions regarding content. Throughout the semester cooperative activities as designed by Johnson and Johnson (1999) were incorporated into the course.

In addition to group accountability during a class session, individual student accountability was reflected on homework assignments, quizzes, exams and individual responses to questions when working with members of their group.

Data Collection

As noted previously, two quantitative instruments and four qualitative data collection methods were used to collect data. Data were collected sequentially throughout the semester. Math reflections, self-efficacy surveys, student interviews and pre and post assessments on math content were administered on an individual basis. Observations and focus group participation were administered on a group basis. Responses to qualitative data collection methods such as interviews, journal entries, and observations were recorded, transcribed, coded and analyzed using open and axial coding. Responses to quantitative instruments were coded and analyzed using SPSS.

Research Questions and Evaluation Methods

Figure 1 shows the evaluation methods that were used to answer my research questions. The various data collection tools and methods assisted in validating my study.

Research Questions	Evaluation Methods
How and to what extent does the integration of cooperative learning strategies in a developmental algebra course affect student learning?	Mathematics Autobiography Pre/Post Self-Efficacy Survey Pre/Post Algebraic Content Assessment Classroom Observation Student Interviews Student Focus Groups Student Reflection Journal Entry
Will changing from lecture-based instruction to learner-centered cooperative learning activities create an environment that will improve student self-efficacy?	Pre/Post Self-Efficacy Survey Student Interviews Student Focus Groups
What are student perceptions of cooperative learning?	Student Interviews Student Focus Groups Student Reflection Journal Entry

Figure 1. Questions and Evaluation

The implementation of pre and post self-efficacy surveys, pre and post algebra assessments, student semi-structured interviews, student journal entries, classroom observations, and student focus groups occurred at specific points throughout the semester.

Study Timetable

Quantitative and qualitative data were collected at multiple times during this action research study. Figure 2 shows the data collection timetable for the study.

Date	Action
August 21, 2012	Distribution of Call for Participation Letter as required by IRB
August 23, 2012	Administration of the Self-efficacy Survey-Pre
August 23, 2012	Autobiography Journal Reflection Assigned
August 28, 2012	Assignment of randomized student base groups
August 28, 2012	Pre-test algebra content administered
September 20, 2012	Assignment of student base groups according to academic ability
October 5, 2012	Training of external observers on CLOG
October 18, 2012	Video recording of classroom observation
October 26, 2012- November 2, 2012	External observers watch classroom observation videotape and record responses using observation instrument
November 1, 2012	Reassignment of student base groups according to academic ability
November 12, 2012- November 16, 2012	Conduct Student Interviews Train external student focus group facilitators
November 26, 2012- November 28, 2012	Conduct Student Focus Groups
November 27, 2012	Collect Student mathematics journal reflection
December 4, 2012	Administer Self-efficacy survey Post
December 13, 2012	Administer Post-test algebra content

Figure 2. Study Timetable

Note: informal and formal cooperative learning activities were implemented throughout the semester.

Students completed the self-efficacy survey on August 23, 2012. That same day, students were assigned a mathematics autobiography that was submitted during the following class meeting.

On August 28th, students completed a pre-assessment on algebraic content and students were randomly assigned to base groups. These groups remained intact for five weeks. Analyses for quantitative and qualitative data collected through survey responses, pre-assessment results, and the mathematics autobiography were conducted between August 31, 2012 and September 14, 2012.

After the first unit exam, students were assigned new base groups according to coursework scores on September 20, 2012. Heterogeneous groups consisted of students of different ethnic backgrounds, gender, age and academic ability. To ensure inter-rater reliability, two external observers were trained on the CLOG October 5, 2012. Video footage was collected on a typical classroom session on October 18, 2012. Observers reviewed a classroom observation video and recorded their impressions using the CLOG; observers viewed the video at their convenience between October 26, 2012 and November 2, 2012. Data collected using the CLOG was analyzed using open and axial coding between November 5, 2012 and November 23, 2012.

On November 1, 2012, students were assigned to new base groups after their second unit exam. Students were grouped according to the same procedure delineated for the first group rotation.

Between November 12, 2012 and November 16, 2012, semi-structured student interviews were conducted as well as the training of two external student focus group facilitators. The purpose of training the focus group facilitators was to control for the

threat of experimenter bias. The facilitators each lead a separate focus group between November 26, 2012 and November 28, 2012.

On November 27, 2012 a student reflective journal entry was assigned as homework. The journal entry collected qualitative data regarding student opinions regarding their cooperative learning experience during the semester.

On December 4, 2012 and December 14, 2012 data were collected through post-surveys and post-assessments. This data were analyzed between December 17, 2012 and January 3, 2013.

Data Analysis

Quantitative Data Analysis. Quantitative data were analyzed by comparing pre and post self-efficacy results and pre and post assessment results on mathematics content. Construct scores for self-efficacy, self-regulation, peer learning and help seeking were computed on the self-efficacy survey as the mean of responses to the items targeting the construct. As a reliability measure, Cronbach's alpha was calculated for each construct and the entire survey. Paired-sample t-tests pre to post were conducted to determine the effect on the innovation on each of the constructs.

The mathematics assessment means were compared to examine changes in learning content. The content assessment measured eight course competencies: (a) solving two-step equations, (b) solving equations with variables on both sides of the equation, (c) solving multi-step equations involving the distributive property, (d) solving ordered pair solutions, (e) graphing linear equations, (f) calculating slope (g) finding the equation of the line and (h) solving problems modeled by a system of two linear equations. Content area scores were computed as the total number of items in each

content area that were scored as correct. Paired-sample t-tests pre to post were conducted to determine the effect on the innovation on each of the competencies.

Qualitative Data Analysis.

The constant comparative method (Strauss & Corbin, 1998) was used to analyze the qualitative data; including responses to interviews, mathematical reflections, focus group notes and observation notes. Through the constant comparative method, open and axial coding was employed to identify themes. Once themes were determined, categories were created that represent phenomena related to the data. Once categories were created, quotes from interviews, mathematical reflections and the focus group were used to support themes. Theme-related components were established and the themes emerged from the data. Components were reviewed repeatedly until reaching saturation. After reviewing themes and theme-related components, assertions were established. Dedoose, an online qualitative analysis software program was used to facilitate this process. These qualitative data were used to support and complement the quantitative data results acquired.

Role of Researcher

My role as the researcher was as a participant-observer. I was a participant since I was integrating the innovation into my course. I was an observer since I was present during interviews and through daily observations of student behavior. My role as researcher had a major role as I analyzed the data collected during the study.

Literature regarding cooperative groups in college classrooms indicates that learning may be enhanced with students being better prepared for the workforce. Through cooperative learning, higher achievement is attained and more positive

relationships are created in comparison to individualistic learning environments (Johnson, Johnson, & Smith, 1991). The current action research study was conducted to determine answers to the research questions above.

Threats to Validity

There were three threats to validity in my action research study; these threats were (a) history, (b) testing and (c) experimenter effect. A description of how each of these threats was accounted for is presented below.

History

History may impact my study by students that may be repeating the course. Students who have completed higher level mathematics in high school may perform poorly on the placement exam due to lack of test preparation. These students may not want to retest and may remain in the course. These students already understand the material thus posing a threat to validity. To control for this threat, a question on the self-efficacy survey will be included to identify students that have been previously exposed to course content.

Testing

Testing may impact my study since a pre and post-test will be administered during the course. The pre-test may impact post-test results since students may practice test taking strategies. This threat was accounted for by rearranging the order of questions and number values in mathematical problems.

Experimenter Effect

Due to my interest that students excel in my course, experimenter effect was a threat to validity. To adjust for this threat, I maintained professionalism, and made a conscious effort not to have personal bias with respect to students participating in my study.

Chapter 4

RESULTS AND FINDINGS

This chapter presents results from the analyses of both the quantitative and qualitative data collected for the study. The first section presents the results of the analysis of the quantitative data (pre and post self-efficacy surveys and pre and post algebraic content assessments). The second section presents the findings of the analysis of the qualitative data (journal entries, focus group discussions and interviews). Review and analysis of these data sources provided insight in answering the research questions: (a) How and to what extent does the integration of cooperative learning strategies in a developmental algebra course affect student learning? (b) Will changing from lecture-based instruction to learner-centered cooperative learning activities create an environment that improves student self-efficacy? and (c) What are student perceptions of cooperative learning? Quantitative results for the self-efficacy survey are in Table 1.

Table 1

Pre/post Survey Constructs, Items, Paired Samples t-test, Means and Standard Deviations

Construct	<i>T</i>	Average Difference	<i>p</i>	Pre		Post	
				<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Self-Efficacy 1, 5, 9, 13 and 17	-2.881	-0.409	0.009*	2.72	0.47	3.00	0.53
Self-Regulation 2, 6, 10 and 14	0.289	0.034	0.775	4.08	0.16	4.05	0.32
Peer Learning 3, 7, 11, 15 and 18	-2.100	-.382	0.048*	3.44	0.50	3.82	0.25
Help Seeking 4, 8, 12, 16, 19 and 20	-0.584	-0.061	0.565	4.11	0.33	4.06	0.24

n =20

*Significant $p < 0.05$

Quantitative Results

Self-Efficacy Survey. The survey, administered pre and post, measured four constructs: (a) self-efficacy for doing math, (b) self-regulation for learning, (c) peer learning and (d) help seeking. Survey questions were formatted with a 5-point Likert-Scale with 5 indicating strong agreement and 1 indicating strong disagreement. The purpose of the survey was to measure potential changes in students' perceptions of the constructs as a result of the implementation of cooperative learning. The pre-survey was administered during the second class meeting of the semester in August 2012, prior to implementation of the innovation. The post survey was administered in November 2012 on the last day of the semester, the last day of the innovation.

Survey Reliability. To determine the reliability of the overall survey and the four constructs, Cronbach Alphas (Cronbach, 1951) were calculated for the posttest results using the Statistical Package of Social Sciences (SPSS 20). The overall survey had a reliability of 0.70, which meets the generally accepted value of 0.70 or higher to be considered valid (Cronbach, 1951). Three of the four constructs met the 0.70 standard, self-regulation ($\alpha = 0.71$), peer-learning ($\alpha = 0.86$), and help-seeking ($\alpha = 0.71$). The construct self-efficacy ($\alpha = 0.66$) did not prove reliable.

Self-Efficacy for Math Results:

Paired samples t-tests at $\alpha = .05$ were conducted to compare pre and post mean scores of the four constructs included in the survey. Self-efficacy had a significant improvement with $t(19) = -2.881$, $p = .009$. Table 1 displays t-test results for pre and post survey constructs. Prior to the use of cooperative learning groups, students tended to disagree that they had strong mathematical ability ($M = 2.71$, $SD = 0.47$). After exposure to cooperative learning groups, student attitudes increased slightly in their perceptions of their mathematical ability ($M = 3.00$, $SD = 0.53$).

The self-regulation construct measured student attitudes regarding the ability to be in control of their own learning by investigating challenges they may have with course content. Self-regulation was not significant with $t(19) = 0.289$, $p = 0.775$. This construct was comprised of four items. Prior to my innovation, students would independently resolve their challenges on their own ($M = 4.08$, $SD = 0.16$). After the innovation there was no significant difference in student attitudes ($M = 4.05$, $SD = 0.32$).

The peer-learning construct included five items. This construct measured student attitudes regarding working with other students on course content. Peer-learning

demonstrated a significant difference with $t(19) = -2.100$, $p = .048$. Prior to use of cooperative learning techniques, students indicated they worked with others on coursework ($M = 3.44$, $SD = 0.50$). After exposure to cooperative learning techniques, students indicated a slightly stronger participation in working with classmates on coursework ($M = 3.82$, $SD = 0.25$).

The construct of help-seeking had six items. This construct measured student attitudes regarding help-seeking strategies related to coursework and course content. Help-seeking was not significant with $t(19) = -0.584$, $p = 0.565$. Before the innovation, students indicated that they asked for help when working on course content ($M=4.11$, $SD = 0.33$). After the innovation, student responses demonstrated little change in help-seeking attitudes ($M = 4.06$, $SD = 0.24$). The following table contains the means and standard the results by each construct pre and post survey mean scores with the pre and post standard deviation.

Statistical results for the content test including paired samples t-tests, means and standard deviations are presented in Table 2.

Table 2

Pre/post Content Paired Sample t-test, Means and Standard Deviations

Content Area	<i>t</i>	Average Difference	<i>p</i>	Pre		Post	
				<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Solving for Variables	-9.200	-2.450	0.000*	3.95	1.43	6.40	1.05
Graphing	-4.292	-0.800	0.000*	0.35	0.59	1.15	0.81
Determining Slope	-4.292	-0.800	0.000*	0.90	0.55	1.70	0.66
Equations of Lines	-3.040	-0.600	0.007*	0.60	0.60	1.20	0.52
Systems of Equations	-0.567	-0.100	0.577	1.15	0.75	1.25	0.85
Overall Test Score				6.95	2.03	11.70	2.38

n =20*Significant $p < 0.01$

Content Test. The Content Test administered pre and post measured student understanding of the algebraic content of the course. There were a total of 15 possible points addressing five different content areas: (a) solving for variables (7 points), (b) graphing linear equations (2 points), (c) determining slope (2 points), (d) determining the equation of a line (2 points) and (e) solving systems of linear equations (2 points). A paired sample t-test at $\alpha = .05$ was conducted to compare whether improvement in algebraic knowledge occurred after the use of cooperative learning strategies. A significant difference was noted between pre and post test scores with $t(19) = -8.606$,

$p < .01$. The mean pre test score was 6.95 with a standard deviation of 2.03 in comparison to the mean post test score of 11.70 with a standard deviation of 2.38. The mean score increased from 46 percent to 73 percent. Paired samples t-tests were conducted to compare the five different content areas of the test. Four of the content areas demonstrated a significant difference between pre and post results. Solving systems of equations did not have a significant difference between pre and post results with $t(19) = -0.567, p = 0.577$.

Observation Results. Information obtained from external observers was recorded using the Cooperative Learning Observation Guide. The focus of the cooperative learning skills for the lesson being observed was positive interdependence and face to face promotive interaction. Results included 100% student participation in both areas. Types of behaviors noted were those of student discussions, collecting data, recording data and collecting data. One observer noted hearing a student tell another student that they needed to complete their part before the group continued with the lesson. This is an example of positive interdependence. Results obtained from observations may be suspect since it is unlikely for 100% engagement all of the time. Observation results will not be included in the data analysis.

Qualitative Findings

Themes and assertions emerged from qualitative data collected from journal entries, interviews and focus groups. Table 3 displays the themes, theme-related components, and assertions.

Table 3.

Themes, Theme-related Components, and Assertions

Themes	Theme-Related Components	Assertions
Returning Students' Anxiety	<p>Students were anxious about returning to school after an absence of several years.</p> <p>Students who were away from school for several years expressed low self-confidence and insecurity.</p> <p>Students who had been in school acknowledged classmates who had been out of school for years.</p>	<p>Students returning to school face unique challenges including insecurity and low self-esteem.</p>
Help Seeking Strategies	<p>Prior to participating in cooperative groups students sought help by asking questions in class and by going to tutoring.</p> <p>After being exposed to cooperative learning students searched for resources in order to complete their homework or supplement their learning.</p> <p>After being exposed to cooperative learning, students mentioned helpful classmates not only at their table but also everyone in class.</p>	<p>Student help-seeking strategies were broadened as a result of cooperative learning.</p>

(table continues)

Themes	Theme-Related Components	Assertions
Communication	<p>Students met outside of class once they began communicating with each other.</p> <p>Students would contact their peers first before contacting their instructor.</p> <p>All students became involved in class even if they had been shy.</p>	<p>Communication through cooperative learning activities creates safe learning environment and positive student interactions that go beyond the classroom.</p>
Student perceptions of math	<p>Students went from disliking math to enjoying the subject.</p> <p>Confidence was gained in mathematics.</p> <p>Students liked math at the end of the semester compared to disliking math at the beginning of the semester.</p>	<p>Participation in cooperative learning activities contributed to students having a greater acceptance of math.</p>

Students returning to school face unique challenges including insecurity and low self-esteem -Assertion 1. Returning students mentioned a high level of anxiety about returning to a formal educational setting after being away from school. This theme was present both prior to and after exposure to cooperative learning. Feelings of anxiety were evident as students mentioned that they were afraid of being judged for not grasping concepts quickly. Students were concerned about how their classmates might see them in regard to their mathematics ability.

Comments such as, “A considerable amount of time has past (sic) since I have been in an educational setting.” as well as “I was afraid of being the old granny” are examples of how students perceived age as well as their insecurity associated with returning to school. It appears that students in general disliked mathematics but had greater anxiety from not being in a formal school environment for several years. Students also were anxious in respect to how their peers viewed them. Once students learned about their peers and developed personal relationships with classmates, the anxiety disappeared and was replaced with greater confidence on both a personal level and mathematically. The components related to the theme anxiety led to the assertion that being away from an educational setting creates anxiety in students causing insecurity and low self-esteem.

Student help-seeking strategies were broadened as a result of cooperative learning.-Assertion 2. Student help seeking strategies changed as a result of participating in cooperative learning activities. Prior to participating in cooperative learning activities, students would seek help from tutors or their instructor. At the end of the semester, after exposure to cooperative learning, students still went to campus tutoring centers but they tended to attend tutoring with their classmates. Students also mentioned how they would text each other math questions or call each other on the phone. Prior to the innovation students would express themselves using the pronoun “I.” An example of this was, “I would study every night to make sure I understood the math and if I didn’t I wrote down questions to ask the instructor the next day in class.” At the end of the semester, statements such as, “We get together to study math,” “It doesn’t matter what groups I’ve been in, we’ve always seem to work well together; Whether it’s

large groups or one on one, we are always able to help each other out.” were common. In general, students help seeking strategies broadened in comparison to the beginning of the semester. The components in the theme help-seeking strategies led to the assertion that cooperative learning activities encouraged students to help each other and search for resources to supplement learning.

Communication through cooperative learning activities creates safe learning environment and positive student interactions that go beyond the classroom.-Assertion 3. Communication during cooperative learning activities creates positive student interaction. One student commented, “People form little groups, study groups, and exchange texts and cell phone numbers to get together and study math.” After communicating with each other, students began to feel safe in their learning environment. Students mentioned feeling that there was never a dumb question. “I am more comfortable asking somebody for help, where before I was just scared or embarrassed.” Constant communication among peers during class helped with student learning, “...standing next to people we don’t even know and that’s helpful because there are also different ways they can explain.”

Students mentioned feeling that there was never a dumb question. “I felt that there was never a dumb question or the teacher was too busy to answer my question or help me.” Through communication, students felt free of judgment and were able to have questions answered without fear of being criticized.

Students would first contact their peers before contacting their instructor. “If I was stuck solving a problem, I would check with people in my group and if they didn’t know I would ask other classmates and then I would ask Ms. Rivera.” Students became

independent learners and were not dependent on the instructor as the sole source of solutions.

Students became involved in class even if they had been shy. “There’s people coming out of their shell in a cooperative learning environment.” Open communication was an outcome of participation in cooperative learning activities. Communication within the classroom extended to out of class communication between students. Students worked together outside of class to study mathematics. Participants often commented on how they learned from their peers.

Students commonly mentioned how they could teach others and classmates could also teach them. “If I was to work in a group, I could teach someone else how I do certain things.” Communicating with others opened the door to feeling safe and providing the opportunity for students to share their knowledge with their classmates.

Participation in cooperative learning activities contributed to students having a greater acceptance of math. -Assertion 4. After participating in a cooperative learning environment, students had developed a greater acceptance of mathematics. Students went from disliking math to enjoying the subject. One student made a comparison to her math course and English course. “I am so surprised to find that I love math now; it is actually fun and way better than writing 12 page essays.” Students that find math fun will continue mathematics courses with a positive attitude. Having a positive attitude in a discipline will motivate students to continue with their studies.

Students gained confidence in mathematics. “With the positive attitude I have gained, I am looking forward to more math in my future.” In general, student confidence

in mathematics increased. “It’s not like I’m going to become a scientist or math teacher. I don’t think that but it’s just, I’m more confident now.” Students who are more confident and positive will be more likely to continue and complete their studies.

Students compared how they liked math at the end of the semester compared to hating math at the beginning of the semester. “My attitude towards math has changed drastically, where I hated it and now I love it.” Another student made the following comment, “My feeling towards math is great but I used to hate math.” After participating in cooperative learning activities, students had a positive change in their perceptions of mathematics as a discipline.

Students expressed feelings of excitement towards math. “With the positive attitude that I have gained, I am looking forward to more math in my future.” Another student mentioned, “I gained more confidence. I feel like I am ready to take on MAT 121 and see what it has to offer.” Participant excitement in math demonstrated the motivation to continue taking mathematics courses. Student comments indicate that students will persist in completing their required mathematics coursework.

Chapter 5

DISCUSSION

This chapter will connect quantitative and qualitative data and answer the following research questions: (a) How and to what extent does the integration of cooperative learning strategies in a developmental algebra course affect student learning? (b) Will changing from lecture-based instruction to learner-centered cooperative learning activities create an environment that improves student self-efficacy? and (c) What are student perceptions of cooperative learning? In order to answer these questions, I triangulated quantitative and qualitative results.

Research Question 1

How and to what extent does the integration of cooperative learning strategies in a developmental algebra course affect student learning? The integration of cooperative learning activities had a considerable impact on student learning. Students would work with each other in their base groups solving algebraic problems as well as perform two different experiments that involved collecting data and graphing results. Students would also work with other students not in their base groups. Students would be assigned randomly in pairs to work on different problem solving activities. Students were constantly asking and answering each other's questions as well as sharing problem solving strategies. There was constant movement between student groups and pairs during a class session. As a result of the constant movement, students became familiar

with other students in class. Through participation in cooperative learning activities, students frequently communicated with each other openly since they knew everyone in class.

Communication was present not only during class but also outside of class. Communication took different forms. During class students communicated with each other verbally; outside of class, students called each other on the phone and also sent each other text messages. The content of student communications involved course content, questions regarding course deadlines, or students informing me regarding the welfare of other students. For example, on occasion a student may be late or absent, the particular student would text a classmate in order for them to inform me regarding their specific situation. The constant communication between groups allowed for students to understand their peers better. Through this communication, students were aware of peers who had been away from school and the challenges these peers were facing. There were students who had been away from school due to military service, dedicating time to raising children, or changing careers and the need to be in school to learn new skills. The anxiety expressed by returning students was evident in every qualitative source of data.

As a result of participating in a cooperative learning environment, students developed a sense of community among their peers. As the semester progressed, participating in peer learning increased. Evidence supporting the importance of peer learning was the slight increase in this construct according to student self-efficacy survey results. Participation in peer learning was present in the classroom and outside of class. A part of peer learning involved student help seeking strategies. During class, students would often ask students having difficulty how they can help them understand course

content. Students would meet with each other on the weekend at their homes or they would meet on campus in the tutoring center to work on their math homework. Through all qualitative sources, students mentioned how helpful everyone was in class. Help seeking strategies were expanded due to participation in cooperative learning activities.

With respect to learning mathematical content, students scored higher on all content areas except for solving systems of equations. Overall there was improvement in content knowledge as demonstrated by the overall means of the content test pre to post (6.95 (2.03)-11.70 (2.38)).

Research Question 2

Will changing from lecture-based instruction to learner-centered cooperative learning activities create an environment that improves student self-efficacy? After participating in cooperative learning activities, student self-efficacy increased. By midterm, students were very comfortable when talking to each other. By working together, students were able to learn more about each other's learning. Students were also able to gain confidence in mathematics when they taught another student how to solve a particular problem. Through all qualitative sources, students mentioned how important it was for them to be able to answer another student's questions and teach them a concept. This helped improve their confidence in mathematics.

Students often mentioned how they appreciated knowing that they weren't the only ones having difficulty with course material. This is supported by student self-efficacy post-survey responses and responses found in qualitative data sources. Results from the Student Self-Efficacy Survey demonstrate a slight increase in self-efficacy after participating in cooperative learning activities (2.72 (0.47) - 3.00 (0.53)). Through

qualitative data sources, students expressed being more confident in math as well as being excited about math and their learning in future math courses. Students frequently mentioned how they were able to teach and help other students.

Students commonly mentioned in all qualitative data sources how much they disliked math at the beginning of the semester. Their dislike changed to liking math.

Research Question 3

What are student perceptions of cooperative learning? Students expressed enthusiasm for the use of cooperative learning strategies. Students were open to moving around the classroom and participating in cooperative learning groups since the beginning of the semester. As the semester progressed, students would move around the room on their own to help other students. Students would also offer different explanations when students could not understand my explanation. Students often mentioned in all qualitative sources that they liked the way there was always more than one way to solve a math problem. Through all qualitative data sources students mentioned how they didn't recall information from previous math courses, but were able to remember different concepts covered in class.

Through the cooperative learning experience, student responses in all qualitative data sources mentioned how they felt safe to ask questions in class. They mentioned how easy it was to ask peers questions and everyone was willing to help. Students expressed how they felt the classroom environment was free of criticism and judgment. Students would ask any type of question and often more than one student would offer an explanation to clarify any questions or misunderstandings. Students mentioned that they were not afraid of what type of reaction they would get after asking a question. They felt

that their peers would not think of them negatively. Communication involved in cooperative learning activities allowed for the creation of a safe learning environment and positive student interaction.

One student mentioned, “All teachers should know that group work really works; they should all do it.” There were comments from several students that their math class was the most fun that semester. Students appreciated having the opportunity to work with every student in class. They also mentioned how learning from each other was important to them. They were also excited when they could teach someone how to apply a problem solving strategy to a particular concept.

Chapter 6

CONCLUSIONS

The discussion includes three major sections: lessons learned, implications for practice, and implications for research.

Lessons Learned

Several students came into my class with fear of and an attitude of dislike towards mathematics. A frequent comment that I heard throughout the semester was that students liked learning that they were not the only ones struggling with the subject. Challenges in mathematics were faced in the company of their peers. It appeared as if struggling inspired students to help each other. As students communicated and helped each other, they developed a strong bond among each other as a community. As members of a community, each participant worked together to help each other succeed. Within the classroom community, students developed a great sense of compassion for each other. One student interviewed commented, “We don’t want anyone to fail.” Another student mentioned how they would miss their classmates and their instructor.

One student referred to the members of her base group as a family. Another student talked about her classmates by using the term friends. On one occasion, one student came to class having lost his brother that morning. I asked the student why he came; I told him he could go home and be with his family; he responded that he just had to be in class. Members of the class were supportive of him and showed him compassion during his time of loss. He was very appreciative that there were people who cared about him.

One conversation I had with a student demonstrated how students communicated with each other regarding the course. While he was home on a Sunday afternoon, classmates continually called him regarding the assigned math homework. This student interaction demonstrates how students continued working together outside of class. Working on class content outside of class will help students complete their courses and increase their likelihood of academic advancement.

Students created strong bonds between each other. There were students who intentionally enrolled in the same math course the following semester. I did not realize how important student interaction is and how it impacts student learning.

The students who participated in the cooperative learning activities worked well together. Their ability to work together may be attributed to the characteristics of the students. Half of the class had experience working in cooperative learning environments from previous classes they took. It is my impression that these students helped students without cooperative learning experience feel comfortable in the cooperative learning environment.

One personal observation I had was realizing how much students value instructors. The teacher is essential to creating a positive learning environment. Students frequently mentioned having a caring instructor. For students it is important to have a caring instructor who wanted them to succeed. “This is the first teacher that actually cares and actually really tries.” A caring instructor motivates students to be proactive in their learning.

Students appreciated reconfiguration of groups in class. “We moved around seats in the class and made friends.” In a focus group session students agreed that they liked

moving to different groups and partners because it helped them get to know other people in class. Working with others helped students learning about different problem solving strategies used by their peers.

Students felt comfortable in class. “I’ve never been in a class where you can feel comfortable enough to raise your hand or talk to somebody.” There was a preoccupation regarding impressions from peers at the beginning of the semester. At the end of the semester, students mentioned that they were never afraid to be criticized by others. “Not being afraid of what kind of reaction we are going to get from asking a question.” Experiencing the freedom to ask questions results in higher student achievement.

Student responses prior to the innovation and after the innovation mentioned their most positive experiences were when they had an instructor who wanted them to succeed and inspired their learning. Pre-innovation comments referred to previous instructors, “The teacher was very interactive and a lot of group projects so that we could get a difference in opinions and learning strategies to math problems.” An example of another comment was, “He was always available for questions and if you didn’t comprehend something one way he looked for avenues to help you understand.” Comments after the innovation include, “She wants us to succeed.” “You (the teacher) want your students to learn.” “From day one, Ms. Rivera told us about different resources we could use and what we could do if we needed help.” Students value an instructor who has an interest in their learning. It was also apparent that students valued an instructor that was helpful; this was correlated to a positive learning experience. Teacher influence in creating a positive learning environment assisted students in feeling safe and comfortable asking questions to enrich their learning.

Implications for My Practice

I will continue to use cooperative learning in my classroom. Community building activities will continue to be integrated in my courses so that students can learn about one another and trust can be established among group members. This part of the cooperative learning strategy is helpful for students to feel safe and comfortable asking questions during class and among their peers.

High attendance was the norm for this particular class. Students were rarely absent. The retention rate was high in comparison to courses I taught in previous semesters. There was a 10 percent withdrawal rate in comparison to an average of 50 percent in courses I have taught in previous semesters.

With respect to learning mathematical content, no significant differences were observed in comparison to courses I have taught in the past. When comparing student results on the content test, participants in cycle 2 performed better than those in the last cycle of my innovation. Although there were differences between pre and post content test results, this may be due to learning something new or receiving a refresher on material that was learned in high school.

One aspect of cooperative learning in my classroom that I need to strengthen is group processing. Group processing was implemented in activities but not to the extent that it could have been. I believe that group processing is vital for cooperative learning groups to be able to view each of its members as a valuable part of a team. It provides the group with an opportunity to reflect and analyze how they can become better as a group as well as improve as individuals in order to positively contribute to the team.

Following student recommendations, I will integrate more algebraic applications in the course. Students felt very strongly about being able to see how algebra is used in relation to their lives. If students understand why algebraic concepts are used, they are more likely to be interested in the topic and be more motivated to learn specific concepts.

Through this action research cycle, I have learned that I did not define clear objectives for using an observation protocol. Although my external observers were provided an orientation on the use of the protocol, the results of the observations information provided yielded results that were suspect. Both observers determined that there was 100% engagement during class, an unlikely outcome. If I was using observation in a similar manner in a future study, I would be sure that the observers clearly understood both the purpose and the use of the observation protocol.

The implementation of cooperative learning techniques in my course has inspired other faculty in my division and in other disciplines to learn more about incorporating the strategies in their courses. As a result of my action research, other faculty have expressed an interest in attending the summer cooperative learning institute I attended prior to my last action research cycle. Having other faculty learn about best practices in cooperative learning and integrate the methods in their courses will provide our students with a different learning experience. It will also help students improve their communication and social skills.

Implications for Research

Findings in my research demonstrated an increase in retention and persistence of students who were exposed to cooperative learning. In my prior experience, attendance rates were poor and low retention rates were the norm. Prior to the use of cooperative

learning techniques, I had a retention rate of 50%. According to the National Community College Benchmark Project (NCCBP), national student retention at the developmental mathematics level was 57.32% for Fall 2012(NCCBP, n.d.). The retention rate of the community college district that includes the college that participated in this study was 56.18% for Fall 2012. There was a retention rate of 86% for the course in my study. With 72.7% of self-identified ethnic minority students in the course, this indicates that minority students benefit from the use of cooperative learning practices. At the end of the semester, groups of students decided to enroll together for their next mathematics class. This indicates that cooperative learning has an impact on student persistence. Further research on cooperative learning and minority student retention and persistence is worthy of exploration.

My next research question would be, “What is the relationship between cooperative learning and motivation?” After observing participants in the study, I was intrigued by how motivated students were to complete their homework, ask questions and simply learn in general. I would be interested in learning about motivation and what elements integrated within cooperative learning directly impact motivation.

For future research I would change my self-efficacy survey from a 5 point Likert scale to a 4 point Likert scale. I would remove the choice of Neutral. I found that students would often select Neutral and this leads me to believe that they may have wanted to finish the survey quickly. It may also imply that the students didn't reflect on the questions and their answers. I would also have another instructor who implements cooperative learning in their courses use the survey in order to compare responses and student success rates.

I would also incorporate interviews and focus groups at the beginning of the semester to note any changes in student attitudes regarding mathematics and cooperative learning. Further, I would include a prompt on a student journal entry that would ask specific questions geared toward student attitudes and experience with cooperative learning. This would allow me to have a baseline and observe any significant changes among student responses. Currently I do not have any information to support whether student attitudes changed regarding their opinions of cooperative learning. I only have data from the end of the semester.

In general, participants were positive and very helpful with their classmates. I believe there may be literature regarding the emotional and social component of cooperative learning. Students made connections with each other that kept them coming to class. I believe I can further investigate cooperative learning on other levels in order to improve what I have recently witnessed in the classroom. Witnessing a room of compassionate individuals who without hesitation help their peers is worth further investigation.

Research literature findings and information from prior action research cycles suggest that cooperative learning strategies promote learning and improve self-efficacy. Integrating different teaching techniques such as cooperative learning in developmental mathematics courses will provide new information for developmental education research at the community college level.

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APPENDIX A
MAT091 ASSESSMENT

Student Created ID: _____

(List the first 3 letters of mothers first name and first 2 numbers of your street address)

Carefully read each question, solve each type of problem and circle the letter of the correct answer.

Solve for the given variable

1. $10r + 4 = 94$

a. 84

b. 9

c. 80

d. 52

2. $4n - 8 = 8$

a. 10

b. 12

c. 16

d. 4

3. $3x - 8x + 2 = -6x$

a. $\frac{1}{2}$

b. $-\frac{2}{11}$

c. -2

d. 2

4. $4x + 10 + 5x - 5 = 13$

a. $\frac{28}{9}$

b. -8

c. $-\frac{8}{9}$

d. $\frac{8}{9}$

5. $-4(4x+1) - 5 = -2(x+3) + 3x$

a. $-\frac{7}{17}$

b. $\frac{2}{17}$

c. $-\frac{1}{5}$

d. $-\frac{3}{17}$

6. $4z - 7 + 4(z+1) = -(5z - 5)$

a. $-\frac{1}{2}$

b. $\frac{8}{13}$

c. $-\frac{2}{13}$

d. 2

Solve for the missing coordinate

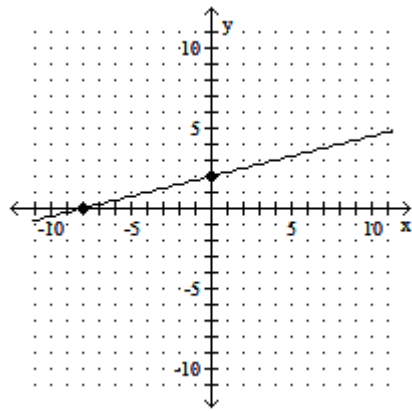
7. $5x + y = -13$ $(\quad, 7), (\quad, 52), (\quad, -13)$

a. $(-4, 7), (-13, -13), (0, -13)$ b. $(-4, 7), (-13, 52), (0, -13)$

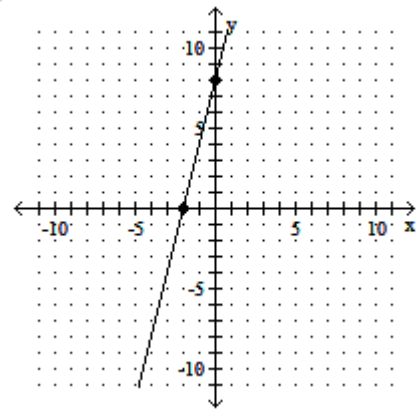
c. $(-4, -4), (-13, 52), (0, -13)$ d. $(-4, 7), (-13, -52), (0, 52)$

Graphing linear equations – *Identify the correct graph for problems 8 and 9*

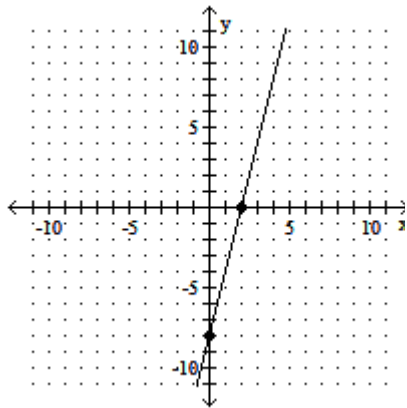
8. $-x + 4y = 8$



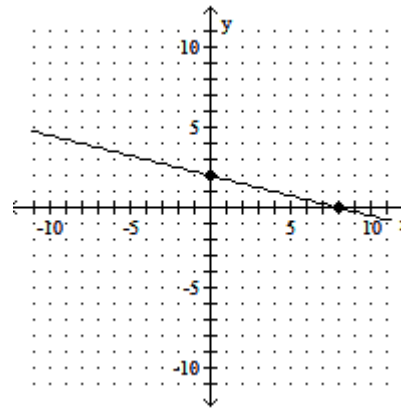
a



b

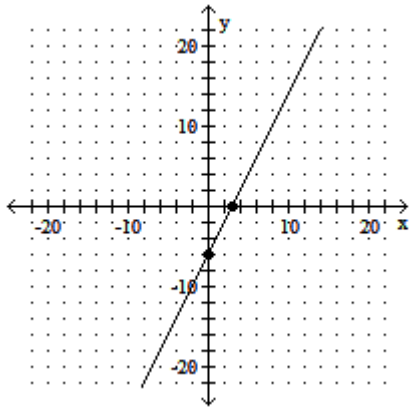


c

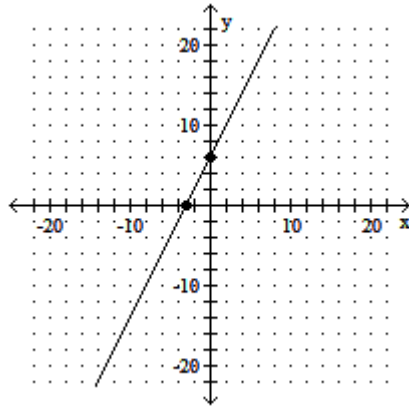


d

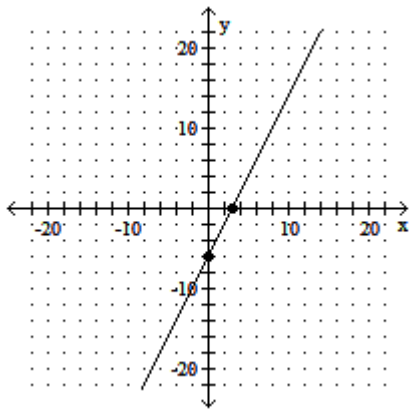
9. $-2x - y = -6$



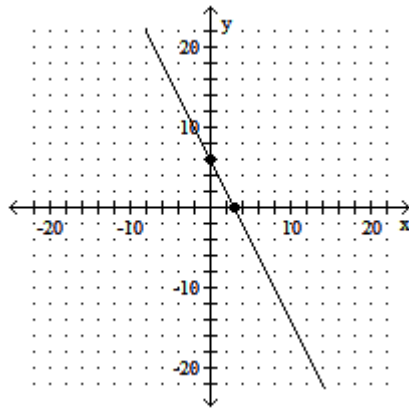
a



b



c



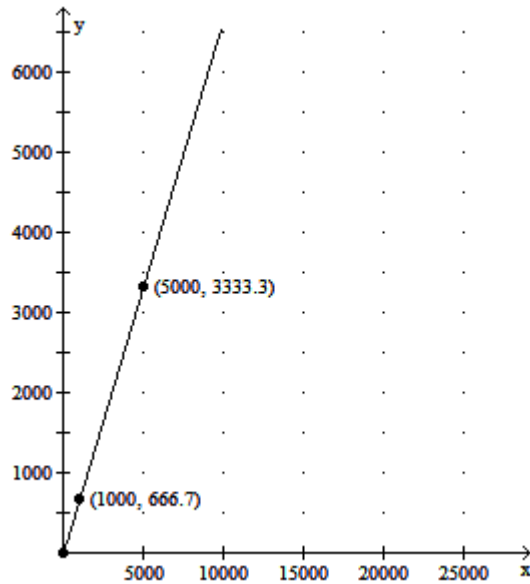
d

Find the slope in problems 10 and 11

10. To the nearest dollar, the average tuition at a public four-year college was \$3117 in 1997 and \$3317 in 1998. Use the ordered pairs (1997, \$3117) and (1998, \$3317) to find and interpret the slope of the line representing the change in tuition (to the nearest dollar per year).

- a. Tuition increased \$217 per year
- b. Tuition increased \$211 per year
- c. Tuition decreased \$200 per year
- d. Tuition increased \$200 per year

11. The graph shows the total cost y (in dollars) of owning and operating a mini-van where x is the number of miles driven. Write the slope as a rate of change.



- a. \$1.50 per mile
- b. \$0.67 per mile
- c. \$25.00 per mile
- d. Cannot be determined

Find the equation of the line for problems 12 and 13

12. In 1985, John invested \$26,000 in the stock market. By 1993 his investment had grown to \$27,500. Find an equation relating time and the value of the investment. If the market continues to grow at the same rate, how much will be in his account in 1998? Give your answer to the nearest dollar.

- a. \$27,501
- b. \$29,000
- c. \$28,438
- d. \$26,939

13. The total sales made by a salesperson was \$25,000 after 3 months and \$68,000 after 23 months. Find an equation relating time and sales. Use the equation to predict the total sales after 45 months.
- a. \$115,400 b. \$115,270 c. \$115,300 d. \$115,342

Solve each problem as a system of 2 linear equations

14. Devon purchased tickets to an air show for 9 adults and 2 children. The total cost was \$252. The cost of a child's ticket was \$6 less than the cost of an adult's ticket. Find the price of an adult's ticket and a child's ticket.
- a. Adult's ticket: \$23; child's ticket: \$17 b. Adult's ticket: \$25; child's ticket: \$19
- c. Adult's ticket: \$26; child's ticket: \$20 d. Adult's ticket: \$24; child's ticket: \$18
15. On a trip to Los Angeles, Rose Perez ordered 120 pieces of jewelry; a number of bracelets at \$8 each and a number of necklaces at \$11 each. She wrote a check for \$1140 to pay for the order. How many bracelets and how many necklaces did Rose purchase?
- a. 60 bracelets and 60 necklaces b. 55 bracelets and 65 necklaces
- c. 70 bracelets and 50 necklaces d. 65 bracelets and 55 necklaces

APPENDIX B

MAT091 INTRODUCTORY ALGEBRA SURVEY

Thank you for taking this survey. I have created this survey to learn more about students and their experience learning mathematics. Your responses will remain confidential and will not impact your grade.

5 Digit Assigned Code

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(Write the first 3 letters of your mother's first name and the first two numbers of your street address)

Please answer the following questions with the response that identifies you best.

Answer Selection: Correct = ● Incorrect = ✕ ✓ ⊖
--

1. Gender:

- Male Female

2. Age:

- 15 - 19
 20 - 24
 25 - 29
 30+

3. Ethnicity:

- American Indian/Alaskan Native
 Asian or Pacific Islander
 Black, not Hispanic Origin
 Hispanic
 White, not Hispanic Origin
 Other

4. Is this your first time taking Introductory Algebra? Yes No

4a. If you answered No to question 4, how many times have you taken Introductory Algebra?

5. What was the last math class you took in high school?

- General Math Algebra 1 -2 Algebra 3 - 4 Calculus Other

5a. If you specified Other, what course did you take? _____

6. When was the last time you took a math class? (Specify the year in your answer)

6a. What was the last math class you took?

The following questions have been adapted from the MMSLQ.

Please circle the choice that you most agree with.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I believe that I will have excellent grades in math class.	SA	A	N	D	SD
2. If I feel confused about class content, I will go over the material to find out where the problem is.	SA	A	N	D	SD
3. In studying math, I will explain the content to my friends or classmates.	SA	A	N	D	SD
4. In studying math, even the most difficult parts, I will solve the problem by myself and will not ask for help from other people.	SA	A	N	D	SD
5. I believe that I can understand the most difficult parts of mathematics on my own.	SA	A	N	D	SD
6. I will reorganize and clarify any confused points I have right after class so it is fresh in my mind.	SA	A	N	D	SD
7. I do my math homework with my classmates.	SA	A	N	D	SD
8. I will ask the teacher for help to clarify questions in my math class.	SA	A	N	D	SD
9. I believe I can master every topic in math class.	SA	A	N	D	SD
10. I will check my answer after I finish answering the question.	SA	A	N	D	SD

11. I will actively invite my classmates to review the materials together.	SA	A	N	D	SD
12. If I do not understand course materials, I will ask my classmates for help.	SA	A	N	D	SD
13. As for math, I am capable to teach my classmates.	SA	A	N	D	SD
14. When I get a wrong answer, I will clarify whether it is a conceptual mistake or miscalculation.	SA	A	N	D	SD
15. In studying math, I will discuss class materials with classmates with better math scores than me.	SA	A	N	D	SD
16. I find classmates who can help me in math class.	SA	A	N	D	SD
17. Math is not difficult for me.	SA	A	N	D	SD
18. I will have a math study schedule to study and review with my classmates.	SA	A	N	D	SD
19. If I do not understand the math course materials, I will go and find solutions on math related websites.	SA	A	N	D	SD
20. I will ask the teacher questions immediately in class.	SA	A	N	D	SD

APPENDIX C
MATH AUTOBIOGRAPHY

Math Homework (12 points)

Your math homework for our next class is a journal entry with two parts.

Part I:

Math Autobiography

For Thursday, August 23, 2012:

An autobiography is a story about your personal experience. This assignment is about your mathematics story.

Type your mathematics autobiography. This document should be in Times New Roman font 12, double spaced. The document should have a minimum of 2 pages. Include proper sentence structure and spelling. Please include a five character identification code that includes the first three letters of your mother's first name followed by the first two numbers of your street address.

In this autobiography, please include the following:

- 1- Your mathematics experience from primary school to high school.(Include how your mathematics courses were taught.)
- 2 - Your most memorable mathematics experience. (Explain what made it memorable)
- 3 – How have you used mathematics in your daily life?
- 4 - Your feelings regarding your ability in mathematics.
- 5 - What was a topic you found challenging in mathematics? What steps did you take to overcome this challenge?

Part II:

Most Recent Math Course

Thinking about the last math course you took, describe your feelings about your mathematics experience and your confidence in problem solving.

Describe how your last math course was taught.

Please turn in:

- 1 - One stapled, hard copy of your assignment.
- 2 - E-mailed copy of your assignment prior to the beginning of class.

If you have any questions, please ask.

Math Homework (10 points)

Your math homework for our next class is a journal entry.

For Thursday, December 6, 2012:

Type your journal entry. This document should be in Times New Roman font 12, double spaced. The document should have a maximum of 1 page. Please include a five character identification code that includes the first three letters of your mother's first name followed by the first two numbers of your street address.

Respond to each of the following statements in your journal entry:

Thinking about this course, please write about your learning experience.

Describe how you feel about mathematics and your confidence level in mathematics problem solving.

How would you compare the last course to this course?

APPENDIX D
INTERVIEWS

Introductory Script:

Thank you for taking time to help your instructor learn about your opinions regarding your math class and your learning. There are no right or wrong answers. Your answers will not affect your class grade. Please feel free to tell me what you think. I will be asking you some questions about your class and your class work. I will be writing down your answers and recording your responses with your permission. You have the right to not answer any question you are not comfortable with or stop participating at any time.

Your instructor is interested in student learning of algebra. She is most interested in learning how to create a learning environment that will help students learn algebra and help them become more confident in the problem solving process. Do you have any questions at this time?

Interviewer: Do I have permission to record this interview?

Introductory Algebra, open-ended questions

Comparison of traditional and cooperative learning teaching strategies

Thinking about the last math class you took, how was the course taught?
(Can you give me an example of a typical class session?)

Thinking about your math class, what do you think about the cooperative learning activities?

(Were the activities helpful? What made them helpful? Which activities were not helpful to you? Tell me about one that particularly sticks in your memory.)

Thinking about your math class, do you see any benefits of using cooperative learning practices?
(Can you explain what you mean?)

Thinking about your math class, tell me about your learning experience.

Mathematics Self-Efficacy

How do you feel about your ability in mathematics?
How do you feel about your ability to solve mathematical problems?
(Can you give me an example?)

Self Regulation

Tell me about yourself as a problem solver.
(Can you give me an example?)

What do you do when you solve a problem?
(How do you approach a problem? How do you solve a math problem?)

Help Seeking

Thinking about your experience in mathematics, what would be the first thing you would do if you are stuck solving a problem? What if that didn't work, what would you do next?
(Do you ask for help? Who do you ask for help? Are there any sources you use to get help?)

Concluding Script:

Thank you again for taking your time to answer these questions. This will help your instructor become a better teacher. Do you have any questions for me?

APPENDIX E
FOCUS GROUP PROTOCOL

Distribute materials	Consent form
Moderator introduction, thank you and purpose (1 minute)	<p>Hello. I'd like to start off by thanking each of you for taking time to come today. We'll be here for about an hour. My name is [name of facilitator]</p> <p>The reason we're here today is to get your opinions and attitudes about issues related to your Introductory Algebra class.</p> <p>I'm going to lead our discussion today. Your instructor is interested in learning whether teaching techniques used in class have been helpful to you. She is also inviting suggestions from you on how to improve this class. My job is just to ask you questions and then encourage and moderate our discussion. Your responses will not affect your grade in this course. You will not be receiving points for your participation. Your comments will help to improve this course. You have the right to not answer any question and to stop participating at any time.</p> <p>I also would like to introduce [name of recorder]. [He or she] will be recording our discussion today.</p>
Groundrules (2 minutes)	<p>To allow our conversation to flow more freely, I'd like to go over some ground rules.</p> <ol style="list-style-type: none"> 1. Please talk one at a time and avoid side conversations. 2. Please silence your phones and store them in your backpack or purse. 3. Everyone doesn't have to answer every single question, but I'd like to hear from each of you today as the discussion progresses. 4. This will be an open discussion ... feel free to comment on each other's remarks. 5. There are no "wrong answers," just different opinions. Say what is true for

	<p>you, even if you're the only one who feels that way. Don't let the group sway you. But if you do change your mind, just let me know.</p> <p>6. Please let me know if you need a break.</p>
<p>General questions (25 minutes)</p>	<p>What has your impression been regarding this course?</p> <p>How do you feel about the classroom environment?</p> <p>How does this course compare to mathematics courses you have taken in the past?</p> <p>How has your level of confidence in mathematics changed since the first week of the semester?</p>
<p>Specific questions (15 minutes)</p>	<p>What has your opinion been regarding the use of cooperative learning groups?</p> <p>Which type of activity has helped you most with your learning in this class?</p> <p>As a result of working with your classmates, are you more or less likely to ask for help from others? This includes classmates, math instructors, tutors and your instructor. What are other ways you search for help when you are stuck solving a math problem?</p>
<p>Closing question (10 minutes)</p>	<p>What are the three most important things that your instructor should know regarding your learning in mathematics?</p>
<p>Closing (2 minutes)</p>	<p>Thanks for coming today and sharing information regarding our Introductory Algebra course. Your comments will help your instructor find different ways to assist you with your learning. Thank you for your time.</p>

APPENDIX F
COOPERATIVE LEARNING OBSERVATION GUIDE

Group Specifics

Group #		Group Composition					
Number of students in group		Female		Male		Student #	

Class Activity Description

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		Cooperative Learning Elements <i>(Indicate frequency of elements with tally marks in provided categories)</i>				
Time	Student behavior	Positive Interdependence	Individual Accountability	Group Processing	Social Skills	Face to face Promotive Interaction

Definitions

Definitions taken from Johnson & Johnson (“Overview”, n.d.)

Positive Interdependence:

Team members are connected with each other; individual members cannot succeed unless each member completes their task. Work completed by individuals is beneficial to the entire team; teamwork benefits each individual.

Examples:

- Group acknowledgement and commitment to complete specific goals
- Positive relationship dynamics among team members
- Team works together to progress in achieving a specific task outcome

Individual Accountability:

Each individual is accountable for a specific task and completes their task. Individuals are responsible for their contribution to the group.

Examples:

- Individual participation by group members
- Expectations set by group members for individual contributions

Group Processing:

Group takes time to discuss progress on goal achievement. Group reflects on how well they are working together.

Examples:

- Group pauses to evaluate team efforts
- Group makes decisions on specific actions to continue or change

Social Skills:

Individual group members use skills that assist in creating a positive group dynamic. Members coordinate efforts in order to achieve mutual goals. These skills include decision making, trust building, acceptance and support of each other, communication, and conflict management skills.

Examples:

- Use of eye contact while talking to group members
- Respecting ideas of group members

Face to face promotive interaction

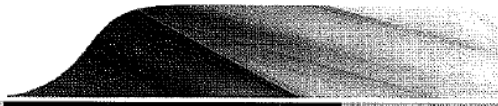
Individual group members assist each other to achieve and complete tasks in order to accomplish a specific goal. Group members encourage and help each other in an efficient and effect way that accomplishes a specific goal.

Examples:

- Group members provide feedback to each other
- Group members encourage others within the group
- Group members provide each other with resource

APPENDIX G

INSTITUTIONAL REVIEW BOARD APPROVAL - ASU



Office of Research Integrity and Assurance

To: Ronald Zambo
FAB

for **From:** Mark Roosa, Chair *SM*
Soc Beh IRB

Date: 06/06/2012

Committee Action: Exemption Granted

IRB Action Date: 06/06/2012

IRB Protocol #: 1206007912

Study Title: Cooperative Learning in a Community College Setting: Developmental Coursework in Mathematics

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(1)(2).

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX H

INSTITUTIONAL REVIEW BOARD APPROVAL - MCCCCD



Maricopa County Community College District
2411 West 14th Street
Tempe AZ, 85281
TEL: (480) 731-8701
FAX: (480) 731 8282

DATE: June 25, 2012
TO: Rivera, Natalie, Mathematics
Zambo, Ronald, Education
FROM: MCCCDC Institutional Review Board
PROTOCOL TITLE: Cooperative learning in a Community College Setting: Developmental Coursework in Mathematics
FUNDING SOURCE: NONE
PROTOCOL NUMBER: 2012-06-200
FORM TYPE: NEW
REVIEW TYPE: EXEMPT

Dear Principal Investigator,

The MCCCDC IRB reviewed your protocol and determined the activities outlined do constitute human subjects research according to the Code of Federal Regulations, Title 45, Part 46.

The determination given to your protocol is shown above under Review Type.

You may initiate your project.

If your protocol has been ruled as *exempt*, it is not necessary to return for an annual review. If you decide to make any changes to your project design which might result in the loss of your exempt status, you must seek IRB approval prior to continuing by submitting a modification form.

If your protocol has been determined to be *expedited or full board review*, you must submit a continuing review form prior to the expiration date shown above. If you make any changes to your project design, please submit a modification form prior to continuing.

We appreciate your cooperation in complying with the federal guidelines that protect human research subjects. We wish you success in your project.

Cordially,
MCCCDC IRB

MCCCDC IRB