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Strategies for teaching developmental mathematics students at the college level

Natalie Lynn Kautz
Rowan University

**STRATEGIES FOR TEACHING
DEVELOPMENTAL MATHEMATICS STUDENTS
AT THE COLLEGE LEVEL**

by
Natalie Lynn Swaincott Kautz

A Dissertation

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Dedications

I would like to dedicate my dissertation work to my family and many friends.

I dedicate this dissertation to my loving parents, Wes and Diane Swaincott, for always believing in me and wanting me to strive for the best. They helped out with childcare and did my laundry and dishes so I could work on this paper. Without my parents, this greatest accomplishment in my life would not exist.

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Abstract

Natalie Lynn Swaincott Kautz
STRATEGIES FOR TEACHING DEVELOPMENTAL MATHEMATICS STUDENTS AT THE COLLEGE LEVEL
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The purpose of this investigation was to identify strategies used by effective instructors of developmental mathematics, and to discover the perceptions developmental mathematics students have about these strategies.

In this research project, college-level instructors of developmental mathematics students were recorded on video before, during, and after the teaching of an algebraic concept. Students were given a pre-lesson survey and post-lesson survey to see if there were gains in their learning. Students completed a survey about their perceptions of effective teaching, and some participated in an extended phone interview after the lesson. Instructors were also asked for their opinions about the effectiveness of the teaching methods and instructional strategies they chose.

The results of the study show that instructors primarily used direct instruction, avoided the use of group work, and did not use games or manipulatives. One of the most important discoveries was that students overwhelmingly felt that the lessons went well, and they appreciated multiple ways to solve problems. Student gains from pre-lesson survey to post-lesson survey confirm that they are learning well via these methods. Instructors and students both felt that there was not enough in-class time for instruction or practice of problems.

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Chapter 1

The Problem

Currently, a major concern in the United States is the lack of mathematical preparedness of students who enter college. A large number of students do not successfully pass a test of basic mathematics skills upon entrance to college, and therefore must take at least one course in developmental mathematics to fill in the gaps in their learning. Unfortunately, more than two million students enroll in developmental education in United States colleges every year (Bonham & Boylan, 2011). Tierney and Garcia (2008) describe developmental classes, also known as remedial classes or basic skills classes, as “courses in reading, writing, or mathematics for college-level students lacking those skills necessary to perform college-level work at the level required by the institution” (p. 1). Remedial classes must be passed in order for a student to take additional mathematics courses for credit and to then fulfill graduation requirements. Unfortunately, a great number of students do not pass these developmental courses on the first attempt, and some do not pass the courses at all. Some students take the developmental courses two or three or more times before successful completion. Other students become frustrated and drop out of college altogether.

According to Boylan and Bonham (2007), “developmental education refers to a broad range of courses and services organized and delivered in an effort to retain students and ensure the successful completion of their post-secondary goals” (p. 2). As such, developmental courses consist of content that is below college level and usually contain course numbers that are below 100 (Boylan and Bonham, 2007). Developmental classes are important because students are coming to college less prepared. A national survey by the Pew Research Center reveals that a majority of college presidents (58%) say that public high school students arrive at college less well prepared than their counterparts of a decade ago ("Is College," 2011). Unfortunately, this suggests that K-12 education is on the decline. The United States college student is changing, and institutions of higher education are adapting to this change by offering, and in most cases requiring, developmental courses.

Bonham and Boylan (2011) also report that developmental education has increasingly become part of the national debate in higher education. This is especially true for developmental courses in mathematics because these have the highest rates of failure and non-completion (Bonham and Boylan, 2011). Developmental courses, which were once viewed as a gateway to opportunity, are now viewed as a barrier to opportunity. Students often must pass a test of basic skills upon entrance to college or complete the requirements of developmental courses before taking typical college courses. Some students may have difficulty successfully completing the entrance test or have trouble passing the developmental courses and may never get to take the college courses for credit. Even if the developmental classes are passed, the student may be behind his or her peers by a semester or a year, and may be constantly fighting to catch up. Students may suffer from low self-esteem, as they perceive themselves as a failure or as stupid because they are in a remedial class. Bonham and Boylan (2011) further point out that while some students who pass developmental courses do well in college, an unacceptable number of students do not successfully complete developmental courses and therefore do not continue on to complete their college degree.

Developmental education is central to United States colleges. Developmental education may be considered as an intervention for students, although the term "intervention" is used with caution. The purpose of developmental education is to enable underprepared students to develop, quickly and inexpensively, the capabilities necessary for college success. Unfortunately, the scope of this enterprise is massive (Cullinane & Treisman, 2010). Community colleges traditionally enroll the most developmental students. McClenney (2004) reports that half of all first-time community college students are in need of developmental education in at least one subject area. Nationally, about 60% of community college students are referred to one or more developmental courses (Attewell, Lavin, Domina, & Levey, 2006; Bailey, Jeong, & Cho, 2010). With more than half of the incoming freshman in need of remedial education, the community colleges must have a major focus on developmental education. In some community colleges, more than 90% of entering students are deemed unprepared to begin college-level work (Kerrigan & Slater, 2010).

Another aspect of the problem is that in many cases, contingent or adjunct faculty members are hired to teach low-level and remedial classes because tenure-track professors often teach higher-level classes. A study by the Virginia State Council on Higher Education found that "many of the [full time] professors' courses are graduate seminars, which typically have 12 to 18 students, while the adjuncts' introductory courses often top out at 38 students and notoriously require more time one-on-one with beginning students" (Williams, 1997). Generally, adjunct faculty members may not remain on campus for as much time each day as full-time instructors, while tenure-track instructors may maintain more required office hours than contingent faculty members, thus contributing to variation in the amount and degree of support available to students outside of the classroom.

Importance of Instructional Strategies

Colleges have recognized that they must offer remedial instruction for their underprepared students, so the importance of developmental education has grown in recent years. Pascarella and Terenzini (2005) point out that academic interventions can be effective in helping students to overcome deficiencies in their precollege academic preparation. Struggling students deserve effective instructors who will guide them through their studies toward successful completion of the remedial courses. Quality instruction will offer students the greatest chance to pass the developmental courses and to move on to credit-bearing courses. Thus, educators have recognized the importance of evaluating the effectiveness of instructors of developmental studies.

Effective teaching. Since the late 1960s, much work has been documented on effective university instructors (Feldman, 1989; Marsh & Roche, 1993). This research has yielded a wide variety of attributes that an effective instructor should possess. According to Marsh and Roche (1993), some of the most important factors that may make one instructor of developmental mathematics more effective than another are the instructor's expertise in and use of technology, and use of various teaching methods and instructional strategies. Feldman (1993) adds that effective instructors may treat students differently, and they may be more patient, more compassionate, or more excited in the classroom. Effective instructors may use classroom techniques that are motivational; they may be skilled at engaging students; or they may use a variety of techniques during one class period to keep students on task and to keep them from becoming bored (Feldman, 1989).

Effective instructors may get students involved by sending them to the board, by doing partner work, or by having students retell what they have learned. An effective instructor may clearly state the objective for the class period and may relate the day's lesson to what students have done in the past and where they are heading next.

The skill of the faculty member may be a factor in the students' success. Some faculty members were trained in the field of education, while others were solely trained in mathematics disciplines. Sometimes those that are trained in mathematics know the subject matter well, but struggle to impart that knowledge to their students. Dewey (1916) defines education as "the reconstruction or reorganization of experiences which add to the meaning of experience, and which increases ability to direct the course of subsequent experiences" (p. 76). Dewey (1916) clearly stated that education was not just about learning the basics, but pointed out that he wanted education to be one in which citizens become capable of solving problems and directing their own lives.

The Hungarian mathematician Pólya (1965) said that the primary aim of mathematics teaching is to teach students to think. Pólya (1965) believed that teachers should be interested in the subject, should know the subject matter, should know about the ways of learning, should give students "know how, attitudes of mind, [and] habit of methodical work," and when it comes to teaching, should "suggest it – [but] do not force it down their throats" (p. 116). Pólya's thinking emphasizes a process-oriented teaching style that is consistent with Dewey's ideas of education.

Davis and Hersh (1981) spoke out against teachers using authoritarian presentations. They envisioned the ideal teacher as one who invites students to "Come, let us reason together" instead of a teacher who uses "proof by coercion" (p. 282). The

National Council of Teachers of Mathematics (NCTM) also shares this perspective. The original set of *Standards* states, “Finally, our vision sees teachers encouraging students, probing for ideas, and carefully judging the maturity of the students’ thoughts and expressions” (“National Council,” 1989, p. 10). In 2000, the *Teaching Principle* stated that “Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well” (“National Council,” 2000, p. 60).

Developmental education. Developmental education promotes underprepared students’ achievement and persistence in the short term – the students’ first semester – and also in the long term, leading to degree completion (Boylan & Bonham, 1992; Braley & Ogden, 1997; Campbell & Blakely, 1996); Weissman, Silke, and Bulakowski, 1997). McClenney (2004) explains, “The plain truth of the matter is that if students don’t succeed in developmental education, they simply won’t have the opportunity to succeed anywhere else (p. 15).”

According to Wright, Wright, and Lamb (2002), the one-year retention rate for freshmen that pass a single developmental course is 66.4%. This statistic shows that only a little more than half of the developmental students will remain at the college, while the others will drop out of college. Ironically, these are students that have successfully completed their first remedial course. The future may be even more uncertain for students who do not successfully navigate remediation. Wright, Wright, and Lamb (2002) found that the one-year retention rate for freshmen who do not pass a developmental course is only 9.6%. Knowing that fewer than ten percent of students who fail a remedial course will stay at college is shocking. Clearly, something must be done to help these students.

Gallard, Albritton, and Morgan (2010) posit that there is no easy solution, and that costs are associated with delivering effective developmental education programs. On the other hand, McCabe and Day (1998) point out, "The greatest misconception about developmental education is that it is costly" (p. 30). Perhaps money spent on remedial studies is money well spent for the institution of higher education? In reality, students who succeed in developmental education provide financial benefits to the institution and, upon graduation, become an integral part of society, generating a positive return to society and decreasing social expenditures (Bailey, Jenkins, Jacobs, & Leinbach, 2003; Schuyler, 1997; Wyman, 1997).

Leveling the playing field. As marginalized individuals on the college campus, students in developmental courses deserve effective instructors. While students may not be able to change who is hired by the university, they may be able to provide their input about effective teaching strategies. Instructors who use effective teaching strategies can level the playing field for students, and they may be able to mitigate the other difficulties that developmental students have. Perhaps an underprepared student experience comparable success if he or she is given an effective instructor of developmental mathematics. Although developmental students enter college behind their non-developmental peers, an effective instructor may help put these students on track to complete a college-level program in the discipline of their choice.

Researcher's Lens

As a mathematics professor, the developmental mathematics students that I teach particularly intrigue me. These students seem so different from the students in other non-developmental mathematics classes I have taught. Generally, I have noted that developmental mathematics students attend class less often, complete fewer homework assignments, and seem to get more nervous about exams. My passion is to find a way to help such students succeed. I suspect that the teaching methods currently being employed by many instructors are not reaching this particular type of student.

I want to make a difference for the students I teach. Developmental students, who have not met preadmission requirements, are sometimes stigmatized on the college campus because of these deficiencies. Historically, these students are the least likely to graduate and the least likely to succeed in society. As a researcher-practitioner, I take an advocacy/participatory worldview because I want to bring about change for marginalized individuals (Creswell, 2009). I believe that every student can learn, and I apply this thinking in my daily teaching of developmental mathematics students.

Purpose of the Study

The purpose of this descriptive observational study is to identify strategies used by effective instructors of developmental mathematics that may increase the success of developmental mathematics students. This qualitative study involves observation of instructor classroom practice, description and categorization of teaching strategies used, and triangulation of effectiveness via student questionnaires and interviews.

As an instructor of developmental mathematics at the college level, I have seen firsthand the alarming rate of failure of these students. I have a vested interest in changing the rate of success by discovering the reasons that some instructors of developmental mathematics are considered leaders in their field. The knowledge gained from this study could be used to discover the ways that any instructor can best educate the developmental mathematics students they teach. This research study will inform my own teaching practices and those of other instructors of developmental mathematics who encounter similar difficulties. I plan to share my findings with other educators of developmental mathematics at Rowan University and other institutions of higher education.

Summary

Educators should pay attention to the intentional use of effective strategies as a method of improving student perceptions of classroom activities, which in turn can serve as an indicator of student success. Instructors must attempt to remove the barriers that hold back students to ensure the success of all students. The study of educators and students is important so that the best instructional practices can be identified. Once these best practices are known and implemented, they can give developmental students the best chance at success in their basic skills courses. Hopefully, this will then help these students to move on to traditional college courses. As the student completes the traditional courses, he or she is on the path to graduation with a college degree. With a college degree, a person is more likely to successfully find employment post-college. The ripple effect of improving developmental education provides valuable insight that will help improve student success and educational outcomes in the future.

The following chapters will offer suggestions for helping developmental students on the college campus. A review of the current literature on this topic can be found in chapter two. Next, chapter three will describe the research study and its implementation. The findings of the study are discussed in chapter four. Finally, chapter five provides a summary and includes suggestions for further research.

Chapter 2

Literature Review

The review of literature discusses the theoretical framework of equity, including the Fairness Model for Individuals. The literature review begins with the topic of research studies utilizing recorded videos, and discusses various teaching methods and instructional techniques. The justification for reviewing the literature is the discovery of what research has been done before on this topic and to find out what has not been previously studied about this topic.

Theoretical Framework

This research study utilized the theoretical framework of equity. Equity theory is a theory of justice that was first developed by the workplace and behavioral psychologist Adams (1963). Adams (1965) believes that people value their treatment and this causes them to be motivated. Equity theory tries to explain the relational satisfaction in terms of perceptions of the fair or unfair distribution of resources. One proposition of equity theory is that when individuals find themselves in inequitable relationships, they become distressed. The more that the relationship is inequitable, the more distress the individual feels. The person who gets too few resources may feel angry or humiliated (Adams, 1965).

Carrell and Dittrich (1978) proposed the Fairness Model for Individuals. According to this model, people judge themselves against a relational partner or comparison person. Students compare themselves to people around themselves and decide if what they are getting is equal or unequal to what others are getting. The individual judges the “fairness” of the situation. Students who feel that they are undercompensated may decrease their efforts, or may even shut down completely (Carrell & Dittrich, 1978).

Theoharis (2007) talks about the lack of focus on equity issues among educational administrators and believes that administrators should focus on eliminating marginalization in schools. Theoharis (2007) goes on to say that administrators are "irresponsible to prepare leaders to take on enormous challenges and face significant resistance without understandings of how to weather the storms that will result" (p. 250).

Goldfarb and Grinberg (2002) define social justice as "actively engaging in reclaiming, appropriating, sustaining, and advancing inherent human rights of equity, and fairness in social, economic, educational, and personal directions" (p. 162). According to Vithal (2012), recent research, theory, and practice have emerged in the literature about connections between mathematics education and democracy and the related issues of equity and social justice. Without a doubt, notions of democracy and development are highly contested in themselves and in education; so too would be any exploration of their links to mathematics education (Vithal, 2012). According to Vithal (2012), "just as human beings are connected in complex relations of cooperation and contradiction, so too are our knowledge forms, including mathematics" (p. 14).

Equity is something to strive for in education. Developmental students start out behind other students and they may need to be given more opportunities and support than their peers who are typical college students. I am approaching this research study through the theoretical framework of equity. Because I believe that all students can learn, including students who have not successfully passed tests of basic skills, I seek to create for all students the opportunities to succeed. Since some students learn at a slower rate or need more help, given the appropriate instructional strategies and teaching methods, all students can learn.

Video Studies

Recording video is an effective way to capture what the instructor is doing in the classroom. Other researchers have done video studies. In the past 10 years, recording video as a teaching strategy has been used in the disciplines of medicine (Gray, 1990), physical therapy (Liu, Schneider, & Miyazáki, 1997; Riólo, 1997), psychology (Baum & Gray, 1992), and physical education (Ignico, 1995).

A study by Ignico (1995) supported video recording as a more effective instructional method, an important consideration because it was demonstrated that teaching effectiveness could be maintained with the recording of video. Yoder-Wise and Kowalski (2012) note that unless educators have had the opportunity to watch videos of themselves teaching, they have very little awareness of effective teaching modalities.

Video aids data collection. Recording video of instructors is well suited as data collection. According to Kowalski (2013), "Watching a video recording of at least twenty minutes of a classroom presentation allows for extensive learning that is only loosely related to the content of the class or lecture" (p. 244). Researchers use video recording when observation is the preferred method of data collection (Heacock, Souder, & Chastain, 1996). Videos provide an accurate and complete record and minimize the selective bias and memory limitations frequently noted in human observation and self-reporting (Blanck, 1987). Additionally, videos offer efficiency in the data collection process because they record rich and permanent documentation of behaviors; and video recordings allow the investigator to analyze the data in different ways (Johnson & Griffith, 1985).

Video aids data analysis. Roberts, Srour, and Winkelman (1996) report that videos can provide an efficient and reliable record for analysis. Videos also permit observation of several important aspects of teaching, such as effective communication, the development of confidence, and the assessment of the achievement of program outcomes (Winters, Hauck, Riggs, Clawson, & Collins, 2003). Furthermore, the recording of video allows the researchers to develop fine-grained coding schemes and use multiple coding systems to capture the various, complex features of the situation under investigation (Asher, 1983).

In a study by Minardi and Ritter (1999), participants reported that recording of video provided a useful learning experience. Both observers and presenters can use videos to assist with assessing the effectiveness of teaching presentations (Kowalski, 2013). A study by Ignico (1995) supported recording of video as a more effective instructional method, an important consideration because it was demonstrated that teaching effectiveness could be maintained with the use of video recordings. Yoder-Wise and Kowalski (2012) note that unless educators have had the opportunity to watch videos of themselves teaching, they have very little awareness of effective teaching modalities.

After taping instructors, the investigator may subsequently replay the video to focus on other aspects of recorded data. Additionally, videos permit other investigators to conduct secondary analyses of recorded data (Heacock, Souder, & Chastain, 1996). According to Booth and Mitchell (1989), it is not unusual for an observer who is replaying a video to detect nuances in behavior that an observer in the field setting missed. Recording of video also permits systematic slow motion analysis of complex or brief behaviors, as well as correction of omissions or coding mistakes (Booth & Mitchell, 1988). Heacock, Souder, and Chastain (1996) go on to say that videos are particularly well suited to studying brief, specific behavioral episodes from a behavioral or social learning model, because they allow the observer to examine the antecedents, behaviors, and consequences in a detailed sequence.

A multimodal approach to data collection in natural settings can be useful when the investigator wants to check one source of data collection against another. For example, an investigator may want to compare participants' answers on a questionnaire with their behavior in a real situation to determine congruency between reported and actual behavior. In this approach, the investigator can make some judgments of participants' reactions to measurement techniques (Blanck, 1987).

A review of the literature indicates that mathematics instructors were recorded on video in a variety of research studies. Jacobs and Morita (2002) compared Japanese and United States teachers, and found that video recordings helped the researcher to make inferences from the data generated. The Third International Mathematics and Science Study (TIMSS) by the United States Department of Education's Institution of Educational Science's National Center for Educational Statistics (1995) compared Japanese, United States, and German teachers using a study where mathematics instructors were recorded on video for similar purposes, and found that there was a strong positive relationship between student and enjoyment of mathematics and higher achievement (Beaton, et. al., 1999).

The use of video recording increases the validity of this research study. Video recordings provide a semi-permanent record of the happenings in the classroom. The researcher can review the video to see if anything was missed. Additionally, by allowing more than one educator to view the video, validity is increased. According to Pinheiro, Kakehashi, and Angelo (2005), videos can be used as an instrument of data collection and data generation; and it may be possible to detect contradictions between discourse and behavior through recording video and interviewing the subjects.

A final advantage lies in the use of materials that are recorded on video for establishing inter-rater reliability. Researchers can play, and replay, taped segments as needed to clarify ratings without using additional subjects. As new members are added to the research team, the tapes can be used again for practice in coding and rating research phenomena (Heacock, Souder, & Chastain, 1996).

Summary

In the United States, many instructors hold relatively traditional views on teaching and learning mathematics (Jacobs & Morita, 2002). Some current teaching methods reflect the way in which instructors themselves were taught (Battista, 1994), perhaps because this is what makes the instructors most comfortable. Most perceive teaching as giving students step-by-step instruction so that they can acquire basic skills (Prawat, 1992). Instructors view their students as recipients of their knowledge and instruction, as if they are giving the students a gift. These beliefs have had a long history in the United States and mirror those beliefs of the larger society. Many attempts to reform mathematics instruction seem to have limited effects on practice and beliefs (Civil, 1993; Grant, Hiebert & Wearne, 1994; Peak, 1996). Yet some instructors do attempt to teach in a way that is different from the way they learned mathematics when they were in school. They may realize that the students today are different from the students of yesterday.

With so many different options available, how can an instructor best help his or her students? Perhaps they can best reach all students by incorporating a variety of teaching methods. According to research by Higbee, Ginter, and Taylor (1991) and by Lemire (1988), student outcomes improve when students are able to use their preferred learning style. According to Kenner & Weinerman (2011), by understanding their own learning preferences and the characteristics of their own learning style, students develop their own strategies to improve their learning and increase their chances for success.

A wide variety of teaching methods and instructional techniques can be utilized in mathematics education. What makes education fascinating is that each instructor can chose any combination of methods and techniques to help his or her students learn. It should be noted that these teaching methods do not exist in isolation. For instance, an instructor could have engagement of students while they play a game and be using two methods at once. The purpose of this research study is to note the techniques and methods that effective instructors of developmental mathematics use. By knowing what works well, new instructors can be informed about what works the best for this type of student.

Chapter 3

Methodology

The purpose of this qualitative study was to observe and record video of effective developmental mathematics instructors as they teach, and then analyze which teaching methods and instructional strategies they utilized. The investigation specifically focused on the following teaching methods: direct instruction, group work, and constructivist techniques; and on the following instructional strategies: the use of manipulatives, technology, games, graphic organizers, think-aloud techniques, active participation, modeling, and scaffolding. After the lesson ended, students in the classroom were given a questionnaire about the instructor's effectiveness. The researcher subsequently telephoned a subset of the student volunteers so that they could expand upon what they wrote. The instructors were emailed after the lesson and asked for their opinions about how the day went. The researcher and two other educators then coded the videos to determine the nature and extent of the teaching methods and instructional strategies that contributed to the perceived effectiveness.

Research Questions

In order to discover more information about the actions of developmental mathematics instructors that help students to be successful, the research was guided by the following overarching questions:

1. Which research-based *teaching methods* do instructors of developmental mathematics use in their daily teaching practices?
2. What research-based *instructional strategies* do instructors of developmental mathematics use in their daily teaching practices?

3. How do students respond to those teaching methods and instructional strategies?

The first and second questions focus on the instructor, while the third question focuses on the students.

Knowing the teaching methods and instructional strategies that work best with developmental students is important because effective techniques can be shared with other instructors. Then these instructors can utilize these techniques to better instruct their students, and students can be assured that the teaching they are receiving is indeed effective.

Setting

Rowan University. The setting of this study is Rowan University in Glassboro, New Jersey. Rowan University is a public university that was founded in 1923 as Glassboro Normal School for the education of teachers. In the 1930s it became New Jersey State Teachers College at Glassboro and was again renamed Glassboro State College in 1958. In the 1970s programs were added in business, communication, and engineering. In 1992, Henry Rowan donated $100 million to the school, the largest gift to a public college at the time, and the school was renamed Rowan College of New Jersey. The institution was again renamed Rowan University in 1997 when it won approval for university status from the New Jersey Commission on Higher Education. In 2012 and 2013, the university acquired two medical schools ("From Normal To Extraordinary," 2013). Rowan University became the second institution in the nation to operate both a D.O.-granting medical school (Rowan School of Osteopathic Medicine) and an M.D.-granting medical school (Cooper Medical School of Rowan University) simultaneously

("From Normal To Extraordinary," 2013). In August 2014, Rowan University was designated as a comprehensive public research university by the State of New Jersey ("Rowan History," 2015).

In the Fall 2015 semester, 16,155 students were enrolled at Rowan University, an increase of 1377 students since the Fall 2014 semester (Saadeddine, 2015). Of those, 2766 students were freshmen (Saadeddine, 2015). The average SAT scores for first-time regularly admitted freshmen was 1115 ("Rowan Fast Facts 2015-2016," 2015). In 2015, there were 74 bachelor's degree programs, 51 master's degree programs, and 4 doctoral degree programs ("Rowan Fast Facts 2015-2016," 2015).

Rowan University received national attention in 2014 when *U.S. News & World Report* ranked Rowan University 19th (tied) in their "Best Regional Universities in the North" category and third among public institutions in the category ("Regional Universities North Rankings," 2014). The College of Engineering was ranked 33rd nationally among master's level programs and 12th in the nation among programs at public institutions ("Regional Universities North Rankings," 2014). Rowan University is listed in *The Princeton Review's* "The Best Northeastern Colleges" and Rowan's Rohrer College of Business was also included in its "Best . . . Business Schools" list, 2016 edition ("Best Northeastern Colleges," 2016).

Rowan University continues to expand. In June 2013, they partnered with the former Gloucester County College to create Rowan College at Gloucester County (RCGC). Similarly, in June 2015, a partnership was created with Burlington County College to create Rowan College at Burlington County (RCBC). In the last ninety years, this institution of higher education has gone through a great deal of growth and Rowan University continues to grow and change.

Basic Skills mathematics. At Rowan University, Basic Skills courses are offered in reading, writing, and mathematics. For admission to Rowan University, students are evaluated by their SAT scores and/or their scores on a placement test called Accuplacer®. Transfer students may be automatically waived from taking a placement test if they have completed certain courses. If the evaluation finds gaps in their learning, some students must take Basic Skills courses before moving on to courses that are needed for their major. Basic Skills courses "provide an appropriate curriculum for students with documented weaknesses in the areas of reading, mathematics, and writing" (Freind, 2014).

The Basic Skills Mathematics program is managed by the Academic Success Center in the division of Strategic Enrollment Management, and is overseen by the Assistant Vice President for Student Retention. The Basic Skills Mathematics sequence includes two classes, Basic Algebra I and Basic Algebra II. Each course currently covers half of the textbook *Introductory Algebra* written by Martin-Gay (1999) and published by Pearson. Although Basic Algebra I and Basic Algebra II are two-credit courses, the credits do not count toward electives, mathematics requirements, grade point average, nor toward any cumulative university averages. The course is graded on a satisfactory/unsatisfactory scale and without letter grades. Basic Skills Mathematics is considered separate from the Mathematics Department, although both are in the College of Science and Mathematics. During the fall 2015 semester, there were 291 students enrolled in Basic Algebra I, and 385 students enrolled in Basic Algebra II ("Section Tally – Fall 2015," 2015).

Basic Skills classes at Rowan University bear two credits, although typical courses at this university bear three or four credits. Basic Skills courses have a class length of fifty minutes and meet twice a week. On the other hand, three-credit courses have a seventy-five minute class period that meets twice a week.

Of the 5,765 students enrolled in mathematics courses at Rowan University during the Fall 2015 semester, 676 students were in Basic Skills courses and 5,089 were in traditional mathematics courses that were not Basic Skills courses ("Section Tally – Fall 2015," 2015). Therefore, approximately 13.3% of students taking math classes at Rowan during the Fall 2015 semester were taking Basic Skills courses.

Rowan Select. The Rowan Select program is for incoming freshman that have not met the regular admission requirements for Rowan University in the fall term. Although their high school performance may be lower than that of the average admitted university freshman, they have been given a chance to increase their access to a university based on their academic potential and growth ("Rowan Select," 2016). These students complete a two-credit hybrid-format course called *Rowan 101: College Success* in the summer before their freshman year. They stay an extra day at freshman orientation to begin their coursework for Rowan 101 on campus and then complete it at home on the computer via Rowan University's Blackboard Learn™ learning management system. During the fall semester, students are fully admitted freshman in the exploratory studies program and are supported by the University Advising Center ("Rowan Select," 2016). They are full-time students carrying 12 to 15 credits in the fall semester. Three of their courses are taken with other Rowan select students: a mathematics course, a writing course, and a Rowan Seminar section of a humanities or social science course. One or two additional courses are taken with the general population. Rowan Select students are given specialized faculty and special supports such as tutoring and advisement (“Rowan Select,” 2016).

Of the 5,765 students enrolled in mathematics courses at Rowan University during the Fall 2015 semester, 420 students were in classes designated as “Rowan Select Students Only” (“Section Tally – Fall 2015,” 2015). Therefore, approximately 0.07% of students taking math classes at Rowan during the Fall 2015 semester were also members of the Rowan Select Program (“Section Tally – Fall 2015,” 2015). Of the students taking Basic Algebra I in the fall semester, approximately 40% of students were also members of the Rowan Select program (“Section Tally – Fall 2015,” 2015).

Of the four classes that were recorded on video for this study, one class contained all Rowan Select students. The other three classes were comprised of students accepted via the regular admission process.

Classroom space. Ordinary classrooms at Rowan University are approximately 20 feet by 20 feet square. Typical rooms seat 40 students, but some lecture-type rooms are larger. Some rooms have desks with attached chairs, and other rooms have tables long enough to pull up two chairs each. Student seating is usually arranged in rows and columns. In the front of each room is an instructor’s desk with a rolling office chair. A computer sits on top of the instructor’s desk. HDMI and VGA cables and ports are available so that an instructor may hook up his or her own laptop computer or other equipment. A projector attached to the ceiling shines the image from the computer or other electronic device onto a retractable screen in the front of the room. A lectern is at the front of the room. Some rooms only contain a tall desk instead of a separate desk and lectern, which also houses all of the desktop computer equipment. Whiteboards, for writing with erasable markers, are either at the front or sides of the room, and sometimes in both locations. Sometimes classrooms have a row of windows along all or most of one side of the room.

Smaller classrooms are often used for Basic Skills classes, because the number of students enrolled cannot exceed twenty. These classrooms typically seat 16 to 20 students, and are located along the internal hallways of the buildings, and do not contain windows, but contain most or all of the other features. Three of the classes observed for this study took place in these smaller classrooms. One classroom where recording of video took place was in the music building; it contained windows, and additionally, a piano and music stands in the front of the room, off to one side.

Participants

Selection of instructor participants. Effective instructor participants to study were explicitly selected via a snowball sampling enrollment technique, starting with the coordinator of the program in question. The Coordinator of Basic Skills Mathematics at Rowan University has served in this position for two years and has taught thirty sections of Basic Algebra I over six years.

Because of her position as Coordinator of Basic Skills Mathematics, this person was deemed an effective instructor for the purposes of this study, and one who would offer a knowledgeable starting point. The Coordinator of Basic Skills Mathematics was then asked to identify other effective instructors of Basic Algebra I at Rowan University who would be teaching in the Fall 2015 semester.

Of the instructors teaching Basic Algebra I on Rowan's main campus in the Fall 2015 semester, two had been selected by a committee of four professors to fill open positions in the Rowan Select Program one year prior. In order to be hired for these positions, candidates were narrowed down from hundreds of applicants. Twenty job candidates were chosen to present a lesson and be interviewed, and two were eventually hired to be instructors of Rowan Select Students. Because these experienced instructors taught a lesson as part of their selection process, were employed successfully for the previous academic year in this assignment, and were chosen by a committee of peer professors, the Coordinator of Basic Skills Mathematics considered them effective instructors of developmental mathematics and likely first participants. Other participants were chosen because of their positive results with students. According to the Coordinator of Basic Skills Mathematics, these instructors "have a good deal of experience and are considered effective instructors of developmental mathematics," (C. Rodano, personal communication, August 18, 2015). Those that were available and willing to participate became the final instructor participants.

Snowball sampling is a technique in which existing participants recruit future subjects from among their acquaintances; thus the sample group grows like a rolling snowball. Snowball sampling is also known as chain sampling, chain-referral sampling, or referral sampling (Morgan, 2008). It can be used to identify experts in a field, or in the case of this study, to identify effective instructors of developmental mathematics.

Biases exist in snowball sampling. There is community bias where the original participant will have a strong impact on the sample. For example, people who have many personal contacts are more likely to be recruited into the sample, as was the case in the present study. Snowball sampling is a convenience sampling and not a random sampling and as such will contradict many of the assumptions supporting the conventional notions of random selection and representativeness (Biernacki & Waldorf, 1981).

One advantage of snowball sampling is the possibility for the researcher to include people in the study that would not have been known to them previously. The population of specific interest for this study is difficult to locate because there exists no lists or other obvious sources for locating members. Social systems are beyond the researcher's ability to recruit randomly; therefore snowball sampling is inevitable in social systems (Biernacki & Waldorf, 1981). For this reason, snowball sampling was selected for this study, and volunteer instructor participants at the university were solicited based upon peer recommendations via this method.

Selection of courses for observation. During the Fall 2015 semester at Rowan University, nineteen sections of Basic Algebra I were offered. One section was offered at the Camden satellite campus, and the rest were held on the main campus in Glassboro. Three of the sections were offered in the evening. Seven sections, all offered during the day, were for Rowan Select students only ("Section Tally – Fall 2015," 2015). This research study included both Rowan Select classes as well as classes for the typical basic skills population. The course material is the same in both classes. Of the four sections of Basic Algebra I observed in this study, one section contained students in the Rowan Select Program and three sections did not. Professors who chose not to participate in the study, including the researcher, taught the remaining sections.

The focus of this study was on instructors teaching three algebraic concepts: factoring trinomials with a leading coefficient, solving quadratic equations, and graphing equations. By looking at an instructor's course syllabus, the researcher identified which part of the semester to observe. In the fall semester, these concepts are generally taught in November. The researcher observed the students in the classes before, during, and after the teaching of that concept.

Selection of student participants. The students included in the study were those students in the classes of the participating instructors. However, students who were not eighteen years old or older could not participate in the study and were excluded. Additionally, individual students had the option of opting out of the study at any time. Students were also given the option to move to the back of the room and behind the camera, so that they would not be captured on the video, or to switch class sessions for the duration of the study to avoid the video recording.

The subjects of this study were students taking the course Basic Algebra I, the first of two classes in the Basic Skills Mathematics sequence. In these classes, there was a gender balance with an approximately equal amount of males and females. Fifty-six students were included in this study and participated in the lessons that were recorded on video.

Student participant consent. The researcher described the study to the students and the instructor in each class that was involved in the study. The researcher told students that their participation in the study was not mandatory and were assured that their scores on these surveys were not going to affect their grade in the course in any way. In fact, only the researcher, and not their instructor, would know the scores on the Pre-Lesson Knowledge Survey and the Post-Lesson Knowledge Survey. Further, the student's instructor would not know any specifics about the students' perceptions until the final study results were shared at the pizza party the next semester.

Each student was asked to fill out a Participant Consent Form for Students (Appendix A). Page one described the researcher's background and the details of the study. Page two reiterated to students that they were not required to participate in the study, described the incentives, listed contact information for the Institutional Review Board of Rowan University, described the benefits of the study, and thanked the students for their assistance. At the bottom of page two, students were asked to check a box to indicate their agreement to participate in the study. Copies of these forms were available for the participants to take home.

Each instructor was asked to fill out a Participant Consent Form for Instructors (Appendix B). Similar to the Participant Consent Form for Students, page one described the researcher's background and the details of the study. Page two reiterated to instructors that they were not required to participate in the study, described the incentives, listed contact information for the Institutional Review Board of Rowan University, described the benefits of the study, and thanked the instructors for their assistance. At the top of page three, instructors were asked to check a box to indicate their agreement to participate in the study. Instructors had the option to choose not to participate. Four instructors agreed to participate in this study.

Data Collection

Recorded video. Recording of video took place during the Fall 2015 semester in developmental mathematics classes at Rowan University, specifically Basic Algebra I classes. A Canon VIXIA Mini X camera affixed to a tripod captured audio and video of the class. The video was recorded on three removable 8-gigabyte SanDisk Ultra III secure digital memory cards. Sliding a tab on the side of the card locked the secure digital card when it was full of data. The equipment was borrowed from the Information Resources and Technology Department of Rowan University, and after recording, the digital memory cards were kept in a secure physical location for the duration of the study.

The camera was set up in the back of the room, in one corner, as this was a non-intrusive position. As necessary, some students were positioned behind the camera, but most students were in front of the camera. The height of the camera was just above the students' heads when they were seated, and a wide-angle lens was used. The camera angle was selected to capture both the white board and the projection screen in the classroom, as instructors used both. The camera also captured the movement of the instructor around the classroom for the entire class period.

The week before the video recording of the target lessons began, the camera was set up in the room and was in operation. The purpose of this was twofold. First, it was an opportunity for the researcher to practice attending to the camera and to work out any difficulties before the filming for the study began. Second, it was an opportunity for the students and instructor to get used to the camera being in the room, thus possibly mitigating the Hawthorne effect. These videos were not used as part of this study, and formatting the secure digital card erased the data from these practice sessions. Instructors were asked if they believed that the recording of video caused the students to behave differently than they ordinarily would. Each instructor felt that the students were not particularly bothered by the video camera. Each class section was recorded on video over the course of three lessons: the lesson before the target lesson, the target lesson itself, and the lesson after the target lesson. In all, six hours of video was recorded.

Pre-lesson questionnaire for students. Page three of the Participant Consent Form for Students contained a short questionnaire. Students were asked if this was the first time they have taken this course, Basic Algebra I, or how many times they had taken the course before. The final question asked students how long ago they took their most recent math class. They were asked to check one of three boxes indicating if it was last year; before last year, but not more than three years ago; or more than three years ago. Students took approximately two to four minutes to complete the questionnaire.

Pre-lesson knowledge survey. The Pre-Lesson Knowledge Survey (Appendix C) was given to students before the lesson was started. The intention was to assess the students' knowledge about the subject before the lesson on that subject was taught.

The survey consisted of two mathematical problems, with the first question being less difficult than the second. Students were asked to try to complete the problems, even if they were unsure of the answer. The researcher assured students that these surveys would not count as a grade, but were for the researcher's information only, so their prior knowledge could be assessed. The students' regular instructor did not see these surveys. Students were allowed as much time as needed to complete the survey, and then they were handed to the researcher.

The survey was graded by the researcher using five points for each of the two questions, for a total of ten points for the survey. Partial credit was possible if a student showed some correct work but did not arrive at the correct answer. Grades were recorded and statistical information on class performance was collected.

Post-lesson knowledge survey. The Post-Lesson Knowledge Survey (Appendix D) was given to students after the conclusion of the lesson. Its intention was to assess the students' knowledge about the subject after that subject was taught. A student's gain or loss of points from the Pre-Lesson Knowledge Survey to the Post-Lesson Knowledge Survey would be noted, and this could be an indicator of student achievement as a result of the instruction received.

The survey consisted of two mathematical problems, with the first question being less difficult than the second. The first question of the Post-Lesson Knowledge Survey was equally as difficult as the first question of the Pre-Lesson Knowledge Survey. Likewise, the second question of the Post-Lesson Knowledge Survey was equally as difficult as the second question of the Pre-Lesson Knowledge Survey. Students were asked again to try to complete the problems, even if they were unsure of the answer. The researcher assured students that these surveys would not count as a grade, but were for the researcher's information only, so their current knowledge could be assessed. The students' regular instructor again did not see these surveys. Students were allowed as much time as needed to complete the survey, and then they were handed to the researcher. The researcher graded the Post-Lesson Knowledge Survey in the same manner as the Pre-Lesson Knowledge Survey.

Post-lesson questionnaire for students. Immediately following the Post-Lesson Knowledge Survey, students were given the Post-Lesson Questionnaire for Students (Appendix E). The questionnaire asked students what went well and what did not go well during the lesson, what were the best and worst things the instructor did that day, and what they liked and disliked about the lesson.

Post-lesson student telephone interviews. At the bottom of the questionnaire, students were asked if the researcher could call them and ask questions about today's lesson, and space was provided for students to write their phone number and the best time to call. Each student responded. Nineteen students in total indicated that they could be contacted on the Post-Lesson Questionnaire. The researcher contacted them by telephone before the end of the day, and used the questioning process highlighted on the Student Telephone Interview Protocol (Appendix F) to delve deeper into the students' responses on the Post-Lesson Questionnaire. All nineteen student participants responded.

Instructor response email. After the lesson was taught, the researcher sent a follow-up email, The Instructor Response email (Appendix G) to each instructor. This email thanked the participant and asked four questions. Each instructor was asked what he or she thought went well with the lesson and what did not go well with the lesson. The instructors were also asked to name the best thing and the worst thing they did in class that day. All four participating instructors responded.

Observed Teaching Methods and Instructional Strategies

The videos captured various teaching methods and instructional strategies used by the instructors as they moved through their lessons. The researcher created a list of three teaching methods and eleven instructional strategies that appeared repeatedly in the literature. From this list, the Checklist of Observed Teaching Methods and Instructional Strategies (Appendix H) was created.

Teaching Methods

For the purposes of this study, the term *teaching methods* will refer to the principles and methods the instructor uses to instruct students. Some examples of commonly used teaching methods are direct instruction, group work, and constructivist teaching. Instructors may vary their teaching methods at their discretion for the skill that is being taught or for other reasons. Students may have seen these methods earlier in their educational careers, as they are common in K-12 education.

Direct instruction. Direct instruction is the explicit teaching of the skill set using lectures or demonstrations of the material, as opposed to the exploratory models such as inquiry-based learning and discovery by the student. Examples of direct instruction include tutorials, discussion, recitation, seminars, workshops, and observation. Direct instruction, also known as lecture-based instruction, may be the most commonly used teaching method, especially in higher education. The reason for this is that its simplicity, and the fact that many topics may be covered in a short amount of time. In direct instruction, the instructor lectures to the students. In the most basic format, the instructor gets the students' attention, teaches them something, and prompts them to respond to demonstrate mastery (Jones & Southern, 2003).

In 1964, at the University of Illinois Institute for Research on Exceptional Children, Engelmann and Becker developed the direct instruction model DISTAR™ — Direct Instruction System for Teaching Arithmetic and Reading (Grossen, 1996). This program has been expanded and rebranded by SRA/McGraw-Hill and is still available today. Another popular example of direct instruction is the Success for All® reading program designed by Johns Hopkins University professor Slavin in the 1980s for the failing inner city schools of Baltimore (Stockard, 2010). In this program, teachers followed a daily ninety-minute pre-preplanned lesson where every minute was scripted with instruction and specific activities. Supporters of this method suggest that during lecture-based instruction, teachers gained a better understanding of student needs, and could adjust their instruction accordingly (Hodara, 2011). Frequent testing, classroom assessment techniques, formative assessments, and student input contributed to student success.

Direct instruction is highly structured and has been a source of great criticism. Critics of this method suggest that is not very engaging for students. An instructor may find it difficult to effectively tailor direct instruction to a wide range of ability levels. Yet Adams and Engelmann's book, *Research on Direct Instruction: 25 Years Beyond DISTAR* (1996), speaks about the myth of direct instruction, and posits that direct instruction continues to be successful after many years in use. Stein, Carnine, and Dixon (1998) call direct instruction an effective teaching practice and provide a rationale for using direct instruction in a variety of content areas.

Group work. Group work is when students work together as partners or in groups. Partner work is a popular type of group work. Think-Pair-Share is one technique that allows students to discuss ideas with a partner. According to Azlina and Nik (2010), Think-Pair-Share involves the sharing ideas with a partner, which enables students to assess new ideas, and if necessary, clarify or rearrange them, before presenting those ideas to a larger group. In group work, the instructor may act as a supervisor or manager, overseeing a project that students complete, and this dynamic allows for the greatest growth of the student (Azlina & Nik, 2010).

Cooperative learning is another method that can be very effective if done correctly. In this technique, popularized by Slavin (1987), students are put in small groups to work together to accomplish a task. Groups are made up of students with many ability levels. Theoretically, the students with the highest ability both model for and assist the students with the lowest ability. At the end of a period of time, groups are asked to report back to the instructor or the class about how they completed the task. Group members may have different roles in the group. For example, one group member may be in charge of obtaining supplies, another may record information, another may orally report to the class, and another may be in charge of making sure everyone in the group is on task. Instructors monitor these groups carefully to make sure that the group is on task and that everyone is participating (Slavin, 1987).

Collaborative learning is a teaching method that has its roots in the ancient civilizations of Greece, India, and China. The term *collaborative learning* may have been coined in the 1950s by a group of British secondary school teachers. Mason (1970), of Goldsmith College at the University of London, used the term in his polemic, *Collaborative Learning*, and suggested that schools should eliminate the socially destructive authoritarian social forms of education and should instead democratize it. Collaborative learning only recently became of interest to college instructors in the United States in the last thirty years (Bruffee, 1984). Although collaborative learning may not have one point of origin or founder, the ideas were brought to the West through the writings of Vygotsky, who believed that there is a social aspect to learning; Dewey, who wrote of the social nature of learning through discussion; Alpert, who described interdependence among group members; and Piaget, who discussed intellectual development being fostered by social interaction (Banerjee, 2012).

Collaborative learning occurs when instructors designate students of varying ability levels to work in small groups. Advanced students are able to help students who are struggling. This helps the advanced student to become more familiar with the subject, while the struggling student gets help. Peer tutoring is another example of collaborative learning. Here the students of higher ability are helping the students of lower ability (Kelly, 2013). Students are given a problem to be solved or a question to be answered. There may be no right or wrong answer. In collaborative teaching, the focus on the instructor's authority is removed. The instructor's role is on mediating student interaction, but not to intervene on the students' conversations. After the groups discuss, the instructor evaluates, but does not judge, the students' work. Next, ideas from each group are presented to the class, and the answers are compared. In this way, authority is not on one individual.

Johnson, Johnson, and Smith (1991) describe the effectiveness of group work in higher education, what they call "cooperation in the college classroom," and refer to it as "active learning." The authors believe that the use of group work increases the productivity of higher education faculty. Mills and Cottell (1997) provide a rationale for higher education faculty to use cooperative learning because it creates communities within classrooms and is part of effective teaching.

Constructivist teaching. The constructivist teaching method, popularized by Dewey (1916) and Piaget (1967), requires that students do experimentation and look at the results of those experiments to reach their own conclusions. This does not involve telling students the rules of math, but instead expects the students to discover these rules on their own. The instructor discusses with and nudges the students toward the right direction by guiding instruction and asking questions of the students that lead them to discovery. An example of constructivist teaching would be letting students manipulate blocks and letting students come up with their own way of finding area of a rectangle, as opposed to giving students the formula. Constructivists argue that students are more likely to remember a rule if they discover it on their own rather than being told about it (Palincsar, 1998).

One type of constructivist teaching method is inquiry-based learning. Inquiry-based learning is based on the scientific method. This method takes much more time, energy, and planning for the instructor, but is very effective. Students use problem-solving and critical thinking skills to make a conclusion. Inquiry-based learning is very student-centered, student-focused, and student-directed and may be modified for students at every ability level. In this approach, posing questions to students stimulates learning. Engaged learners construct new knowledge and understanding. The instructor's role is a facilitator role, and learning is more self-directed (Spronken-Smith et. al., 2012).

Rovai (2004) describes a constructivist approach to learning in college as promoting effective learning. Both cognitive and social constructivist approaches are keys to an effective college environment because of the potential for individual discovery learning, according to Powell and Kalina (2009). Yilmaz (2008) mentions that constructivism is "a learning theory [that] can guide the process of learning and teaching in real classroom settings" (p. 161).

Instructional Strategies

Teaching methods are not the only information about effective teaching provided by the instructors. The videos may also capture a range of instructional strategies used by the instructors in the classroom. For the purposes of this study, the term *instructional strategies* will refer to those experiences in teaching that make the attainment of knowledge and skill interesting, effective, and appealing to students. Some examples of commonly used instructional techniques are the use of manipulatives, graphic organizers, technology, games, or graphic organizers. As an instructional technique, instructors may choose to use humor or may show their positive attitude toward the subject and the lesson. Stating the objective, engaging students, modeling, scaffolding, and letting students know why the current topic is important and relevant in the real world are additional instructional techniques. Instructors may vary the instructional techniques they use as different skills are being taught.

The Checklist of Observed Teaching Methods and Instructional Strategies (Appendix H) was developed by listing these common methods found both in the literature and also prevalent in contemporary practice. Three teaching methods and eleven instructional strategies were included on the checklist, and the coders looked for those methods and strategies when watching the videos.

Statement of the objective. Instructors may state the objective at the beginning of the class period. They could tell the students what they have done in the past, how that relates to what they are working on today, and how that will lead into what they will learn tomorrow. This sets the stage for learning. Instructors who clearly state the objective of the class have a clear plan for where they are going with the lesson. According to Iwanicki (1990), stating the objective creates excitement and gives students something to work for and achieve.

In the book, *Effective Teaching: A Practical Guide to Improving Your Teaching,* Perrott (2014) discusses the effectiveness of stating instructional objectives adequately. She goes on to say that teachers should state what they expect the pupils to learn and not simply describe the upcoming learning activity (Perrott, 2014). Wong and Wong are leaders in the field of professional development for classroom teachers. In *The Effective Teacher,* Wong and Wong (2001) describe the importance of stating the objective of a lesson in order to make student expectations clear.

Use of manipulatives. Teaching with manipulatives is a technique that instructors use when helping students to learn concepts that are more abstract. Using an object that students can touch and manipulate such as geometric shapes, graphs, charts, number lines, or plastic pieces can help students to visualize representations and understand concepts in a more concrete way. Manipulatives can be commercial, or can be instructor-made or student-made. Virtual manipulatives also exist online.

After 1989, the National Council of Teachers of Mathematics, the national professional association in this discipline, recommended the use of manipulatives in the mathematics classroom (Johnson et. al; 2012). Manipulatives help students to think and reason in meaningful ways. According to Stein and Bovalino (2001), "By giving students concrete ways to compare and operate on quantities, such manipulatives as pattern blocks, tiles, and cubes can contribute to the development of well-grounded, interconnected understandings of mathematical ideas" (p. 356). Moyer (2001) also noted the positive effects of the use of manipulative materials in mathematics instruction.

Use of technology. Teaching using technology is another technique to engage learners in mathematical concepts. In fact, technology can be used to supplement a student's college course in multiple ways. For example, courses could be completely online, courses could be hybrid and consist of both classroom and online experiences, or computers could aid only instructors and not students. Technology may be used sparingly, such as when an instructor shows an animated clip that illustrates a concept, or technology may be used in place of instructor instruction.

The use of a calculator can also be considered a use of technology. According to Zavarella and Ignash (2009), when computer-based instruction is used, the instructor can take a back seat and let the computer help the students. This could allow for more differentiated instruction. Advantages of computer-based instruction included cost savings, flexibility in scheduling needs, and the use of modern technology (Zavarella & Ignash, 2009). Using technology in the instruction of developmental mathematics gives students more choices in where, when, and how they learn. Students can then choose the method of instruction that can best meet their needs and that uses their preferred learning style, as pointed out by Kinney and Robertson (2003).

Kulik, Kulik, and Smith (1976) first discussed the effectiveness of interactive video computer-based instruction, what they referred to as a "personalized system of instruction," on the performance of underachieving mathematics students in the 1970s, when computers were just beginning to be used. Decades later, technology is still being used to motivate and assist students in mathematics, especially underachievers in mathematics, as Kulik and Kulik (1991) describe in their updated analysis. The National Council of Teachers of Mathematics included the use of technology as an effective teaching strategy in their *Handbook of Research on Mathematics Teaching and Learning* project, a collection of scholarly works in mathematics research (Grouws, 1992). Additionally, Fairweather (2008) calls the use of technology in STEM (science, technology, engineering, and mathematics) undergraduate education a "promising practice" (p. 25).

Use of games. Some instructors reinforce mathematics skills through the use of games in the classroom. Students can benefit from this technique because games help students to stay motivated and on task because they are perceived as fun and entertaining. Games can be paper-based, board games, manipulative-based, or technology-based. Games permit student engagement, according to Harskamp and Suhre (2006). For example, a card game called the 24 Game® could reinforce the concept of the order of operations. Each card shows four numbers, and students must use those numbers and the operations of addition, subtraction, multiplication, and division, to make a total of 24. Another example is that instructors could make a *Jeopardy!*®-style game on the board and let students solve problems of increasing difficulty. Many more examples are possible.

In their research studying the effectiveness of games in education, Randel, Morris, Wetzel, and Whitehill (2014) found that in subject matter areas where very specific content can be targeted, students were more likely to show beneficial effects when games were used. The authors also found that of all the subject areas studied, mathematics was the subject area with the greatest percentage of results favoring games (Randel, Morris, Wetzel, & Whitehill, 2014).

Crocco, Offenholley, and Hernandez (2016) used a large sample size and quantitative measures in their study and found that game-based learning in higher education increased students' enjoyment levels, especially where students reported the greatest anxiety about learning. The results of this study (Crocco, Offenholley, & Hernandez, 2016) also showed that this enjoyment resulted in positive improvements in both "deep learning" and higher-order thinking.

Use of graphic organizers. The use of graphic organizers is another teaching technique. Graphic organizers can be graphs, charts, trees, webs, flowcharts, diagrams, and more. Instructors use graphic organizers with students to facilitate their learning. Keeping their thoughts in one place keeps students from getting confused (Monroe, 1998). For instance, steps for solving equations could be presented in a flowchart to help students keep track of the order of the steps. Another example would be the use of a Venn diagram to show the relationships between whole numbers, natural numbers, rational numbers, radicals, real numbers, and imaginary numbers.

Graphic organizers can be used to help students visualize information. Students may have more success with this concrete tool rather than thinking more abstractly about a topic. A study by Ives (2007) shows that students who used graphic organizers as a tool to assist them with mathematical concepts and steps had a stronger grasp of the conceptual foundations for solving equations than those students who did not.

Horton, Lovitt, and Bergerud (1990) studied the effectiveness of graphic organizers on learning disabled students in a mainstream setting and remedial students. Their research found that the use of graphic organizers produced significantly higher performance than self-study whether the graphic organizer was teacher-directed, student directed with text references, or student-directed with clues (Horton, Lovitt, & Bergerud, 1990).

Student engagement. Alvarez, et. al. (2013) discuss the importance of keeping students engaged by having them actively participate in class. Active participation of students can take many forms, such as using individual whiteboards to write on and holding up the correct answer for the instructor to see, indicating agreement or disagreement with the responses of other students by showing thumbs up or thumbs down, and using the technique of think-pair-share which allows students to discuss ideas with a partner. Some forms of active participation can be aided by technology. Equipment such as interactive whiteboards and pens and computerized student response systems are available. For example, students can select a multiple-choice response using a remote control linked to a SMART Board® interactive whiteboard. The instructor can see at a glance the percentage of students who answered correctly and adjust the lesson accordingly.

Handelsman, Briggs, Sullivan, and Towler (2005) measured college student course engagement with the Student Course Engagement Questionnaire. The authors analyzed skills engagement, participation and interaction engagement, emotional engagement, and performance engagement; and found that freshmen college students engaged in the course wanted to learn the material and did not just worry about receiving an external grade for the class (Handelsman, Briggs, Sullivan, & Towler, 2005). A study by Kuh, Kinzie, Schuh, and Whitt (2011) found that students who connect in meaningful ways with their instructors in college have success, but also describe that some students who do not connect with their instructors in this way still succeed. Umbach and Wawrzynski (2005) say that engagement by college faculty plays a role in student learning. Students in this study report that higher levels of learning at institutions where faculty members engage students in experiences, interact with students, and challenge students academically (Umbach & Wawrzynski, 2005).

Modeling. Jonassen and Ionas (2008) describe modeling as the most commonly used teaching technique. Behavioral modeling is when an instructor demonstrates to students how to perform the activities he or she is teaching and asks students for similar behaviors. Cognitive modeling is when an instructor articulates what he or she is thinking to illustrate the reasoning that a learner should use while engaged in these activities.

Bonner (2013) believes that think-alouds have their place in mathematics education. A think-aloud is a teaching technique using explicit explanation of the steps of problem solving through instructor modeling and metacognitive thought. Instructors speak to the students about what they are doing as they work through problems at the board. This allows the students to know the instructors' thought processes more explicitly as he or she constructs solutions.

Hartman (2001) encourages teachers to teach metacognitively, what she describes as thinking about thinking, and knowing about knowing. She advocates planning what will be taught and demonstrating to the students and illustrates techniques for modeling (Hartman, 2001). Collins, Brown, and Newman (1989) contend that the difference between a novice and an expert in mathematics is that experts employ modeling techniques to coach students. The authors refer to a "knowledge-telling" technique when modeling a concept with students where the teacher externalizes a cognitive process that is usually internal (Collins, Brown, and Newman, 1989). In this way, a student observes an expert carrying out a task and builds a conceptual model of the processes that are required to accomplish the task.

Scaffolding. Scaffolding is another teaching technique that uses a more systematic approach to supporting the learner, as described by Coulson and Harvey (2013). Here, the instructor focuses on the task, environment, and learner. When a learner and instructor are performing a task together, the instructor provides temporary frameworks to support the learning and student performance. For example, the instructor may ask students to solve a problem, and may at first have the steps of the problem solving process written out for the student to follow. Later, the steps may not be written out, but there may be a hint. These hints are eventually removed until the student can do the activity on his or her own. This differs from behavioral modeling in that the student is doing the work and is actively engaged, and not just watching the instructor.

Instructional scaffolding is a term first introduced by the cognitive psychologist Jerome Bruner. To promote a deeper level of learning, students build upon the skills they have learned in the past. If the learning process is tailored to the needs of the student, students can be helped to achieve their goals. As the student progresses, the supports are removed until the student is completing the task on his or her own (Sawyer, 2006). Vygotsky (1987) suggests that higher order thinking occurs when teachers instruct at the student's zone of proximal development, the place between where a student can complete a task independently and the place where a student can complete a task with scaffolding. The term "fading" is used to describe the gradual removal of the supports until the student can complete the task on his or her own.

Decades ago, Brown and Palincscar (1984) described what they called "reciprocal teaching," a form of suggestions and help that teachers offered their students. In this form of scaffolding, the teacher carries out the parts of the work that the student cannot yet manage, and this cooperative problem solving effort results in an increase in student achievement (Brown & Palincscar, 1984). Collins, et. al. (1991) described a framework for scaffolding, or the "cognitive apprenticeship model," in three subjects, including mathematics. He found that this method was useful for all students, but was especially effective for disadvantaged or at-risk students because learning is embedded in a setting that is more like work, with a connection to the students' lives (Collins, et. al., 1991).

Use of humor and fun. Instructors often search for ways to reach their students and hold their attention. One technique that instructors may use is humor. Telling a joke may serve to keep students engaged and to keep the mood lighthearted. Stress and frustration may be reduced when an instructor uses humor. Instructors with a sense of humor may leave a lasting impression in the students' minds. Students also remember instructors that they describe as "fun." Humor, if used wisely, may even increase a student's learning, according to Torok, McMorris and Lin (2004). However, Garner (2012) cautions that in some cases humor can also be detrimental to a learning environment.

A study by McBride and Rollins (1977) found that humor used while discussing the effects of history on mathematics positively impacted students' attitudes of college algebra. More than thirty years later, Kher, Mostad, and Donahue (1999) found that using humor in the college classroom enhanced teaching effectiveness and learning for students, especially in "dread courses" that students avoid due to their lack of confidence, perceived difficulty of the material, or a previous negative experience in a content area. The use of humor and fun motivates students and establishes a classroom climate that is conducive to their learning, according to Kher, Mostad, and Donahue (1999). Further, appropriate and timely humor fosters mutual openness and respect between the student and the instructor, and contributes to the overall teaching effectiveness of the instructor (Kher, Mostad, & Donahue, 1999).

Positive Attitude. Instructors may exhibit a positive attitude toward their students and also the subject matter. An instructor who is upbeat and energetic may be able to more effectively motivate his or her students. Instructors may show their passion for their subject area, or may show that they enjoy their work. When instructors are excited about a topic, students tend to also be excited. The positive energy can be contagious. Koballa and Crawley (2010) discuss the positive attitudes of instructors when teaching subject-area material and its positive effect on their students.

Pupils' attitudes and achievement in mathematics are positively related, according to Aiken (1975), and students improved their arithmetic self-concept through positive reinforcement. Wachtel (1998) reviewed student written evaluations of the teaching performance of college and university instructors. Students rated components of instruction unrelated to grading fairness, such as humor, self-reliance, and positive attitude, and Wachtel (1998) found that there was a moderate positive correlation for student achievement when an instructor displayed positive attitude.

Real-world relevance. Bell (1988) posits that children's learning of subject matter is the "product of interaction between what they are taught and what they bring to any learning situation," a constructivist perspective. Thus, she concludes, a teacher must illustrate to his or her pupils a reason for learning the material (Bell, 1998). Bell (1998) goes on to say that prospective teachers learning to become formal teachers should "unlearn" their images of mathematics teaching and feelings about mathematics. In order to be effective instructors, Bell (1998) says teachers must not teach the way they were taught; and must dispel myths such as, "mathematics does not have much relationship to the real world, and most mathematical ideas cannot be represented any way other than abstractly, with symbols," and, "knowing mathematics means knowing *how to do it*," rather than applying it to real-world situations.

Kenner and Weinerman (2011) suggest that instructors should explain to learners the reasons that the skills being taught in the classroom are important in the real world. Students want to know the answers to the questions, "Why is this important?" and "When will I need to use this information?" Instructors may give the students the rationale for what they are learning. In this way, students could see the relevance to their own academic careers and beyond. Learners want to know how the course would meet their individual needs and need to know that there is a reason behind the tasks they are being asked to complete.

Limitations of the Study

Recording video and the Hawthorne effect. Video does not always capture the entire dynamics of the class. Additionally, when there is a video camera in the room, subjects may behave differently than if the scene was not being recorded. Further, the Institutional Review Board may limit the ways in which a researcher may use captured video of human subjects.

The Hawthorne effect is a limitation of video-recorded data collection. The Hawthorne effect, also known as the observer effect, is a term coined by Landsberger in 1950 while analyzing experiments done at the Hawthorne Works. This is a phenomenon where the people being recorded on video may change their behavior because the camera is rolling (McCarney, Warner, Iliffe, van Haselen, Griffin, Fisher, 2007). However, the researcher can develop techniques to minimize disturbances associated with video recording in the natural setting, thus reducing participant reaction. For example, the camera operator should be in the setting at least 10 minutes before starting the recording, should minimize physical movement, and should dress in a manner similar to those being observed (Waltz, Strickland, & Lenz, 1991). Strategically placing the camera next to a large piece of furniture, a pillar, or a hallway so that it blends into the setting will also reduce participant reaction to it. By setting up the video camera in advance and then moving away from the scene, the operator will also decrease reactions to himself (Waltz, Strickland, & Lenz, 1991).

To minimize the Hawthorne effect, the researcher recorded lessons on video before the lessons that were studied in an effort to get students to be used to the camera. While filming was taking place, the researcher remained in one place, next to the camera. The researcher did not move about the room during the lesson to minimize distraction. The camera was set up at the back of the classroom, behind the students, so that the students were not looking at it. The camera did not make any noise while it was running. The students may have forgotten that they were being recorded on video.

There may be issues of informed consent and privacy. Because video recordings are not anonymous to anyone who knows the participant, Robson (1991) suggests that any investigators considering using video recording should ask themselves three questions: (a) *Why do we need videos?* (b) *Who is going to watch them?* and (c) *How will we handle data to maintain confidentiality?* An investigator who records video at public events is acquiring information that ordinarily is not permanently recorded. Investigators must adhere to ethical principles to avoid violation of participants' rights to privacy and informed consent. A consent form may be necessary (NIH, 1991). Students and instructors will be asked to give their informed consent to be recorded on video, and if they do not consent to be part of this study, this could be a limitation.

Participant identification. The research literature does not report the rate of refusal to participate in research studies specifically using recording of video. However, Spoth and Redmond (1992) noted that nonparticipants most often cited intervention time demands and the recording of video as reasons for their refusal to participate.

It could be possible that effective instructors were not included in this study. Some instructors opted out of the study because of time constraints, perceived conflicts of interest, and fear of the permanence of video recordings. It is possible that some of the instructors who opted out of the study are effective instructors. Because this study was limited to one course, effective instructors who did not teach Basic Algebra I may have been missed. Further, effective instructors could be new and unknown to the researcher.

The selection of the students may be considered a limitation of this study. These students were not randomly selected. A convenience sample was used when we selected the students because they were registered in the class of the chosen instructors. Students in this study may not be representative of all students at Rowan University. In fact, students in this study were unlike the general population at Rowan because the students in the study were all developmental mathematics students who scored low on the Accuplacer® test. In this study, only one student requested not to be part of the study. Another student was eliminated because he was less than eighteen years old. Other than that, all students were willing to be part of the study.

Subject loss associated with the recording of video may be reduced by recording behavior unrelated to the research, thus allowing subjects to become desensitized to the camera. The investigator can also strategically stimulate a potential subject's interest in the research before revealing that he or she will be recorded on video. Additionally, the investigator should carefully explain why the recording of video is the preferred method of data collection, should emphasize that video recording will be stopped immediately if the subject becomes uncomfortable, and should give assurance that confidentiality will be maintained. Additional limitations of recorded video include the risk of acquiring poor-quality data because of mechanical problems, the need to provide backup copies of recorded data, and the inability to capture more than one part of a scene at any given time (Heacock, Souder, & Chastain, 1996).

Selection of teaching methods and strategies. A limitation of this study may be the theoretical assumptions. In developing a theoretical framework, the researcher brainstormed the key variables in the research. Large amounts of teaching methods and instructional strategies were found in the literature. The researcher chose the teaching methods and instructional strategies that seemed to appear most frequently in the literature. It is possible that this study would yield different results if other teaching methods and instructional strategies were chosen.

Survey content and validity. There may exist a difference between reported behavior and actual behavior. There is a gray area of in-between responses that may be missed with a survey. There may be too few options on the survey; students may want to answer more. It is possible that the respondent did not understand the question that was being asked on the survey. There may have been too few options for the respondent to answer. If there was a low return rate of the surveys, then perhaps only the passionate people responded, showing respondent bias.

In this study, nearly all students completed the survey. Only one student did not complete the Post-Lesson Knowledge Survey as asked. While it is true that there could be limitations with the use of surveys, using surveys also has benefits for the researcher. The researcher is able to collect data from a large sample size. Many responses can be obtained from a wide demographic group. Surveys are inexpensive, quick, and may be analyzed easily.

Although this study has limitations, the study is important to complete. Even though imperfections in the study exist, the information gleaned from the study may be useful to instructors of developmental mathematics. Therefore, the valuable information to be gained by completing this study outweighs the limitations of the study. It is possible that these and other limitations can be removed in future versions of this study.

Data Analysis

Multiple methods for collecting information are important in qualitative research, according to Maxwell (2013). Using methods such as observation, description, and interview allows a check on each process and eliminates the bias that may come from using only one method. Using different methods also allows the researcher to look at different aspects of the phenomena being studied. For example, observation can describe settings, behavior, and events; while interviewing is used to understand the instructors' perspectives and reasoning (Maxwell, 2013). Analysis of multiple types of data makes qualitative research a rich source of detailed information about lived experiences, which is especially useful in assessing students' perceptions in the mathematics classroom.

Video coders. Some of the data for this research was extracted from the videos of instructors as they taught. The researcher and two additional instructors watched and then coded the videos independently, prior to meeting for discussion of the codes. The second and third coders did not participate in collecting data, but rather only in analysis. The researcher and the second coder are mathematics educators who are familiar with the content that was taught by virtue of their own similar professional experience. The third coder is a director of a teacher preparation program and has extensive experience evaluating teaching skills.

The researcher holds a Bachelor of Science degree in Elementary Education with a Mathematics concentration from Millersville University and a Master of Arts degree in Mathematics Education from Rowan University. She has experience in teaching both developmental mathematics and typical mathematics courses in a college setting. Additionally, she teaches the same Basic Algebra I course with similar students.

The second coder is a teacher of basic skills mathematics. For twenty-four years she has taught all levels of middle school and high school mathematics. She holds a Bachelor of Science degree in Elementary Education with a Mathematics concentration from Trenton State College and a Master of Arts degree in Education from Rowan University. This coder has taught the concepts shown on the videos to her own students.

The third coder is a director in a teacher preparation program at a university. This program serves as a center for the advancement of research on effective educational strategies and programs for advancing best practices. She holds a Bachelor of Arts degree in English Literature from the University of Minnesota and a Masters of Education degree in Curriculum and Instruction from Concordia University. She previously taught in a public high school, and was an instructor at a community college.

Emergent Coding. The coding method chosen for video analysis was *emergent coding*. In emergent coding, categories are established after a preliminary examination of the data (Stemler, 2001). According to Haney, Russell, Gulek, and Fierros (1998), in emergent coding, first two people independently review the videos and come up with a set of features that form a checklist. Next, notes are compared and any differences that show up on the initial checklists are reconciled. Third, the video viewers use a consolidated checklist to independently apply coding. Fourth, the reliability of the coding is checked. If the level of reliability is not 95% agreement, the previous steps are repeated. Once the reliability has been established, the coding is applied on a large-scale basis. Periodic quality control checks are implemented (Haney, Russell, Gulek, & Fierros, 1998). The checklist used for coding in this study can be found in Appendix H. The coders come to a consensus after comparing their individual notes.

Weber (1990) notes, "To make valid inferences . . . it is important that the classification be reliable in the sense of being consistent: Different people should code the same . . . in the same way" (p. 12). The use of emergent coding will help to make the inferences valid. Weber (1990) continues, "reliability problems usually grow out of the ambiguity of word meanings, category definitions, or other coding rules" (p. 15). Emergent coding is a type of methodology can answer the question, "What was going on in this area?" by generating either a substantive or formal theory (Stern, 1995).

Video coding process. Initial analysis began by selecting one lesson at random. The researcher and the other two coders were asked to watch the video independently and were provided with a document, Instructions for Video Watching and Coding (Appendix I). This document asked the coders to be analytical while watching the video. They were instructed to write down insights, impressions, and anything interesting that happened, along with the time that it occurred on the video. Each coder collected approximately 100 entries.

After all three coders completed this task, they met and watched the same video together, and patterns were noted. During this second showing of the video, the three coders compared their notes to determine if they observed the same circumstances. The purpose of this step was to demonstrate validity, and to establish inter-rater reliability. Appendix J shows the Sample of Coder Consensus During a Selected Video Clip, an example of a snippet of the video and what the coders thought it was. In all cases, the coders agreed with each other.

While keeping the research questions in mind, and while referring to the Checklist of Observed Teaching Methods and Instructional Strategies (Appendix H), the researcher and the other two coders used the technique of open coding to organize the data, establish categories and to determine key words that could be used as codes. After the three coders arrived at a consensus about the criteria for each code, these codes were organized into a codebook, the Glossary of Terms for Coding (Appendix K). The Sample of Coder Consensus During a Selected Video Clip (Appendix J) shows a sample of the information heard and seen on a video clip, along with the corresponding conversations among the three coders and their consensus of the codes to be used.

From the codebook, an organizational checklist was created. This could be used to record information as the videos were viewed. The Checklist of Observed Teaching Methods and Instructional Strategies can be found in Appendix H. Next, the researcher viewed all videos while using the Checklist of Observed Teaching Methods and

Instructional Strategies. Notations were made along with a time stamp of when in the class period it occurred. The results were then categorized and summarized by individually looking at each teaching method or instructional strategy. If something came up in the videos for which no code had been established, the researcher would call on the other two coders to meet again, watch that section of the video together, and establish a new code. In this study, nothing unusual came up in the videos that would necessitate further meeting.

To further reduce the data, the researcher looked for overlap in the codes, and then collapsed the codes to make fewer codes. Redundancy was minimized and codes were categorized into themes. After watching all the videos and completing the Checklist of Observed Teaching Methods and Instructional Strategies for each video, the researcher organized the data using an Excel spreadsheet. Color-coding was used, and information was categorized in table form.

Reduction of bias. According to Crotty (1996) and Schutz (1994), it is impossible for a qualitative researcher to remain completely objective because complete objectivity is not humanly possible. However, a researcher should attempt to not allow his or her assumptions to influence the data collection process. Crotty (1996) uses the term bracketing to describe the data collection process whereby the researcher is mindful of his or her assumptions. Bracketing can be a reflexive process in which the researcher evaluates the way he or she has collected the data (Frank, 1997).

According to Szpara and Wylie (2005), a bias awareness tool helps researchers to recognize their biases and to identify actions that can be used to reduce the impact of bias. Rather than abandoning the bias, the researcher recognized it. Kathryn Ahern (1999) developed Ten Tips for Reflexive Bracketing. These tips were given to the coders in this study as A Bias Awareness Tool for Coders (Appendix L). During the coding process of this study, this bias-notating tool was used and the coders kept a reflexive journal so they could become aware of their biases. By reflecting on their own biases, the coders attempted to view the data without judging it.

Ethical considerations. At the conclusion of this study, the pretests, posttests, and student questionnaires were destroyed with a paper shredder. Reformatting the compact flash cards erased the lessons that were recorded on video.

For confidentiality purposes, the researcher did not discuss the contents of the videos with anyone other than the other coders. This includes the instructors and the students who were recorded on video. In writing up the instructors' methods, even if they were ineffective, the researcher did not use emotional language to describe the actions and behaviors of the instructor. Privacy and protection for the instructors and students were maintained. What the researchers or video coders see on the videos will not be used against students or count toward their grade. In fact, the videos were viewed after the Fall 2015 semester ended and grades were submitted. This will be documented by informed consent procedures. Additionally, the Internal Review Board at Rowan University protects the rights of research participants.

Summary

In order to study teaching methods that are effective for students in developmental mathematics education classes, instructors of developmental mathematics who have been deemed as effective instructors were observed and interviewed. Triangulation of data was achieved, as the viewers of the videos, instructor, and students were all asked their opinion on the lesson. Effective teaching methods and instructional strategies that are observed will be shared with other instructors of developmental mathematics in the hopes of increasing the success rate of marginalized individuals.

Chapter 4

Results

This research study aimed to discover the effective instructional methods and teaching strategies that the instructors of developmental mathematics employ at the college level. In qualitative research, data analysis is a process of organizing data into themes and patterns and then bringing meaning to those patterns. The researcher uses his or her knowledge of the literature, theory, and current practices to categorize and interpret the instructional data collected.

In this study, students and instructors were recorded on video before, during, and after the teaching of the mathematical concept of factoring trinomials with a leading coefficient using the grouping method. The videos captured some additional topics as well, as instructors went beyond that lesson and into different lessons. The concepts of graphing equations of a line and factoring trinomials without leading coefficients were additionally captured on the videos.

The Findings

Age of student participants. Page three of the Participant Consent Form for Students contained the Pre-Lesson Student Questionnaire. Here, students listed their age. Table 1 summarizes the ages of the student participants. In this study, the average class size was fourteen students. The students in this study had a median age of 18.25. The youngest student in the study was eighteen and the oldest student was twenty years of age, a range of two years. Therefore, the student participants were generally within their first year or two of college.

Course repetition. On the Pre-Lesson Student Questionnaire, students were asked if this was the first time they have taken the course Basic Algebra I, and if not, how many times they had taken the course before. For each instructor, the mean of the number of times students who were repeating the class had taken the class before was calculated. Another question on the Pre-Lesson Student Questionnaire asked students when their last math class was taken. They were asked to check one of three boxes indicating if it was last year; before last year, but not more than three years ago; or more than three years ago. Two students did not answer the question and there is missing data. Table 1 below summarizes the number of times students have taken the course and when they took their previous math course.

Table 1

Course Repetition by Class Section

Instructor	Have you taken this class before?		If repeated, how many times before?	When was your last math class?		
	Yes	No		L	B	M
A	10	5	1.0	13	1	1
B	3	10	1.4	6	6	0
C	7	5	1.5	11	1	0
D	8	8	1.3	6	5	4

Note. L = last year, B = before last year, but not more than three years ago, M = more than three years ago.

Surprisingly, of all of the students, the number of students who took this class before and the number of students who were taking this class for the first time were the same. However, there was some disparity in this ratio when looking at the numbers for each individual instructor. For example, Instructors A and C had more students that were repeating the class than first-time students. On the other hand, Instructor B had far fewer students who were repeating the class. Instructor D had an equal number of first-year and repeat algebra students. As for when students last took a mathematics class, 67% of students indicated that they had taken a mathematics course within the last year, 24% indicated that they had taken a mathematics course before last year, but not more than three years ago, and 9% indicated that they had not taken a mathematics course for more than three years.

Indication of learning. The Pre-Lesson Knowledge Survey (Appendix C) contained two mathematical problems and was given to students before the lesson was started. The second question was slightly more difficult than the first question. The intention of this survey was to assess the students' knowledge about the subject before the lesson about that subject was taught. The survey was graded by the researcher using five points for each of the two questions, for a total of ten points for the survey. Partial credit was possible if a student showed some correct work but did not arrive at the correct answer.

Similarly, the Post-Lesson Knowledge Survey (Appendix D) contained two mathematical problems and was given to students after the conclusion of the lesson. The Pre-Lesson and Post-Lesson Knowledge Surveys had similar test content and contained nearly the same problems, but with different numbers. The mathematical problems on both surveys were taken from the practice section of the student textbooks. The intention of this survey was to assess the students' knowledge about the subject after that subject was taught. The survey was graded in the same way that the Pre-Lesson Knowledge Survey was graded, and the results of the students' mathematical knowledge survey scores appear in Table 2 below. Because some of the students did not take the Post-Lesson Knowledge Survey due to absence, there is missing data.

Table 2

Mathematical Knowledge Survey Scores

Instructor	Mean Survey Score	
	Pre-Lesson	Post-Lesson
A	0.5	5.0
B	0.6	6.8
C	0.5	6.0
D	4.2	7.9

Table 2 summarizes the grades that students received on these two surveys. A student's gain or loss of points from the Pre-Lesson Knowledge Survey to the Post-Lesson Knowledge Survey was noted. This could be an indicator of how much learning took place during the lesson as the two had similar test content. As indicated by the Pre-

Lesson Knowledge Survey, most students did not have much knowledge about the mathematical concept before attending the class. Out of ten possible points, students were awarded 1.45 points on average. After the class, as evidenced by the Post-Lesson Knowledge Survey, students had more knowledge about the mathematical concept that was taught. Students were on average awarded 6.425 points, a gain of 443%.

Figure 1 illustrates the changes in each instructor's students' scores from the Pre-Lesson Knowledge Survey to the Post-Lesson Knowledge Survey. Each bar spans the distance from the average score on the pre-lesson survey to the average score on the post-lesson survey. A longer bar would indicate a greater increase in the students' scores.

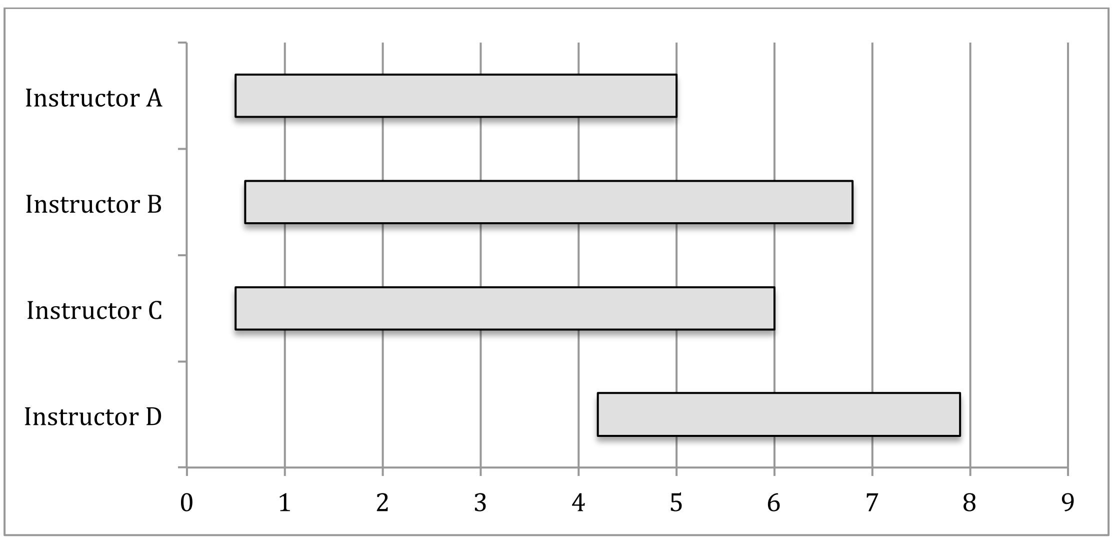

Figure 1. Comparison of Pre- and Post-Lesson Knowledge Survey Scores. For each instructor, the bar spans from the mean student score on the Pre-Lesson Knowledge Survey to the mean student score on the Post-Lesson Knowledge Survey.

Instructor B's students had the most points gained between the pre-lesson survey and post-lesson survey, with an average of 6.2 points gained. The students of Instructor A had an average of 4.5 points gained, and the students of Instructor C gained an average of 5.5 points. The students showing the least gain were the class of Instructor D with a gain of only 3.7 points, but this information may be misleading. This instructor's students had the highest score on the Pre-Lesson Knowledge Survey, an average of 4.2 points, whereas the other instructors' students had an average of 0.5 or 0.6 on the Pre-Lesson Knowledge Survey. Instructor D's students also had the highest number of points on the Post-Lest Knowledge Survey, 7.9, as opposed to the other classes which had an average of 5.0 to 6.8 points. Figure 1 shows that although Instructor D's students had the least gain in points, this class was the class that scored best on the overall post-lesson survey.

Looking at the students of all four instructors as a whole, between the pre- and post-lesson survey, the students improved their scores from an average of 1.45 points to 6.425 points out of ten possible points, a gain of nearly five points. With a total of ten possible points, it may be said that the students on average completed half of the mathematical problems successfully.

Student Response

Immediately following the Post-Lesson Knowledge Survey, students were given the Post-Lesson Questionnaire for Students (Appendix E). The questionnaire asked students what went well and what did not go well during the lesson, what were the best and worst things the instructor did that day, and what they liked and disliked about the lesson. If students indicated on the Post-Lesson Questionnaire that they could be contacted for further information, the researcher contacted them by telephone before the end of the day. The researcher used the questioning process highlighted on the Student Telephone Interview Protocol (Appendix F) to delve deeper into the students' responses on the Post-Lesson Questionnaire for Students.

The researcher aggregated the data from all the class sections and looked for patterns. The data was categorized, and the student responses were placed into the tables below. The student responses are, in some cases, not the students' words directly, but the students' meaning as interpreted by the coder. Kagan (1990), citing Leinhardt (1990), explains that because beliefs are "associated with specific classrooms, events, and students," it is generally best to use indirect tasks that then enable the researcher to make inferences from data generated by these tasks (p. 420). Pajares (1992) concludes, "it is unavoidable that, for purposes of investigation, beliefs must be inferred" (p. 315).

Student perceptions about the lessons. On the Post-Lesson Questionnaire for Students, the first question that students were asked was, "What went well with this lesson?" Student responses were categorized into two types, those comments specifically about the instructor, and those comments about the student as learner. If students offered additional information during the telephone interview, those responses were counted as well as the information the students wrote on the questionnaire. The results of this questioning process are shown in Table 3 below.

Table 3

Students' answers to the question, "What went well with this lesson?"

Student Responses	Count For Each Instructor			
	A	B	C	D
"The instructor explained concepts well"		1	2	4
"The instructor interacted with the students"				1
"The instructor gave one-on-one help to students"		1		
"The instructor explained concepts step-by-step"		1	1	
"The instructor showed more than one method to solve the problem"		3		
"The instructor used a Microsoft® PowerPoint® presentation"				1
"The instructor helped us to visualize the lesson"	1			
"The instructor held my attention"	1			1
"The instructor had us complete classwork practice"	1			
"The instructor had good classroom control, the room was quiet"			1	
"The instructor helped me to get caught up after my absence"		1		
"The instructor had a good attitude"	1			
"I was able to solve problems, I understood, I learned the concept"	6	2	5	6
"It was easy to learn"	1	4		2
"I remembered how to solve this type of problem"			1	
"I liked this particular mathematical concept"		1		
"The instructor did everything well"	1	2	2	3

Eight students said that all went well with the lesson. Twenty-six students thought the lesson went well, indicating that they understood the concepts, mastered the material, or found the concepts to be easy. During an interview, one student said that she liked when the concept was completely understood, resulting in her paying more attention in class and completing homework. However, some students became annoyed when the instructor continued to give examples after they understood the concept. Surprisingly, students liked how instructor B showed more than one way to solve the type of problem. In probing deeper, the interviewer found that the students liked the second method of factoring better than the first method. Students found it easier because it was broken down into steps. Students also thought that the first method was longer and more difficult.

In contrast to the first question, the second question that students were asked was, “What did not go well with this lesson?” The results of this questioning process are shown in Table 4 below.

Table 4

Students' answers to the question, "What did not go well with this lesson?"

Student Responses	Count For Each Instructor			
	A	B	C	D
"I did not understand the concept"	3	2	1	3
"The problems were too difficult"	1			
"There was a lack of student participation"	1			
"The beginning was difficult"	1			
"The problems took too long to complete"		1		
"The white board was cluttered with too much information"			1	
"I have a math learning disability"			1	
"The lesson was bland"		1		
"The instructor went too fast and I got lost"			2	1
"I had trouble with negative signs"			1	
"There was no time for more practice problems"				1
"Nothing went wrong with this lesson"	3	5	6	11

As expected, it seemed that students thought the lesson did not go well when they did not understand the concept that was taught. One student said in an interview that he did not understand on the first day, but eventually understood on the second day of the lesson. Many students left this question blank or responded that there was nothing that did not go well. One student did not like that the problems took too long to complete, especially all the little multiplications that needed to be done. Three students commented that the instructor went too fast and they got lost. One student wished there was more time for practicing problems. One student felt that the whiteboard was overly cluttered with information.

Student comments about their preferences. The third question that students were asked was, “What was the best thing your instructor did today?” This question differs from the first question, “What went well with the lesson?” because the focus is more on the instructor. The researcher included this question so students may elaborate on the first question and to delve deeper into the students’ thoughts about their instructor. The results of this question are shown in Table 5 below.

Table 5

Students' answers to the question, "What was the best thing your instructor did today?"

Student Responses	Count For Each Instructor			
	A	B	C	D
"The instructor went over examples many times"	2		2	2
"The instructor made sure students understood before moving on"	2	1	1	
"The instructor explained the concept well, the instructor taught well"	4	2	5	7
"The instructor used an organizational aid"	1		1	
"The instructor showed more than one way to solve the problem"		4		
"The instructor went around the classroom and helped individuals"		1		
"The instructor got me caught up after an absence"		1		
"The instructor took a break"			1	
"The instructor used good metaphors"			1	
"The instructor answered students' individual questions"				1
"The instructor avoided the use of fractions"				1
"The instructor interacted with students"				1
"The instructor allowed students to practice problems on their own"				2

In general, students liked it when the instructor went over examples on the board, and especially found it useful if they were able to practice problems on their own during class without help. Students thought it was best when an instructor checked for student understanding before moving on to the next concept. The most common response from students was that they enjoyed an instructor who could explain the concept well, or teach well. Because this was not terribly descriptive, the researcher probed deeper when interviewing students. In an interview, one student described how the examples on the board helped her. She said that when she saw the problem being done on the board, she would know how to solve it because she saw the process and the steps. Other students described similar experiences.

Instructor B showed two methods for solving the same problem. This instructor's students had a lot to say about the two options during the interviewing process. One student discussed having the option to do either method and described which one she liked and did not like. Another student said that he liked one method over the other because it had steps to follow, and because "breaking down the work" made it simpler. A third student described how he didn't like the first method, but he did like the new method because it was faster and easier.

In contrast to the third question, the fourth question that students were asked was, "What was the worst thing your instructor did today?" The results of this question are shown in Table 6 below.

Table 6

Students' answers to the question, "What was the worst thing your instructor did today?"

Student Responses	Count For Each Instructor			
	A	B	C	D
"A student asked a question and the instructor didn't answer it well"	1			
"The instructor did not have activities"		1		
"The instructor made a mathematical mistake"			1	
"The instructor went too fast"			1	1
"The whiteboard was cluttered, with too many things at once"			1	
"The instructor showed the class things they didn't understand yet"				1
"The instructor used a lot of big numbers"				1
"The instructor did nothing wrong, the lesson went well"	8	8	8	13

Overwhelmingly, students responded that "nothing" was the worst thing the instructor did, or indicated that the lesson went well overall. Only a handful of students indicated that something went wrong. Two students said that the instructor went too fast, and one student thought the instructor showed the class concepts the students didn't understand. One student was disappointed that there were no activities such as games or other situations that would get the students active that day, and one student did not like it when an instructor made a mathematical mistake, a mix-up of positive and negative signs. One student pointed out that an instructor's cluttered whiteboard showed too many things at once. Finally, a student was troubled when a classmate asked a question and the instructor did not answer the question well.

During the interview process, the researcher tried to ascertain more information from the students, but the students did not have much more to share other than that they liked the lesson because they found it easy or because it was a "good, solid lesson."

The fifth question that students were asked was, "What did you like about today's lesson?" The results of this question are shown in Table 7 below.

Table 7

Students' answers to the question, "What did you like about today's lesson?"

Student Responses	Count For Each Instructor			
	A	B	C	D
"The instructor kept the class involved"	1			
"The instructor is good, clear, explains well, easy to understand"	2	1		
"The instructor used different strategies"	1	2		
"The instructor enhanced my skills"	1			
"The instructor used many examples on the board"		1	2	1
"The instructor broke information down into smaller chunks"				1
"The concept clicked, was easy for me, I knew how to do it"	3	4	2	3
"The mathematical concept was insightful, thought-provoking"			2	1
"This refreshed my memory, I remembered this from high school"			2	
"This lesson was a good review"			1	
"I liked that the lesson was quick"		1		
"I am glad that the lesson was not boring"			1	
"I liked practicing on the worksheet"			1	
"I think that this concept will help me on my homework"				1
"I didn't like anything about today's lesson"			1	

It seems that students appreciate having options. Three students pointed out that they liked when their instructors showed different strategies for solving problems. Other students appreciated having an instructor who made the mathematical concepts clear and kept the students involved. Students also noted that they liked when instructors broke down the information into manageable chunks and used many examples on the board to illustrate the concept.

The most frequent answer students gave was that they liked when the lesson was easy for them, or when the concept was one with which they were familiar. Several students mentioned that the mathematical concepts were "thought-provoking" and "insightful." Students also seemed to like "lessons that are not boring," and "practicing problems on a worksheet." Only one student did not like anything.

In contrast to the fifth question, the sixth question that students were asked was, "What did you dislike about today's lesson?" The results of this question are shown in Table 8 below.

Table 8

Students' answers to the question, "What did you dislike about today's lesson?"

Student Responses	Counts For Each Instructor			
	A	B	C	D
"I was confused, I did not understand"	2			1
"I didn't get enough practice"	1			
"The mathematical concept was difficult, I didn't care for it"	2	1	4	3
"I didn't like participating in class"	1			
"I don't like surprising answers, i.e., when the answer was prime"	1			
"The lesson was boring, the lesson was tedious"		1	1	
"I didn't like that I was hungry"		1		
"I have seen this mathematical concept before"			1	
"The instructor did not let us complete the worksheet by ourselves"			1	
"I thought the Microsoft® PowerPoint® was too long, I didn't like it"				2
"There was nothing I disliked about this lesson"	3	6	5	11

Overwhelmingly, students responded that there was nothing that they disliked about the lesson. When students did mention that they disliked something, they mentioned that they were confused, didn't care for the mathematical concept, or that the concept was difficult for them.

Other students felt that they did not get enough practice, or did not have enough time to complete the worksheet. Others noted that they were bored or hungry. Some students commented that they had seen this lesson before and that they did not like when answers were surprising, as in the case where the polynomial they were factoring was prime. Both students who mentioned the Microsoft® PowerPoint® did not like it.

Instructor response. After the lesson was taught, the researcher sent a follow-up email to each instructor (Appendix G). The purpose of collecting this data was to elicit the instructors' ideas so that the researcher could obtain more information about how the class went from a different perspective. This triangulation of data was important to this study.

Instructor perceptions about the lesson. Each instructor was asked what he or she thought went well with the lesson, and the results can be found below in Table 9.

Table 9

Instructors' answers to the question, "What went well during this lesson?"

Instructor	Instructor Response
A	"Students were engaged."
	"Students used the graphic organizer handout as a guide."
B	"Students were actively learning."
C	"Graphing points."
	"Getting students to recognize positive- and negative-sloping graphs."
D	"Most of the students remembered how to factor when there was a leading coefficient."

Half of the instructors recognized that engaging their students was something that went well with the lesson. The other half of the instructors focused on the learning outcomes of the students as what went well.

Next, each instructor was asked what he or she thought did not go well with the lesson, and the results can be found below in table 10 below.

Table 10

Instructors' answers to the question, "What did not go well with this lesson?"

Instructor	Instructor Response
A	"Students forgot to check for a greatest common factor before moving to the next step in factoring."
B	"I wish there was more time."
C	"Students need to practice graphing equations."
D	"A few students did not remember how to factor when there was a leading coefficient."

Conversely, when asked what did not go well with the lesson, three out of four instructors mentioned what went wrong with their students, as opposed to what went wrong with what they were doing. Instructors pointed out what their students forgot to do, or pointed out that they needed more practice.

Instructors were asked to name the best thing and the worst thing they did in class that day. In response to the question about what they did best, instructors gave a variety of answers, as shown in Table 11 below.

Table 11

Instructors' answers to the question, "What was the best thing you did today?"

Instructor	Instructor Response
A	"In the past, students have said they do not know where to start with factoring. I provided a graphic organizer handout, which gave students a sense of security and confidence."
B	"Students liked that I showed two different methods for solving the same problem. Students could choose the method they liked best."
C	"Making connections with graphs and what they mean." "Modeling the fact that every point should be labeled."
D	"I made sure the students understood the concept of writing a quadratic equation in standard form and how it must be factored completely."

Some instructors thought it was best that they used a graphic organizer, or showed several methods to solve a problem. Another instructor judged that having the students make connections with the math and modeling desired behaviors for the students was best. A fourth instructor said that checking for student understanding was something that was best about the lesson.

For the final question, instructors were asked to name the worst thing they did in class that day. Instructors gave a variety of answers in response to this question, as shown in table 12 below.

Table 12

Instructors' answers to the question, "What was the worst thing you did today?"

Instructor	Instructor Response
A	"I didn't give the students the amount of practice time I would prefer to give them. I would have provided more time for this concept, but the schedule did not allow for more time."
B	"I think I may have made a mathematical mistake, but I corrected it."
C	"Rushing at the end of class to graph an equation, I used the wrong coordinate pairs. However, I used this as a teachable moment."
D	"I did not get to do as many problems as I had hoped, and felt I rushed through the lesson."

In response to this question, instructors discussed the lack of time to have students practice and their own mathematical mistakes made on the whiteboard. A major finding from this survey was that instructors feel that they are short on time. Three out of four instructors expressed their frustration with not having enough time in class to do what they wanted. They felt rushed, and felt that more practice time would benefit the students. This echoed some of the comments made by students as well. These developmental classes bear two credits, so the length of the class is fifty minutes. Typical college classes last seventy-five minutes. Instructors mention that this allows only enough time to teach the lesson, with little time during class to practice what has been taught.

Overall, the findings of the student and instructor questionnaires and interviews showed that there are both similarities and differences between the instructors' perceptions and the students' perceptions. Differences were noted when it was uncovered that students did not like the Microsoft® PowerPoint® presentations. Similarities were noted when both students and instructors alike discussed feeling rushed and wanted more instructional time.

Observed Teaching Methods

The researcher looked for evidence of three selected teaching methods: direct instruction, group work, and constructivist teaching. Table 13 below summarizes the teaching methods that were observed for each of the four instructors.

Table 13

Observed teaching methods

Selected Teaching Methods	Instructor			
	A	B	C	D
Constructivist Teaching	Yes	Yes	No	No
Direct Instruction	Yes	Yes	Yes	Yes
Group Work	No	No	No	No

Table 13 shows that all instructors who were recorded on video used the teaching method of direct instruction. None of the instructors used group work. Two of the instructors used constructivist teaching techniques while the other two instructors did not.

Direct instruction. Direct instruction is the explicit teaching of the skill set using lectures or demonstrations of the material here examples of direct instruction included tutorials, discussion, recitation, seminars, workshops, and observation. The instructor lectures to the students during direct instruction. In the most basic form, the instructor will get the students' attention, teach them something, and prompt them to respond to demonstrate mastery. Direct instruction is highly structured.

Nearly all of the captured footage showed that direct instruction was used throughout the course of the lesson. While some instructors used other types of instruction when reviewing previously covered material, every observed instructor primarily used direct instruction when presenting information that was new to the students. The most common scene on the videos was an instructor at the whiteboard, writing problems, and explaining the reasons for each step completed. The lessons were highly structured.

Group work. Group work is when students work together as partners or in groups. Think-Pair-Share is a technique that allows students to discuss ideas with a partner.

Cooperative learning is a technique in which instructors put students in small groups to work together to accomplish a task. Groups can perhaps consist of students with many ability levels. Theoretically, the students with the highest ability both model for and assist the students with the lowest ability. At the end of the period of time, groups are asked to report back to instructor or to the class about how they completed the task. Group members are often assigned different roles within the group. Instructors circulate through the classroom and monitor the groups carefully to make sure that the group is on task, and that everyone in the group is participating.

In collaborative learning, the instructor would make small groups of students with varying ability levels and advanced students would help students who were struggling. This would help the advanced student to become more familiar with the subject, while the struggling student would get help. Peer tutoring is another example of collaborative learning. In peer tutoring, students of a higher ability level help the students of a lower ability level. Students may be given a problem to be solved or a question to be answered. The focus on the instructor's authority is removed in collaborative teaching. The instructor's role becomes one of mediating student interaction, but not intervening on the students' conversations. After the group discusses, the instructor evaluates, but does not judge, the students' work. The group's ideas are presented to the class, and the answers are compared. In this way the authority is not on one individual.

None of the observed instructors used the teaching techniques of partner work, cooperative learning, collaborative learning, or any other types of group work. At all times, the videos showed student working as individuals, without speaking to one another. During the observed lessons, each instructor acted in a role as the authority.

Constructivist teaching. Constructivist teaching requires students to do experiments and look at the results of those experiments. A constructivist instructor would not tell students the rules of mathematics, but would instead allow students to discover the rules on their own. Two of the observed instructors used the constructivist teaching technique. The other instructors observed on the videos told students the steps to solving the mathematical problems, and students did not make discoveries on their own.

One possible example of constructivist teaching was observed when a student was working out a warm-up problem on the board and Instructor A nudged the student to help him to get a step further along in the problem. This instructor guided the instruction and asked questions of the student that led to the student's own discovery of the next step.

Another possible example of constructivist teaching was when instructor B was teaching the concept of factoring trinomials by grouping using the "X-Box Method." The instructor asked students to switch the positions of the terms in the upper right and lower left quadrants of the box, "to see if it will make a difference." This instructor allowed students to experiment and then reach their own conclusions. The students discovered that they could switch the order of the terms and that the answer would come out the same either way. This may be considered constructivist teaching because the students reached their own conclusion without being told outright.

Observed Instructional Strategies

The videos were observed to see which of eleven selected instructional strategies the instructors utilized. Table 14 below summarizes the instructional strategies used by each instructor.

Table 14

Observed instructional strategies

Selected Instructional Strategies	Instructor			
	A	B	C	D
Objective stated	Yes	Yes	Yes	Yes
Use of manipulatives	No	No	No	No
Use of technology	No	Yes	Yes	Yes
Use of games	No	No	No	No
Use of graphic organizers	Yes	Yes	No	No
Student engagement	Yes	Yes	Yes	Yes
Modeling	Yes	Yes	Yes	Yes
Scaffolding	Yes	Yes	Yes	Yes
Humor and fun	Yes	Yes	No	No
Positive attitude	Yes	Yes	Yes	Yes
Real-world relevance	No	No	Yes	No

Statement of the objective. Stating the objective at the beginning of the lesson helps students to be aware of what they have done in the past, how that relates to what they will be doing next, and what will be learned in the future. When an objective is stated, students have a clear picture of how the day will progress and it sets the stage for learning.

After the completion of the warm-up problems on the board, Instructor A explained to the students that two lessons would be taught that day because the instructor was behind. Near the end of the class period, Instructor A again repeated the day's objective and told students that they were to go into Basic Algebra I, the next class in the sequence, knowing this information. During another class period, Instructor A stated the day's objective when the new lesson was started approximately twenty-two minutes into the period.

Instructor B, on the other hand, stated the objective at the very beginning of class. The instructor told students, "we are going to work on factoring." At approximately halfway through the class, Instructor B told students that there was an alternative way to factor, called "factoring by grouping," then proceeded to teach that new method.

Less than a minute into the class, Instructor C told the students, "here's what we are going to do today," and stated the objective. Similarly, within the first minute of class, Instructor D had told the students the objective and also talked about how this day's lesson related to the last two lessons.

Every observed instructor clearly stated the objective of the lesson to his or her students. This was either done at the very beginning of the class period or at the point in the class where review work stopped and new concepts were about to be taught.

Use of manipulatives. Instructors may use manipulatives to help students move from concrete examples to more abstract examples. When students touch and manipulate plastic pieces or geometric shapes, they can better visualize representations and can understand concepts in a more concrete way. Many types of manipulatives are available. They can be bought at a store or be instructor- or student-made. There are also virtual manipulatives available online. One type of manipulative is the square and rectangle shaped Algebra Tiles, which can help students to better understand algebraic concepts, including factoring.

Surprisingly, no observed instructors used any types of manipulatives. Using objects that students can touch and manipulate can help students to visualize representations and understand concepts that are very abstract in a more concrete way. Although many of the concepts that were being taught were abstract, no manipulatives were used.

Use of technology. Technology may be used to engage learners in mathematical concepts. An instructor may show an animated clip to illustrate a concept. Many resources exist online that an instructor may make use of. Technology may even take the place of some instructor instruction. Working on a calculator could be considered a use of technology.

Some use of technology was observed in the lessons. Instructor A did not use any technology, choosing to only use a marker and a whiteboard to instruct. Both Instructor B and Instructor C used a Microsoft® PowerPoint® presentation projected on the screen during class. The Microsoft® PowerPoint® was part of the resources included with the textbook. This Microsoft® PowerPoint® was used throughout the entire class period, and each instructor flipped through the slides as concepts were explained. Instructor D also used the same Microsoft® PowerPoint®, but only for 16 minutes at the beginning of the class, and then the projector was shut off.

It should be noted that students have homework online which is done outside of class time. None of the instructors utilized that online program during the observed classes. Surprisingly, instructors and students did not use calculators in the observed lessons. A graphing calculator could be used to factor trinomials and to complete other tasks seen on the videos, but these were not used.

Use of games. Games could be motivating for students. They can pique students' interest and engage learners to keep them on-task. There are many types of games that an instructor could use when instructing students. Games could be paper-based, board games, games on the whiteboard, manipulative-based, or technology-based. Interestingly, no instructor used any type of games during the observed lessons.

Use of graphic organizers. Graphic organizers are useful to students because they can help to organize ideas so that learning is facilitated. There are many types of graphic organizers such as graphs, charts, trees, webs, flowcharts, diagrams and more. Some graphic organizers are available commercially, while the instructors may make others.

Instructor A used what this instructor called a "Factor Tree," given to students on the handout in shown in Appendix M. Within the first minute of class, the instructor encouraged students to follow the steps on this "Factor Tree." The handout was a type of flow chart to organize students' thoughts when factoring, detailing which type of factoring technique to use with different types of situations. This handout was referred to four times during the first observed class period. In subsequent class periods, the handout was referred to again. When one student said she was lost and did not know where to start, the instructor asked if she had consulted the graphic organizer to help her to know which technique to use.

Instructor B used other types of graphic organizers. First, a table of factors was drawn on the board so that students could use it when they factored trinomials using guess and check. This instructor also used a method of factoring trinomials called "X-Box." A handout, as shown in Appendix N, was given to students. The letter X was drawn, and the product of the first and last terms of the trinomial was placed at the top of the X. The middle term of the trinomial was placed at the bottom of the X. Then students were prompted to think of two terms whose sum was the bottom number and whose product was the top number; these two terms were placed on the two sides of the X. Next a box was drawn, with two lines dividing the box into four quadrants. The first term of the trinomial was written in the upper left quadrant and the last term of the trinomial was written in the lower right quadrant. The terms from the left and right parts of the X were placed in the other two quadrants. Next, the greatest common factor of each row and column was factored out and placed on the outside of the box. The terms on the outside of the box formed the factored answer. Another graphic organizer that Instructor B used was a set of four steps for factoring by grouping that was shown on the Microsoft® PowerPoint®.

Instructor C gave students coordinate grid paper, shown in Appendix O, so they could use to plot points in the Cartesian plane. While helpful, this likely would not be considered a graphic organizer. Other than that, this instructor did not use any other graphic organizers. Instructor D did not use any graphic organizers.

Student engagement. Active engagement of students may be crucial to their learning. There are many techniques that instructors can use to keep their students actively engaged. One idea is to have students write responses on individual whiteboards and hold them up so that the instructor can see their answer. This allows the instructor to quickly assess whether the students understand the concept or not. Students may show a thumbs-up or thumbs-down signal to indicate their agreement or disagreement with the responses of other students. Another technique used to involve students is to allow discussion with a partner. Some forms of active participation can be aided by technology.

Each of the observed instructors engaged students throughout the class period. Instructor A called on students and waited for them to answer. At one point, the instructor asks for feedback from the students. At another point, the instructor asks students, “who considers themselves a visual learner?” Some students left their seats to go to the board to work problems, while other students were asked if they agreed or disagreed with the answers that were written on the board. Instructor A attempted to increase the students’ attention by telling them, “This is what you need to know, absolutely, unconditionally.”

At the beginning of the class period, Instructor B had warm-up problems on the board. As seen on the video, some students worked these problems at their desk, while others did not. The instructor walked around the room and checked the students’ papers. Students seemed engaged when the instructor was working with them, but then became off-task when the instructor moved to a different student. Later in the lesson, Instructor B had students work problems on a handout as new concepts were taught. At one point on the video, a student asked, “is there an easier way?” after multiple steps were shown. The instructor answered that they would get the hang of it. Later in the class period, students were asked, “do you think this [method] will help?” It seemed that some students were engaged in the lesson while others were not.

Three minutes into the class, Instructor C gave students a handout of coordinate grid paper, referred to a set of ordered pairs on the whiteboard, and asked them to graph the five points on the grid. Some students seemed to complete this task, while other students were observed texting on their cellular phones. Next, as the instructor pointed to sets of points on the whiteboard, the students were asked to call out the quadrant in which those points lie. At one point in the video, the instructor showed two equations on the Microsoft® PowerPoint® and told students that he would give them four minutes the graph two lines.

When a student factored a trinomial on the board, Instructor D asked another student, “Do you know how she got that answer?” At one point, the instructor checked for students’ understanding by asking, “Is this making sense?” Another time, the instructor was modeling the Guess and Check technique of factoring trinomials on the whiteboard. After making a guess and checking it, the guess turned out to be incorrect. Instructor D asked the students, “What should I do [next]?” Questions like these keep the students engaged in the learning process and bring daydreaming students back to focus.

Modeling. Every instructor observed used modeling during his or her lessons. Behavioral modeling is when an instructor demonstrates to the students how to perform the activities that he or she is teaching. Behavioral modeling was seen throughout all the videos. Also seen on the videos was cognitive modeling, where the instructor articulates his or her thought process to illustrate the reasoning that a learner should use while engaged in these activities. The videos also showed evidence of the use of think-alouds. A think-aloud is a technique where the instructor explicitly explains the steps of problem solving so that students will know the instructors’ thought processes.

Instructor A demonstrated modeling throughout the video. Using the whiteboard, the instructor modeled new concepts and strategies. At one point, a new method of factoring (the Box method) was introduced and modeled. Students were called to the board and asked to “walk through” the steps used to solve the problem so the other students could understand. The instructor used the think-aloud technique when working out problems on the board.

Instructor B first modeled the Guess and Check technique of factoring trinomials, and then demonstrated the X-Box technique for factoring trinomials. In each case, the instructor told students about the thought processes used at every step. This thinking-aloud technique allowed students to visualize the instructor's thoughts as the problems were worked. The same process was repeated over and over with problems of increasing difficulty.

Instructor C demonstrated modeling while at the whiteboard instructing students. Steps were carefully explained to the students as problems were done on the board. This instructor would say, "Why do I do this?" and then answer that question. This enabled students to know the thought processes that were used to arrive at a solution.

Similarly, Instructor D demonstrated concepts to students on the whiteboard. As the problems were written, this instructor stopped to tell students the reasoning behind each step. At times, the instructor asked students what they might do next.

Scaffolding. Scaffolding is an approach to teaching that uses a systematic approach to support the learner. At first, the instructor gives students temporary frameworks to guide the learning. Then those supports are gradually removed until the student can do the work on his or her own.

Instructor A used scaffolding with the Factor Tree handout. The instructor had students use the flow chart to guide them to the next step, but explained that the handout could not be used on the final exam. When a student asked if the handout could be used on an upcoming test, the instructor said, "We will see." It seemed as if the instructor wanted students to practice with the graphic organizer at first, but would later remove this scaffolding so that students would be able to complete the task without the steps in front of them.

Instructor B demonstrated scaffolding when working with students as they solved problems on the board. At first, the instructor would tell the class every step that was coming up next. Later in the period, the instructor would give hints, and near the end of the period, no hints were offered and the student could complete the problem on his own.

When Instructor C was factoring, the class was reminded that last week they were multiplying two binomials and getting a trinomial. Then the instructor told students that this week they were starting with the trinomial and breaking it down into the two binomials, and that factoring is the reverse of multiplying using the FOIL method. The instructor increased or decreased the distance between hands and arms to show that breaking up and putting together were the reverse of each other. Steps of each process were discussed, and then each process was discussed again, but with fewer steps mentioned. Another example of scaffolding by this instructor was observed when the class was moved from doing the X-Box method the one day to factoring by grouping without the X and the Box the next class period. Here, the supports were taken away from students and instead of writing everything down in the X or the Box, more was done in the students' heads.

Instructor D showed scaffolding by walking the students through the steps at the beginning of the class period, and then letting the students do the problems more on their own later. As problems were worked on the board, the instructor wrote less for each problem as the class period progressed. At first, many steps were written down between the question and the answer. Later, the instructor said, “Do this part in your head,” and did not write it down on the board.

Another observation that may be a form of scaffolding was observed with all instructors. The instructor would begin with a simple version of the problem, and then gradually increase the difficulty of the problems as the class went on. For example, students may have a basic trinomial that they needed to factor into the product of two binomials at the beginning of the lesson. In the middle of the lesson, the trinomial contained larger and more difficult numbers. Then, at the end of the lesson, students may have to first factor out a greatest common factor before factoring the trinomial into the product of two binomials.

Use of humor and fun. Instructors often search for ways to reach their students and hold their attention, and one technique that instructors may use is humor. Telling a joke may serve to keep students engaged and to keep the mood lighthearted. Stress and frustration may be reduced when an instructor uses humor. Instructors with a sense of humor may leave a lasting impression in the students’ minds. Students may also remember instructors that they describe as “fun.”

Of the four observed instructors, Instructor A seemed to use humor the most. Three minutes into the class period, this instructor observed his yawning students and made a joke about it being 8 a.m. on Monday morning. When discussing the upcoming final exam, the instructor told students, “I took the final exam this weekend, it wasn’t bad, I scored a 100%.” Later he joked with a student, asking him if he was scratching an itch or raising his hand to ask a question. Another day, when a student put his glasses on at the beginning of the period, Instructor A said to the class, “Game on. He put his glasses on. It just got real." When demonstrating that the two factors could be moved around because of the commutative property of multiplication, the instructor said, "If you like (x+6) better, you can put it first, the other guy [binomial] won't mind."

Instructor B also showed humor when teaching students. After putting a more difficult exercise on the board she said to students, "These have higher exponents. What does this mean? We should skip it? Don't you *wish* we could skip it!" Near the end of the period, when she observed a student yawn, Instructor A said, "If one more person yawns, I'm going to yawn along with you."

Instructor C did not show much humor with the students. At one point this instructor referred to the camera and said, "that may be on the video," when a student made a careless mistake. Instructor D did not demonstrate humor during the lessons.

Positive attitude. An instructor who is upbeat and energetic may be able to more effectively motivate his or her students. Instructors may show their passion for the subject area, or may show that they enjoy their work. When instructors are excited about a topic, it may be that students would tend to also be excited. This positive energy could be contagious.

Instructor A showed a positive attitude throughout the observations. The instructor seemed to have a good rapport with the class, and continuously told them that if they needed help, that an instructor would be available for them. This instructor made small talk with the students as they entered the room, as they worked on problems at their desk, and as they exited the room at the end of the period. The instructor asked students about their weekend, about the rainy weather, and about their upcoming final exams. Instructor A encouraged the students, and never put students down when they did not know what to do next or gave an incorrect answer. Instead, the students were redirected and led to find the correct answer, often with help.

Instructor B also showed positive attitude with students. Often, this instructor would tell students that they would get the techniques, and that it would get easier the more they practiced. When the students got discouraged, they were encouraged to not give up yet. “Stick with me,” this instructor told the students, “you’ll get it.” Instructor B did not show any negative behavior toward students, and did not put down students when they did not get the correct answer.

Instructor C’s attitude was positive. This instructor was upbeat in his instruction and also asked the students how their day was going. When students answered correctly, they were praised. When students answered incorrectly, he called on a different student to “help out” the first student. At the end of each class period, Instructor A thanked the students for their attention and for being willing to participate in the study.

Instructor D showed a positive attitude and encouraged the students to keep trying. When students groaned about a longer, more difficult problem, the instructor told them, “It's not that bad, you can do it.” This instructor’s instruction techniques were upbeat and energized. This energy seemed to be passed along to the students, who were alert and engaged in the tasks.

Real-world relevance. Instructors could explain to the learners the reasons that the skills being taught in the classroom are important in the real world. Students want to know the answers to the questions, “Why is this important?” and “When will I need to use this information?” Stating the lesson’s real-world relevance help students to see the reason that they need to pay attention to the upcoming information.

Instructor A did not seem to tell students how what they were learning would help them in the real world, other than to say, "there will be a test on Monday." Similarly, Instructors B and D did not mention to students that would indicate why the taught concepts would be important in the real world.

On the other hand, Instructor C spent a lot of time referring to the real-world applications of the mathematical concepts that were taught. This instructor especially mentioned how these concepts related to the students' college majors. The instructor said, "if you're a science major, you'll use graphing when you show results of an experiment," and "if you're a business major, you would take profits and expenses and put them on a graph." In talking about the slope of a line, this instructor related slope to the steepness of a road when riding a bike as positive slope, negative slope, and no slope were described. Another day, Instructor C talked about graphing change in temperature in a science class.

Performance Comparison

To find out if there was a connection between student performance and the comments students made on the questionnaires, or if there was a relationship between student responses and the teaching methods and instructional strategies utilized, the researcher analyzed the survey data. The comparisons below are not comprehensive.

Low-performing survey students. For the purposes of this comparison, a Low-Performing Survey Student was defined as one who did not have a gain of points from the Pre-Lesson Knowledge Survey to the Post-Lesson Knowledge Survey. Eleven such students were identified, and their responses on the Post-Lesson Student Questionnaire were examined.

What Low-Performing Survey Students seemed to like about the lesson was when "the teacher showed the concept in an easy way," and when thorough explanations were offered, when the lesson was not overly difficult, when they understood or when the "lesson clicked," as one said, when the lesson was "clear and concise," and when the teacher interacted with students. It seemed that these students did not like when there was a lack of student participation, times when they didn't understand, and the Microsoft® PowerPoint® presentation. One student commented that they did not like the topic, and two students commented, "I have a learning disability, so I can never completely grasp it," and "I had trouble with number sets."

There may be a connection between the teaching methods and instructional strategies used and the type of student. Low-Performing Survey Students may like the step-by-step instructional techniques used in direct instruction and in both modeling and scaffolding. Although they didn't use the term " student engagement," these students wrote about the benefits of student participation and teacher interaction.

Of the eleven Low-Performing Survey Students, six had not taken this class before, four were repeating it for the second time, and one student was taking this class for the fourth time. Of the eleven students, four indicated that their last math class was last year, three said that their last math class was before last year, but not more than three years ago, three indicated that their last math class was more than three years ago, and one did not answer the question.

Nearly half of the students who made no gains from the pre-lesson survey to the post-lesson survey were repeating this class. Students seemed to struggle with both the mathematical concepts and their own learning disabilities. A recurring theme was that students wanted the teacher to explain mathematics clearly and concisely, until they understood the concepts. For these students, it was not a good lesson if they didn't understand the concept before the end of the class period.

High-performing survey students. For the purposes of this comparison, a High-Performing Survey Student was defined as one who scored ten points on Post-Lesson Knowledge Survey, demonstrating mastery of the concept. Nineteen such students were identified, and their responses on the Post-Lesson Student Questionnaire were examined.

High-Performing Survey Students seemed to like when the lesson was easy to learn, when the instructor interacted with students, when the instructor offered clear and detailed explanations and instructions, when mathematics problems were done on the board, when practice problems were given, and when learning was step-by-step. Unlike the Low-Performing Survey Students, the High-Performing Survey Students enjoyed the Microsoft® PowerPoint® presentation. Two students mentioned that they liked when they understood and when "the subject was mastered." On the other hand, High-Performing Survey Students did not like when the instructor used big numbers, when the instructor went too fast, when the whiteboard was overly cluttered, and when they had a moment of not understanding the concepts before regaining their understanding. Overwhelmingly, the most frequent response among these students was that "nothing" was wrong with the lesson. It seems that the successful students were pleased with the lesson.

Of the nineteen High-Performing Survey Students, only two had not taken this class before, nine were repeating it for the second time, two students were taking the class for the third time, and one student was taking this class for the fourth time. Of the nineteen students, seven indicated that their last math class was last year, four said that their last math class was before last year, but not more than three years ago, three indicated that their last math class was more than three years ago, and one did not answer the question.

Nearly all of the students who demonstrated mastery on the post-lesson survey were repeating this class. This may account for their high scores on the post-lesson survey, as these were concepts they had seen before. This population of students liked the lessons in general and responded frequently that no part of the lesson went wrong. When they did comment that there was something they did not like, it was that the teacher went too fast and that the white board was overcrowded with written information.

There may be a connection between the teaching methods and instructional strategies used and the type of student. Like the Low-Performing Survey Students, the High-Performing Survey Students seemed to like the "step-by-step" examples that may be offered in direct instruction, modeling, and scaffolding.

Consistency among participants. The data was sorted by the gender of the students. In these classes, there were no marked differences between males and females in terms of achievement and the content of their responses. An interesting difference between the responses was that males tended to write less, and females tended to write more, even though they may have been indicating the same response. One question that students were asked was, "What was the best thing your instructor did today?" Males' answers tended to be short, such as "teach," or "not hard," or "factoring." On the other hand, females' answers tended to be lengthier, for example, "showed us how to do the problem, and then let us try it on our own," or "very easy to understand and thought-provoking" or "I found it easier to use the second method she showed us, she broke it down into steps and that make it easier."

Students were then re-categorized into four groups: male students with a male instructor, male students with a female instructor, female students with a female instructor, and female students with a male instructor. No appreciable differences in student achievement and responses were found. It seems that the gender of the instructor did not make a difference for these students. Further, no student responses mentioned gender differences.

Consistency among responses. Students in this study tended to be consistent in their responses to similar questions on the questionnaire. For example, many responded similarly on the questions,

"What went well with this lesson?" and "What was the best thing your teacher did today?" Similarly, the questions, "What did not go well with this lesson" and "What was the worst thing your teacher did today?" had identical responses in some cases. Even when the questions were worded differently, responses often had the same meaning. For instance, a student who answered that "the lesson went well" when asked about the best part, also responded that "there were no flaws, it was a good lesson" when asked about the worst part. This could demonstrate that students were being truthful with their responses, indicating how they really felt.

At times students in the same class would answer in completely different ways. For example, one student said, "I don't understand most of it," while another student said that the best part of the lesson was "completely understanding." A check of these students' levels of achievement on the post-lesson survey showed that the second student scored well, while the other did not. Another discrepancy noted was the two students in the same class who had opposite comments: “the teacher went too fast,” and “the lesson moved too slow *[sic]*.” A possible explanation is that the instructor moved at a given rate of speed, which may have been an appropriate speed, but one student found that speed to be overly quick to them, while the other student found that same speed to be too slow for them. It may be impossible for an instructor to meet all the students’ needs at once.

Summary

Several pieces of information may be gleaned from the findings as described in this chapter. Compiling the data from the questionnaires, emails, videos, and observations gave the researcher a view of what is happening in Basic Algebra I classrooms at Rowan University. While this view cannot be generalized to represent the entire population of all Basic Algebra I classes, it gives a general idea of the structure of some algebra classes and the teaching techniques of a handful of instructors.

Looking at the demographics of the students in this study, it could be said that the students in Basic Algebra I classes are around eighteen years old, with the oldest student being twenty years old. The average class size was fourteen students. About half of the students were taking this class for the first time, while another half was repeating this class. More than half of the students indicated that they had taken a mathematics class within the last year, about one quarter of the student had taken a mathematics class within the last three years, and fewer than 10% of the sample had not had a mathematics course in the last three years.

In this study, students were asked to complete a Pre-Lesson Knowledge Survey that consisted of two mathematical problems before the lesson began. The intention was to assess the students' knowledge about the content before the lesson on that subject was taught. Not surprisingly, overall the students did not score well on this test, accumulating an average of only 1.45 points out of 10. At the conclusion of the class, the students were assessed again using the Post-Lesson Knowledge Survey. At this point, students had more knowledge about the mathematical concept that was taught, and subsequently had higher scores. The average student was awarded 6.425 points out of 10 on the Post-Lesson Knowledge Survey, a 443% gain.

After the Post-Lesson Knowledge Survey, students were given a questionnaire that asked them what they thought about the lesson. The first question students were asked was, "What went well with this lesson?" Eight students indicated that all went well with the lesson and other students said that they liked the lesson when they understood the concept or mastered the material. On the other hand, some students became annoyed when the instructor continued to give more examples when they felt that they had already mastered the material. Students reported that when material was broken down into steps, it was easier to comprehend. When students were asked, "What did not go well with this lesson?" the students responded that they did not think the lesson went well when did not understand the concept in the end. Some students commented that some methods took too long to complete, while others commented that the instructor went too quickly and they became lost. One student wished there was more time to practice problems. Another student was confused by the instructor's overly cluttered whiteboard.

On the questionnaire, students were asked about the best thing and the worst thing that the instructor did that day, and what they liked and did not like about the lesson. Students found it favorable when the instructor involved the students, checked for student understanding, broke larger concepts into steps, worked problems at the board, gave the options for solving problems, and explained mathematical concepts well. Nearly all students responded that "nothing" was the worst thing the instructor did that day, or indicated that the lesson went well. When students did indicate that something went wrong, the students said that the instructor was boring, moved too quickly, gave too much information at once, had students complete a worksheet, cluttered a whiteboard, showed the class concepts that they did not understand, made mathematical mistakes, failed to answer student questions appropriately, and had no activities.

In a follow-up email, instructors were asked how their day went. Half of the instructors said that student engagement went well, while the other half focused on the learning outcomes of the students. When asked about what did not go well, instructors pointed out what their students forgot to do, or said that their students needed more practice, but did not talk about their own inefficiencies. When asked what they did best, the instructors discussed their graphic organizers, checking for understanding, modeling, and ability to make connections for the students. Three out of four instructors mentioned their frustration with not having enough time in the day. Additionally, some student comments echoed the same sentiment.

Every instructor in this study used direct instruction almost exclusively. Neither cooperative learning nor collaborative learning was used by any of the instructors, and no partner work or group work was observed. Two of the instructors used constructivist teaching, while the other two did not.

Observed instructional strategies that were used by all instructors included stating the objective, modeling, scaffolding, student engagement, and a positive attitude. None of the instructors were observed using games or manipulatives. Three out of four instructors used technology during the lesson and half of the instructors used a graphic organizer on a handout. Half of the instructors used humor and fun with their students, and only one instructor showed students the real world relevance of the lesson.

Chapter 5

Discussion

This chapter will discuss the implications of the findings of the study, will offer suggestions for using the results of this research, and will conclude with recommendations for further study.

Introduction

This research study attempted to identify effective teaching methods used by instructors of developmental mathematics classes at the college level. This study utilized the theoretical framework of equity. Equity theory is a theory of justice. If implemented, the results of this study will improve equity by giving developmental students, who may have a greater need for help than typical students, additional help. In theory, instructors who teach this type of student will be given the skills they need to best reach this unique category of students. If policies are changed to allow developmental classes the same amount of instructional time that most classes are afforded, an increase in student success may result.

Teaching methods. The first research question this study attempted to answer was, "Which research-based teaching methods do instructors of developmental mathematics use in their daily practices?" The researcher looked for evidence of three selected teaching methods: direct instruction, group work, and constructivist teaching. In the few classes observed, a wide variety of teaching methods was not observed. It is possible that this is because of the subject matter of mathematics itself, as the teaching of mathematics lends itself to a step-by-step approach. It is also possible that there was a lack of variety of observed teaching methods because video of the entire semester was not captured. The low ability level of the students in this population may be a contributing factor in the types of teaching methods observed. A lack of diversity in teaching methods could be a result of time constraints put on the instructor. If given more time, instructors may have been able to use different teaching strategies.

The teaching method that was used the majority of time was direct instruction. Every instructor observed used this method for most of the class period. None of the instructors placed students into groups or partners, and neither cooperative learning nor collaborative learning was seen. It should be noted that only a few lessons were observed, and it could be that during other lessons during the semester, other teaching methods were used. Further studies that incorporate all the lessons in a semester could help to verify this theory. Constructivist teaching was used part of the time by instructors A and B, yet not at all by instructors C and D.

Allowing students to reason for themselves may be an important technique in developmental instruction. This study showed that of the four instructors, Instructor B's students had the greatest gain in points from the Pre-Lesson Knowledge Survey to the Post-Lesson Knowledge Survey. Students in Instructor B's classroom commented, "The instructor gave one-on-one help to students" and "The instructor went around the classroom and helped individuals." Student comments suggest that they liked when the teacher walked them through the problem. Students in Instructor A's classroom commented, "The instructor had us complete classwork practice" and "The instructor helped us to visualize the lesson." Four students of Instructor A commented, "I was able to solve the problems, I understood." In Instructor A's classroom and in Instructor B's classroom, two students in each noted, "I mastered the material, I learned the concept."

Additionally, students in each classroom observed, “The instructor made sure students understood before moving on.”

Direct instruction is very structured. The instructor lectures to the students and then asks them to demonstrate mastery of the subject. Traditionally, constructivists have suggested that direct instruction is inferior to experiential learning techniques that have students discover answers on their own without being told (Reiber, 1992). The passivity of students learning by direct instruction has also been criticized (Baumann, 1988). However, according to Sweller, Kirschner, and Clark (2007), direct instruction may not be inferior. While it is true that some knowledge, such as the development of speech in toddlers, is acquired without direct instruction, not every subject area lends itself to a discovery approach to education. Following the same analogy, toddlers are exposed to language all around them, and this is why they start to use it themselves. Yet college students are not exposed to factoring trinomials in the world around them, and would not learn this information without explicit instruction. Geary (2005) emphasizes that what he called “biologically primary knowledge” is learned automatically and unconsciously, while “biologically secondary knowledge,” like mathematics that is taught in schools, must be explicitly taught.

It is possible that the observed instructors used direct instruction most of the time because they were short on time, or because that is the way they had been taught math. It could be that they purposely chose not to use other strategies. Instructors could have been less confident with other teaching methods and so avoided them because they were being video recorded. It may be interesting to find out if instructors would use other teaching techniques if they had more class time to teach each concept.

Students seemed to like the direct instruction that the instructors used. Student comments suggest that direct instruction was appreciated. Comments such as “The instructor explained concepts step-by-step” and “The instructor showed more than one method to solve the problem” indicate that students appreciate the direct instruction approach. The gains in score from the Pre-Lesson Knowledge Survey to the Post Lesson Knowledge Survey show that students learned some mathematical concepts. Student comments such as “The instructor explained the concept well, the instructor taught well” and “I was able to solve the problems, I understood” and “I mastered the material, I learned the concept” show that students felt good about learning with direct instruction.

Instructional strategies. The second research question this study attempted to answer was, “Which instructional strategies do instructors of developmental mathematics use in their daily practices?” The researcher looked at the videos for evidence of eleven selected instructional strategies: whether the instructor stated the objective, the use of manipulatives, the use of technology, the use of games, the use of graphic organizers, student engagement, modeling, scaffolding, the use of humor and fun, an instructor’s positive attitude, and whether the instructor told the students how the mathematical concepts were relevant in the real world.

The objective and real-world relevance. The statement of the class period’s objective should be done at the beginning of class. Every observed instructor stated the objective. Most instructors let the students know the objective at the start of class, however one instructor did review work as a warm-up first, then stated the objective of the remainder of the class, the new mathematical material, twenty minutes into the period. The instructors in this study told the students what they had already learned, how that related to where they were going today, and how today's lesson would relate to future lessons. Students seemed to have a clear idea of what would be done in the next fifty minutes.

One area in which instructors seemed to fall short was telling students why today's lesson mattered, and how these concepts could help them in the real world. Only one of the three instructors told students how the lesson would benefit them in their future careers, and that instructor offered multiple examples, telling students how graphing could be used in multiple fields. This instructor told students that temperature change was graphed in science fields, that the stock market fluctuations could be graphed, and that athletes could track their times on a graph. Students should feel connected to their learning, and offering explanations of the use of the material is important. One benefits of relating instruction to the student's lives would be a possible increase in the student's attention level. Knowing that a subject matter was important and valuable could make instruction more memorable for students.

Games and manipulatives. The researcher found that no instructors used games or manipulatives of any type. Instructors may perceive college-age students as being too old or too mature for games and manipulatives. But college students may not feel the same way. One student in this study wished there were more activities during the lesson. Perhaps the use of games would keep the students' attention, as some off-task behavior was noted in the students, especially that students were using their cellular phones. If students have difficulty with abstract concepts, manipulatives could help them to move from concrete examples to abstract concepts.

The concept of factoring trinomials could easily be taught with Algebra Tiles. Algebra Tiles are rectangular pieces that students can manipulate. They are commercially available as plastic pieces, but can also be made out of paper by instructors utilizing measurements and templates available online. Lessons and suggestions for use are abundant online. The tiles are used to represent variables and constants in algebra. Students learn to represent algebraic concepts with the tiles, and then use the tiles to assist with solving equations, show substitution in variable expressions, expand, factor, remove zero pairs, and more. The use of Algebra Tiles helps students to form a better understanding of algebra. The concepts students learn in developmental classes are the same as the concepts that typical students learn around grades seven or eight. Students in grades seven and eight use Algebra Tiles with success. Manipulatives may therefore be effective at the college level. Some instructors may believe that manipulatives are too babyish for college-aged students who are adults, but there may be merit to using them.

Carbonneau, Marley, and Selig (2013) found that there were moderate to large effects on retention of material, and small increases in students' problem solving skills when students used concrete manipulatives at levels ranging from middle school through college. Perhaps instructors of college Basic Skills classes could try using Algebra Tiles or other manipulatives with their students.

Maccini and Hughes (2010) discuss the effects of a problem-solving strategy with Introductory Algebra students with learning disabilities. Students' strategy-use increased as students were given a three-part instructional strategy. At the first stage, students were taught at a concrete level using manipulatives, then progressed through a semi-concrete level, and finally an abstract representation. This type of instruction may be ideal for developmental students, even though not all developmental students have learning disabilities. Unfortunately, it seems like this method would take a great deal of time, something that instructors are short on.

Use of technology. Technology could be used to assist students in learning developmental mathematics concepts. The researcher was surprised by the lack of technology used in the classroom. The only evidence of technology was a Microsoft® PowerPoint® projected onto a screen, utilized in three of the four classrooms. However, students reported that they did not like the Microsoft® PowerPoint® presentations. The Microsoft® PowerPoint® presentations these instructors used were taken from the textbook materials and were not particularly interesting. It was just a copy of what was in the textbook, but in a Microsoft® PowerPoint® format. Instructors could use other materials that come with the textbook such as videos and animations that are available on Pearson® MyMathLab®, the online component to the textbook, but none of the observed instructors used these materials. More dynamic animations, Microsoft® PowerPoints®, and Prezi® presentations are available online. These could serve to hold the students' attention.

Perhaps another missed opportunity was the lack of the use of calculators. While it is important to show students how to solve problems on their own, a graphing calculator could additionally help students with this skill. Developmental students seem to want to use calculators more than typical students, so perhaps this area could be explored. Again, time may be a factor in not showing students both methods of instruction – solving the problems by hand and solving them on a calculator.

Use of graphic organizers. Student responses indicated that they enjoyed the use of graphic organizers. It helped students to see the step-by-step progression of multi-step problems as well as kept them organized when there was a lot to remember. In the observed classes, two instructors used graphic organizers, while the other two did not.

Instructor A gave students a handout of what the instructor called a Factor Tree. This was a type of flow chart that guided the students on the ways to tackle factoring trinomials. Students reported that they did not know where to start when factoring trinomials, and the Factor Tree flowchart clarified that for them. While I appreciated the general idea of the flow chart, I found this instructor's Factor Tree to have a few flaws, and I would make improvements to it.

Instructor B gave students a handout of the X-Box method of factoring trinomials. This method seemed complicated to the students at first, but students seemed to catch on after doing multiple problems. The same handout offered many problems for the students to work through. The X-Box method taught students to break down the process of factoring into small, simple steps. Later, the instructor taught an alternate method for factoring without the X and box. Presumably, the students moved from a concrete visualization to a more abstract process. Student responses still indicated that they did not like the tedious X-Box method because it was too many steps.

The use of graphic organizers should be encouraged in developmental mathematics classes. An instructor should take care to be sure the organizer makes sense to the students, and does not confuse them further. Graphic organizers can help students to know what to do and when to do it, as in the case of Instructor A's Factor Tree which helped students see the steps of factoring displayed in a flow chart. Students responded favorably to this organizational aid, especially those that commented that they did not know where to begin. Graphic organizers also can help students follow an algorithm, as in the case of Instructor B's X-Box. Students followed along step-by-step to fill up the X and the Box, and could easily tell if they had completed all the parts by looking at the empty spots that remained. Instructor B started students with a graphic organizer and then had students complete the steps without the organizer as they became more proficient. This movement from concrete to abstract thought is well-documented in the literature as a good teaching technique.

Student engagement. Instructors should be encouraged to engage their students so that the most learning takes place. This can be especially challenging at the developmental level due to the nature of some students. All instructors recorded on video engaged their students throughout the class period by calling on students to answer mathematical questions and work problems at the whiteboard. Students' attention was captured when instructors announced that the upcoming information was very important. Questions such as, "Do you know how she got that answer?" or "What should I do [next]?" or "Who considers themselves a visual learner?" or "Is this making sense?" or "Do you think this [method] will help?" were posed to the students to be sure they were engaged in the learning and are excellent techniques to draw student attention. One of Instructor A's students answered that the lesson went well because "the instructor held my attention," while a student of Instructor D replied that a lesson went well because "the instructor interacted with students."

Another way to engage students is to allow them time to work mathematical problems on their own, either at their desks, or on the whiteboard. A student wrote on the survey, “The instructor had us complete classwork practice.” One student commented that in Instructor A’s classroom, “there was a lack of student participation.”

All instructors recorded on video allowed students time to work mathematical problems independently, which students seemed to enjoy. In Instructor D’s class, two students commented, “The instructor allowed students to practice problems on their own,” and one student expressed dissatisfaction when the practice time came to an end by commenting, “There was no time for more practice problems.”

Humor, fun, and positive attitude. Using humor and having fun during class is another way for instructors to hold students’ attention. It also may make class time more enjoyable and less like drudgery. One of Instructor B’s students commented, “the lesson was bland.” Other students also reported that they did not like classes that were boring. The use of humor and fun may reduce the boredom for students. An instructor should attempt to use to humor and fun as much as possible to keep students’ attention and to make mathematics class a pleasant experience.

A positive attitude is another attribute that students like in a teacher. Student comments indicated that they appreciated instructors who were upbeat and encouraging. It could be that an instructor’s energy and passion for a subject area could be contagious to students. Encouraging students and letting them know that they can be successful is important. Developmental students at the college level may be accustomed to hearing about their shortcomings, so hearing a phrase such as “stick with me, you’ll get it,” or “it’s not that bad, you can do it” from an instructor may be particularly encouraging. As one commented, “The instructor had a good attitude.”

Modeling and scaffolding. Modeling and scaffolding are two teaching techniques that may be used during instruction, and they can be used in tandem. Every observed instructor used both techniques. Almost instinctively, instructors demonstrated techniques to students as they worked problems on the whiteboard. The instructor's reasoning and thought processes were explained throughout. Instructors helped students to understand difficult mathematical concepts by first helping them a great deal, then slowly taking away supports, and then eventually giving no supports when the student could complete the task on his or her own. This method of scaffolding was effective as students became more proficient over the course of a class period. Students commented that they liked when instructors broke difficult problems down into smaller parts. One student commented, "The instructor helped us to visualize the lesson," while another student noted, "the instructor explained concepts step-by-step."

Both modeling and scaffolding have a place in algebra instruction. Algebra lends itself to be algorithmic and methodical, where steps are followed in a certain sequence. Instructors should break information into smaller chunks for students and then walk them through the processes using a technique of speaking the steps they are thinking in their head. Students should be started with much support, and gradually, the amount of support should gradually be diminished. An exemplary example of both scaffolding and modeling was demonstrated when Instructor B began her factoring trinomials lesson with students using the X Box method. At first, students placed parts of a problem into locations in an X and a Box. The teacher spoke her thoughts aloud, telling students why each factor was placed in each position. Later, she had students use the same techniques, but without the graphic organizers. The teacher again demonstrated using a think-aloud technique. As students gained confidence, the supports were gradually taken away, until students could complete the task on their own. It may not be a coincidence that this instructor's students had the greatest learning gains.

Student response. The third research question this study attempted to answer was, "How do students respond to the teaching methods and instructional strategies their instructors use?" This research study found that in general, students enjoyed the lesson when they understood the mathematical concepts and liked an instructor that could explain concepts well. Students seemed to like individual attention, being involved in the lesson, and instructors with a positive attitude. The results of this study show that students made some gains in their learning; however, they did not completely master the concepts. Students did not like feeling rushed, and did not care for Microsoft® PowerPoint® presentations. They liked graphic organizers to help them keep their thoughts straight, but did not like when too much information was presented at once, as in the case of a cluttered whiteboard.

Some difficulties are easily corrected. If an overly full whiteboard seems complicated to students, the instructor could instead erase the board before adding more information. Instructors who have not previously used humor could try to incorporate it. Instructors who have not used graphic organizers could try them to help students stay organized with complex tasks. Other difficulties prove more challenging. Students like individual attention, but there may be twenty students in the class. While every student may not be able to receive individual attention all of the time, instructors could circulate around the room and offer individualized attention to those that need it as students work out independent practice problems. Developmental students, who often need more individualized attention, may also be referred to tutoring services offered on campus so they can receive one-on-one attention outside of class. Often solutions for problems do not seem obvious, but a quality instructor will think outside of the box to come up with solutions for his or her students.

Many of the students' responses were very general compared to other things they said. Students often said, "nothing was wrong," or "everything went well." When students cannot be clear about their feelings, it may be that their analytical skills or their self-reflective skills are weak. The researcher attempted to probe deeper into the student's thoughts through the interviewing process, but this did not always yield favorable results. Perhaps a more effective approach would have been to ask the students more direct questions on the original questionnaire, such as, "tell me your thoughts about instructors using Microsoft® PowerPoint® presentations," or "did you like the graphic organizer handout, or would you have rather had the steps for solving this type of problem written out?" Another idea is to thoroughly question students in a longer interview format that is less generalized. In this way, a researcher can delve deeper into the items that each individual student mentioned. Then again, researchers are justified in not doing long interviews with students because they can be observed on videos, and a researcher may be able to tell what a student is feeling by looking at their body language and listening to the questions they ask.

The questionnaires the students answered and the interviews with students clarified the preferences of the students. Students seemed pleased with their instructors overall, with more students reporting that the lesson went well and that the instructor did nothing wrong than those who reported otherwise. Students responded that they liked the lesson best when they understood what was going on. Students were happy when they found the concepts easy or when the concepts were mastered. On the other hand, once the students mastered the concept, they became aggravated when the instructor kept going over the same concept again and again. Some students liked when more than one procedure was given to solve the same problem, yet others found this to be confusing. Students also appreciated a quiet room, an instructor with good classroom control, and instructors who helped students get caught up after an absence. Good instructors, according to the students, keep students' attention and have them be involved, are easy to understand, have a good attitude, and break complicated tasks into smaller, more manageable pieces. Students responded favorably when instructors went over examples many times, used a graphic organizer, made sure the students understood before moving on, and helped individual students at their desks.

Conversely, students did not like when instructors went too fast, when the problems took too long to solve, and when problems were overly difficult. They became frustrated when they did not understand the mathematical concept, when the lesson was boring, and when there was not time to practice. A visually cluttered whiteboard, too much information at once, and an instructor who did not answer a student's question satisfactorily turned off students. Students also did not care for problems involving fractions, big numbers, and surprising answers such as prime numbers that could not be factored. One student reported that participating in class was undesirable. Most students felt that the Microsoft® PowerPoint® presentation was unnecessary.

Implications

Practice and leadership. A great deal of information can be gleaned by recording video of instructors teaching a learners learning. Some of the instructors that were recorded on video for this study asked to see the videos at the conclusion. The researcher told the instructor participants that these particular videos could not be shared as part of Internal Review Board protocols for purposes of this study. However, if this is something that would interest college instructors, perhaps someone could tape the instructors so that they could then watch the tapes to self-reflect. With this new perspective, instructors may be able to see the ways students react to different aspects of their teaching. At Rowan University, one of the goals of the Faculty Center is to promote a high standard of quality in teaching and learning (Faculty Center, 2016). This center will record a video of instructors and help to provide feedback. According to their website, they offer "professional development focused on research-based teaching practices, learner-centered teaching, action research and reflective pedagogy" (Faculty Center, 2016). Similar supports for instructors are likely offered on most college campuses, or they could be easily implemented.

One factor for student success may be the status of the professor who is instructing the class. Jacoby (2006) found that college rates decreased as the proportion of part-time faculty that was employed at the institution increased. This was of particular interest to me as I am a part-time faculty member. It could also be that professors do not know how to best teach developmental mathematics students. This may be because they were never taught to teach this unique population or perhaps they do not know the best techniques to use with this population. No instructor of developmental mathematics at Rowan

University is a full-time faculty member. Perhaps if full-time faculty members were employed, and then those professors were properly trained in effective instructional techniques, there would be more gains in the students' learning.

Not only may the findings of this study affect instructor practice, but these findings may also affect how supervisors of instructors evaluate and assists them. The recording of video may be considered to evaluate instructors, to provide feedback, and to help instructors to become better instructors. Supervisors or coordinators of the Basic Skills program may use video recording as a way to illustrate the best methods for instructing developmental students.

The implications described in this paper have the potential to uncover instructors' underlying notions about what constitutes effective instruction. Examining and critiquing fellow instructors helps to bring clear, specific, and detailed opinions to the surface, which can then be examined by instructors, researchers, and policymakers. Ultimately, this type of exercise may produce more reflective instructors, more informed researchers, and more effective practice in the classroom.

Public policy. The teaching methods observed were largely direct instruction. The reason for this may be that there is a lack of time during class, as class is only fifty minutes long. Perhaps if there was more time, more could be done during class time, and this would allow for other types of teaching methods such as partner work, and cooperative or collaborative learning. For each instructor, practice of the learned skills is done outside of class as students work through their homework on a computerized program. Again, there is not much time for students to practice mathematics during class time. Policy makers may consider the findings of this study and rethink the amount of instructional time given to Basic Skills classes.

Additionally, professional organizations may be able to help. Instructors may be trained in best teaching practices for students. Conferences could highlight the changes that need to be made in the way college students are educated. Publications may contain articles on effective teaching strategies. A way to best reach instructors may be to give a short blurb about one technique or method at a time. Because they are busy, instructors may not put in the time to read a long article. This method of teacher education could be offered as a workshop, a short article or graphic in a publication, or as an email blast.

Recommendations for Future Research

The topic of effective teaching in developmental mathematics is indeed an important one, and one that should continue to be investigated. It is possible that developmental instruction is different from instructing typical college students. Future researchers may want to delve into additional topics in developmental instruction.

This study focused on teaching methods and instructional strategies of effective instructors. Another area of research may focus on additional qualities of effective instructors, such as the instructor's personality, compassion, passion about the subject area, excitement, enjoyment of his or her work, energy, sense of humor, persistence, approachability, or consistency. One may want to look at an instructor's motivation of students, if students perceive the instructor as fun, and if the instructor leaves a lasting impression. One may want to find out how an instructor accepts and embraces all students, plans for classroom management and routine procedures such as attendance-taking and passing out worksheets, utilizes Bloom's Taxonomy, gets ideas from a variety of sources, uses assessment, provides feedback, teaches holistically, uses praise, takes risks, communicates clearly, adapts to student needs, welcomes change, masters his or her subject area, lets students ask questions, and becomes comfortable with the unknown. The use of videos was an interesting aspect of this research study. The researcher found that instructors wanted to view the tapes to see their own teaching from a different perspective. Showing instructors two different lessons that had been recorded on video and having them compare and contrast a lesson may prove interesting. This type of comparison would allow researchers to examine instructors' evaluation of the most ideal script for a mathematics lesson, as well as why one script may be more effective than another. Other types of lessons, such as practice or review, could yield very different results, as could lessons in different subject areas.

Another suggestion is to investigate within-country differences such as the differences between more and less reform-minded instructors. Finally, a more thorough probing of instructors' comments, including asking them why they believe that particular events are strengths or weaknesses, or how they think that such events could be improved, would help elicit more ideas that could aid in the interpretation of instructors' ideal lessons.

This study showed that instructors did not use games or manipulatives. Perhaps instructors perceive that college-age students are too old for games and manipulatives. It may be interesting to find out if college students feel the same way. The subject matter in developmental classes is the same as the concepts that typical students learn around grades seven or eight. Students in grades seven and eight use Algebra Tiles with success. There is a possibility that manipulatives would be effective at the college level. Perhaps a research study may ask students if they would like to have games in their mathematics class, or if they think they may benefit from using manipulatives. Another study could compare the students' understanding of an identical concept in two classes, one in which manipulatives such as Algebra Tiles was used, and one in which only direct instruction was used.

This research study found that students made an average learning gain of five out of ten points when the scores of the Pre- and Post-Lessons surveys were evaluated. It could be that students may make further gains after they practice the concepts as they complete their online homework at home. One possibility for further research is to evaluate the students again after the homework has been completed. In this study, many students did not demonstrate mastery of the mathematical concept. Perhaps more students would demonstrate mastery after the homework had been completed, and this could be an area for future research.

Currently, Basic Skills mathematics classes at Rowan University are two-credit classes, and there is less instructional time than typical three- or four-credit classes. The rationale for this is that Basic Skills classes are "pre-college" classes that do not count for college credit. A recurring theme of this research study was that both students and instructors felt that there was not enough time in the day. A research study could be conducted that looks at the amount of time (or credit hours) for classes, possibly comparing different institutions of higher education. It would be interesting to find out if students may benefit from having more instructional time if the classes were to be three-credit classes. It would be interesting to see if instructors employ different teaching methods because they have more time. A study could be set up to see if direct instruction is used less and group work is used more when classes have more instructional time.

On average, all students made learning gains from the Pre-Lesson Knowledge Survey at the beginning of the class and the Post-Lesson Knowledge Survey at the end of class. It should be noted that these two surveys were given approximately forty minutes apart and that the students did not have time to complete their homework or practice the concepts in the lesson aside from what was done in one class period. It could be that students may have more learning gains after the students complete their online homework.

Following the lesson, instructors were emailed and asked how they thought it went. Instructors reported that engaging their students and using graphic organizers were highlights of their lesson. They also were pleased with the learning outcomes of their students and the connections they had made with their students. Three out of four instructors pointed out their student's insufficiencies when asked what did not go well with the lesson. The fourth instructor wished there was more time in the period, and the other three instructors echoed the fact that they felt rushed. A lack of time in the class period seemed to be a major problem.

As the researcher worked through this study, other ideas were revealed. Some other topics of interest include the instructors' behaviors. One may study whether the instructor circulates around the room while instructing, or only stands in the front of the room. Another idea would be to assess the instructor's wait time after asking students a question. Were students given enough time to think about a question before answering? It seems as though instructors often rush students to give a quick response. Developmental students, especially, may need additional time to think.

This study represents a convenience sample. Video methodology could be implemented using a considerably larger, more random sample of instructors. Such a sample would allow a thorough exploration of important within-country factors, such as experience and knowledge. Only one or two lessons were done and therefore can make no conclusions about how generalizable or stable student evaluation would be across lessons.

Conclusion

There are many aspects of a classroom climate, including a social climate, an emotional climate, and the way teachers influence the growth of the students. The climate of a mathematics classroom has been linked with mathematics achievement, and is frequently an area where reform is necessary, according to Wang and Eccles (2014). Wang and Eccles (2014) go on to suggest that the most learning takes place when students see the relatedness of fields and feel confident in their ability to master the material being taught. Instructors should ask their students what helps them to be successful and listen closely to their answers. To increase their students' academic performance, instructors should reflect on their teaching and make changes that benefit the most students. This environment that supports the emotional needs of students may be where students will make the most learning gains.

Frenzel, Pekrun, and Goetz (2007) studied the relationship between student emotions of anger, anxiety, enjoyment, and boredom in the mathematics classroom and the impact that made on student performance. Frenzel, Pekrun, and Goetz (2007) suggest that emotional well-being of an instructor's students should be a desired educational goal for an instructor. While test anxiety has received attention in the literature, other thoughts about the students' emotional well-being seem to have been glanced over. Instructors should consider their students' happiness and excitement for mathematics and make positive changes to increase student happiness in the classroom.

The low rate of success of developmental mathematics students is a problem that has not yet been solved. Sometimes it seems that these students are forgotten or ignored. Could the reason be that these students are moneymakers for the college? These students pay tuition for these developmental courses, which they need to complete before they take the courses for credit. After completion of the developmental course, the students will take their typical for-credit courses. Because they have taken additional courses, they have spent additional time on the college campus and have tuition expenses that are higher than the typical student.

The improvement of student mathematics performance is an important educational goal. Without being proficient in math, students will struggle to develop the critical thinking skills and problem-solving skills needed to participate fully in society and to be successful in life (Wang & Eccles, 2014). As the world changes, including the global economy, and as we move into the twenty-first century, having educated citizens is imperative, according to Fike and Fike (2007). Because of this, instructors should look for ways to help at-risk students. Leaders of colleges should look into these findings and take action to improve the educational outcomes for underserved students, say Fike and Fike (2007).

Developmental students enter college behind their peers. Passing the developmental mathematics classes allows these students to take additional courses for college credit. These additional courses could lead to the students obtaining a college degree. Degree earners are likely to be more successful in finding employment. Thus, passing developmental mathematics courses are a gateway to student success.

Colleges want students to successfully complete their degree programs. The goal of basic skills classes is to give developmental students the tools they need to be on an even playing field with their peers, so that they may have an equal chance at earning a college degree. The education of our country's youth is essential for keeping up with our peers in the global economy.

> Now is the time to build a firmer, stronger foundation for growth that will not only withstand future economic storms, but [will] help us thrive and compete in a global economy… We believe it's time to reform… colleges so that they provide Americans of all ages a chance to learn the skills and knowledge necessary to compete for the jobs of the future… Providing all Americans with the skills they need to compete is a pillar of a stronger economic foundation, and, like health care or energy, we cannot wait to make the necessary changes. We must continue to clean up the wreckage of this recession, but it is time to rebuild something better in its place.
>
> —President Barack Obama (2009)

A change is long overdue. The future is grim for students who do not pass developmental courses. These students will not move on to take other courses for credit, and will not graduate. Without graduating, they will not have the same opportunities as others in the job force. Now is the time to educate tomorrow's leaders properly so that they can lead tomorrow's world.

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Appendix A

Participant Consent Form for Instructors

Natalie Kautz

xxx xxxx xxxx • Glassboro, NJ 08028
856-256-xxxx • kautzn@rowan.edu

September 20, 2015

My name is Natalie Kautz. I am an instructor of Basic Algebra I at Rowan University. I am also a doctoral student in the Educational Leadership program here at Rowan. I am currently working on a dissertation titled, *Strategies for Teaching Developmental Mathematics Students at the College Level*. The purpose of this investigation is to identify strategies used by effective instructors of basic skills mathematics that may increase the success rate of developmental mathematics students. My hope is that this will help instructors to improve the way they teach math.

As part of the research for this dissertation, I am studying instructors of Basic Algebra I as they teach the skill of factoring trinomials with a leading coefficient (of the form $ax^2 + bx + c$) by grouping. This lesson corresponds with section 4.4 of the textbook *Introductory Algebra* (4^{th} edition) by Elayn Martin-Gay (1999).

Instructors will be recorded on video as they teach three sections of the textbook: sections 4.3, 4.4, and 4.5. This will take approximately three to five class periods during this semester. The video camera will be positioned at the back of the room and will capture both students and instructor.

Before lesson 4.4 begins, I will give students a brief pretest to assess their level of comprehension on the skill of factoring trinomials with a leading coefficient (of the form $ax^2 + bx + c$) by grouping. After the completion of lesson 4.4, I will give students a posttest on the same concept. The two tests will be compared to see if knowledge has been gained.

At the end of each lesson recorded on video, the students will be asked to answer a few questions about the lesson. Additionally, instructors will be emailed and asked how they thought the lesson went.

You are not required to participate in this study. Your participation is voluntary. If you agree to participate and then change your mind, you may opt out at any time.

During the spring semester, you will be invited to a discussion outlining the results of my study. Pizza will be served at this event.

The Institutional Review Board of Rowan University has approved this study. You may contact the IRB at the Office of Research, 201 Mullica Hill Road, Glassboro, NJ 08028, or at (856) 256-5150.

There are no risks associated with participating in this study, as participants' names will be kept confidential and data will be stored in a locked office. The benefit of this study is that the knowledge gained from this study could be used to discover the ways that any instructor can best educate the developmental mathematics students they teach. The purpose for doing this research study is to inform my own teaching practices and those of other instructors of developmental mathematics who encounter similar difficulties. I plan to share my findings with other educators of developmental mathematics at Rowan University and other institutions of higher education.

If you have any questions about this study, please feel free to contact me. Thank you in advance for your help with this study.

Sincerely,

Natalie Kautz

Natalie Kautz

Please return this part of the document to me:

- -

Please check the appropriate box.

☐ I agree to participate in this research study and be recorded on video.

☐ I do not agree to participate in this research study and be recorded on video.

______________________________ ____________________

Instructor Signature Today's Date

____

Please print your name

Appendix B

Participant Consent Form for Students

Natalie Kautz

xxx xxxx xxxx • Glassboro, NJ 08028
856-256-xxxx • kautzn@rowan.edu

September 20, 2015

My name is Natalie Kautz. I teach Basic Algebra I here at Rowan University. I am also a doctoral student here at Rowan. As part of my studies, I am currently working on a dissertation titled, *Strategies for Teaching Developmental Mathematics Students at the College Level*. I am trying to find out how teachers can best help students learn math so that instructors can improve the way they teach.

During this semester, three classes will be recorded on video. The video camera will be positioned at the back of the room, and therefore will also capture the students in the classroom.

Before the instructor teaches the lesson, I will ask you to take a short pretest. I am trying to find out how much you know about the concept that will be taught. After the lesson, I will ask you to take a posttest. I want to see how much you know after the lesson has been taught. By comparing the two tests, I can see how much you and the class have learned. These tests will not be factored into your grade for this class. Your regular teacher will not see these tests.

At the end of the lesson recorded on video, I will ask you to fill out a short written questionnaire. There are no right or wrong answers. I would like to know what you think about your teacher's instruction. If you would like to talk more about the lesson, you can write your phone number on the questionnaire and I will call you.

You are not required to participate in this study. Your participation is voluntary. If you do not want to be recorded on video, you may be positioned behind the camera. If you agree to participate and then change your mind, you may opt out at any time.

Please understand that your participation or nonparticipation in this study will not affect your grade in this class in any way.

If you choose to participate in this study, incentives will be offered. The questionnaire you fill out becomes your ticket to a drawing. At the end of the video recording, one ticket will be drawn and the winner will receive an assortment of gift cards and coupons from area merchants. Not everyone in your class will win this prize. During the spring semester, all students who participated in the study will be invited to a discussion of what I found out in my research study. Pizza will be served at this event.

The Institutional Review Board of Rowan University has approved this study. You may contact the IRB at the Office of Research, 201 Mullica Hill Road, Glassboro, NJ 08028, or at (856) 256-5150.

There are no risks associated with participating in this study, as your name will be kept confidential and data will be stored in a locked office. The benefit of this study is that the knowledge gained from this study could be used to help mathematics instructors in the future.

If you have any questions about this study, please feel free to contact me. Thank you in advance for your help with this study.

Sincerely,

Natalie Kautz

Natalie Kautz

Please return this part of the document to me:

- -

Please check the appropriate box.

☐ I agree to participate in this research study and be recorded on video.

☐ I do not agree to participate in this research study and be recorded on video.

________________________________ ________________

Student Signature   Today's Date

________________________________ _________ ___________

Please print your name   Your age   Your date of birth

Your teacher: ________________ The time and day your class meets: ___________

Is this the first time you have taken this course, Basic Algebra I? ____________

If no, how many times have you taken this course before? _________

Before this class, when was your last math class (not counting statistics)?

- ☐ Last year
- ☐ Before last year, but not more than three years ago
- ☐ More than three years ago

Appendix C

Pre-Lesson Knowledge Survey

Name: ________________________________ Algebra Teacher: ___________________

Date: ___________________ Time and Days Your Class Meets: ___________________

Basic Algebra I   Section 4.1   Pre-Lesson Knowledge Survey

Even if you are not sure how to do these, please make an attempt.

1. Factor completely. Show your work. Circle your answer.

   $15x^2 + 11x + 2$

2. Factor completely. Show your work. Circle your answer.

   $4x^2 - 8x - 21$

Appendix D

Post-Lesson Knowledge Survey

Name: ________________________________ Algebra Teacher: ___________________

Date: ___________________ Time and Days Your Class Meets: ___________________

Basic Algebra I Section 4.1 Pre-Lesson Knowledge Survey

Even if you are not sure how to do these, please make an attempt.

1. Factor completely. Show your work. Circle your answer.

   $21x^2 + 17x + 2$

2. Factor completely. Show your work. Circle your answer.

   $6x^2 - 11x - 10$

Appendix E

Post-Lesson Questionnaire for Students

Today's Date: ______________ The time and day your class meets: ______________

Your teacher: ______________________________

What went well during this lesson? ____________________________________

____

What did not go well during this lesson? _________________________________

____

What was the best thing your instructor did today? ____________________________

____

What was the worst thing your instructor did today? ___________________________

____

What did you like about today's lesson? ______________________________

____

What did you dislike about today's lesson? ______________________________

____

Could I call you today and ask you questions about today's lesson, or for clarification of your above answers?

If yes, please provide your phone number: ___________________

When is the best time to call? _______________________

Thank you for participating in this study!

Appendix F

Student Telephone Interview Protocol

Thank you for letting me call you today to ask about today's math lesson.

You said that _______ went well during today's lesson. Why do you think that went well? ____

____

You said that _______ did not go well during today's lesson. Why do you think that didn't go well? ____

____

You said that _______ was the best thing your instructor did today. Why do you think that?____

____

You said that _______ was the worst thing your instructor did today. Why do you think that?____

____

Probing questions:

Could you please tell me more about this?

I believe I heard you saying this… Did I understand you correctly?

Please help me understand what you mean.

Please provide an example.

Is there anything else you would like to say?

Thank you again for allowing me to interview you.

Appendix G

Instructor Response Email

Thank you for allowing me to record video in your class today.

Please answer a few questions about today's lesson.

Thank you in advance for your cooperation.

What went well during this lesson?

What did not go well during this lesson?

What was the best thing you did in class today?

What was the worst thing you did in class today?

Appendix H

Checklist of Observed Teaching Methods and Instructional Strategies

Coder's name (your name) : ________________________________

Name of instructor on video: ____________________________

Date of video recording: __________________

Date of video observation (today's date):_____________________

Checklist of Teaching Methods used by the instructor.

Examples: direct instruction, group work, and constructivist teaching.

Note the time when this occurred, the method, the time spent on each method, and the order in which the methods happened.

Time Stamp: ______ Method: __________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Method: __________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Method: __________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Method: __________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Method: __________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Method: __________________________Time spent: ____ mins.

Notes: ____

Checklist of Instructional Techniques used by the instructor.

Examples: manipulatives, technology, games, graphic organizers, think-alouds, active participation and engagement, modeling, scaffolding, telling students why this is important.

Note the time when this occurred, the method, the time spent on each method, and the order in which the methods happened.

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Time Stamp: ______ Technique: ___________________________Time spent: ____ mins.

Notes: ____

Appendix I

Instructions for Video Watching and Coding

How to do video coding

Make a list with two columns.

The first column is the time as shown on the counter on the video.

The second column is a description of what you saw on the video.

Watch the video of a teacher teaching.

Write down anytime something interesting happens, and the time it happened.

For example (I made these up):

2:58 Teacher made a joke to calm the class.
3:15 Gave a handout.
3:45 Wrote objective on the board.
9:55 Asked students if they had any questions.

If it is a non-teaching thing, you don't have to write it down
(Ex.: made an announcement about a parking lot closure).

You may write approximately 100 things down for the 40-minute video.

Then send me your list.

Thank you so much for helping out with this!

Natalie

Appendix J

Sample of Coding Consensus During a Selected Video Clip

<u>**Occurring in the classroom:**</u>	<u>**Coders' response**</u>
On the white board were four warm-up problems.	
The instructor asked students to take out a handout that was given out the other day, and instructed the students to use the handout if they didn't know how to start, and if they didn't know what to do, they should look at the steps on the handout.	**Graphic organizer** **Scaffolding (supports), later these supports were taken away.**
The instructor circulated around the room, pointed to two individual students' papers, then pointed to the problem on the board.	**Student engagement**
Instructor: "That's four terms, factor by grouping here."	
The instructor circulated around the room as students worked.	**Student engagement**
Instructor asked one student where she should start with the problem on the board.	**Student engagement**
Instructor: "Where's this one fall on the chart?"	
Student: Factor by grouping.	
The teacher repeated the correct answer.	
Instructor: "What do we do once we put the parentheses in?"	**Modeling**
The instructor continued to question the student when she got lost.	
Student: "Seven?" *The student answered incorrectly.*	
Instructor: "Seven? Can you factor a seven from eight?"	
Student: "Four?" *The student again guessed wrong.*	
Instructor: "You can't factor a four from a seven either."	

The instructor gave the student the answer when she did not come up with it on her own.	
Instructor: "There are no common factors of the numbers, but look at the letters *w* and w^2, you can take out a *w*."	**Modeling**
The instructor allowed the girl to finish factoring.	**Student engagement**
Instructor: "What goes here? And over here?" *The instructor pointed to the second half of the problem.* "What's over here? You definitely have one that you can factor out."	**Student engagement**
Instructor: "With grouping, we have to have the same value in both parentheses." *The teacher finished the problem at the board.* "Who got it? . . . One person?"	
The instructor told a student who got it correct, "nice job."	**Positive attitude**
Instructor: "What got you stuck on that problem?"	**Student engagement**
Student: "Just drawing a blank."	
Instructor: "Monday morning . . . eight o'clock, . . . long weekend?"	**Use of humor**
Student: "I need a refresher."	
The instructor pointed to the second problem on the board.	
Instructor: "How about this one? . . . I should back up." *The teacher referred back to the first question.* "Any questions on this one?" *The instructor waited for students to respond, but there were no questions.*	**Student engagement**
A student pointed out a mathematical mistake that the teacher had made on the board. The instructor corrected the math.	
Instructor: "Wow, I got the Monday morning eight o'clock blues, too, apparently! Sorry about that, guys. You had that, right?"	**Use of humor**
Student: "I was like, wait—"	

Instructor: "Now what we want to do with this trinomial, we want to see if we can continue to factor that. Factors of negative twelve whose sum is negative one."	**Modeling** **Direct instruction**
Student: "Three and negative four." *The instructor wrote these numbers to the side of the problem.*	
Instructor: "The four comes down. This is a trinomial with a leading coefficient of one, or negative three and negative four. . . . Anyone get that? . . . *(acknowledges a raised hand)* Did you? . . . Good! . . . How about the third one? Any thoughts on the third one?"	**Modeling** **Student engagement**
A student says something inaudible.	
Instructor: "If that were the answer, how could I check it? Could I validate my answer? . . . Use FOIL? . . . Right."	**Student engagement**
Instructor: "Anyone do the homework over the weekend?"	**Student engagement**
Instructor: "I'll group sections 4.3 and 4.4." (*Instructor writes on the board) "*Factoring of the form $Ax^2 + Bx + C$.*" (points to the board.)* "The big difference is the A, there's going to be something other than one in the front." (*$25x^2 + 20x + 4$ is written on the board.*)	**Statement of the objective** **Student engagement**
Instructor: "You may have heard this called the smiley method, or the rainbow method. . . . Take twenty-five, multiplied by four. *(The instructor draws an arc from 25 to 4.)* We're looking to factor one hundred. How does this differ from the other trinomials with a leading coefficient of one? What are we doing different here that we didn't have to do before?"	**Student engagement**
A student answers. The instructor writes $x^2 + 7x + 12$ on the board.	
"Technically, it's the one in front that is times Instructor: "What do we factor here?"	**Student engagement**
Student: "The last term."	
Instructor: "It's not just the last term, it's *one times* the last term. . . . Watch this for a second."*(points to the board and the current question.)* "Technically, it's the one in front of the last term." *(points to the problem with the leading*	**Direct instruction** **Modeling**

coefficient) "Here, you explicitly have to do it. . . . Does that make sense? . . . We're looking for factors of one hundred whose sum is twenty."

Student: "Ten and ten."

Instructor: "Here's what we want to do: copy the first term, copy that last term, and instead of using 20x in the middle, I'm going to use a combination of 10x and 10x. Whatever the variable is for the middle term, add it to both of those terms. . . . Now look at these four terms. . . . If I combined my like terms, doesn't it get me back to my original? . . . All I really did is stretch it *(uses hand gestures to illustrate the point)* from three terms to four terms. . . . But those terms are very specific, and very methodical."

The instructor refers to the handout and points out an arrow.

Graphic Organizer

Instructor: "There's a line on the bottom that takes us right back to factoring by grouping – four terms." *On the board, the instructor adds parentheses to make two groups, then continues the problem.* "The second half of the problem is stuff that we've learned."

Scaffolding: removing the supports (fading)

A student answers correctly.

Instructor: "What could be another way to state the answer? . . .What do you think?"

Student engagement

$12x^2$ - 5x -2 is written on the white board.

Instructor: "You always want to look for the greatest common factor. Does this one have a greatest common factor? (*It does not.)*

Instructor: (*refers to the handout*) "Go down that factor tree."

Graphic Organizer

Student; "Can we use the handout on the test?"

Instructor: "On the final exam? Absolutely not. . . . By the way, I took the final exam this weekend. Got 100%. It's not bad."

Use of humor and fun

Appendix K

Glossary of Terms for Coding

A Glossary of Terms

Teaching Methods

For the purposes of this study, the term *teaching methods* will refer to the principles and methods the teacher uses to instruct students.

Direct Instruction

Direct instruction is the explicit teaching of the skill set using lectures or demonstrations of the material. Examples of direct instruction include tutorials, discussion, recitation, seminars, workshops, and observation. In direct instruction, the teacher lectures to the students. In the most basic format, the teacher gets the students' attention, teaches them something, and prompts them to respond to demonstrate mastery. Direct instruction is highly structured.

Group Work

Group work is when students work together as partners or in groups. Think-Pair-Share is a technique that allows students to discuss ideas with a partner.

Cooperative Learning is a technique in which students are put in small groups to work together to accomplish a task. Groups are made up of students with many ability levels. Theoretically, the students with the highest ability both model for and assist the students with the lowest ability. At the end of a period of time, groups are asked to report back to the teacher or the class about how they completed the task. Group members may have different roles in the group. Instructors monitor these groups carefully to make sure that the group is on task and that everyone is participating.

Collaborative learning is when instructors make small groups of students with varying ability levels. Advanced students help students who are struggling. This helps the advanced student to become more familiar with the subject, while the struggling student gets help. Peer tutoring is another example of collaborative learning. Here the students of higher ability are helping the students of lower ability (Kelly, 2013). Students are given a problem to be solved or a question to be answered. There may be no right or wrong answer. In collaborative teaching, the focus on the instructor's authority is removed. The teacher's role is on mediating student interaction, but not to intervene on the students' conversations. After the groups discuss, the teacher evaluates, but does not judge, the students' work. Groups' ideas are presented to the class, and the answers are compared. In this way, authority is not on one individual.

Constructivist Teaching

The constructivist teaching method requires that students do experimentation and look at the results of those experiments to reach their own conclusions. This does not involve telling students the rules of math, but instead expects the students to discover these rules on their own. The instructor discusses with and nudges the students toward the right direction by guiding instruction and asking questions of the students that lead them to discovery.

Inquiry-based learning is based on the scientific method. Students use problem-solving and critical thinking skills to make a conclusion. Inquiry-based learning is very student-centered, student-focused, and student-directed and may be modified for students at every ability level. The teacher's role is a facilitator role, and learning is more self-directed. In this approach, posing questions to students stimulates learning. Engaged learners construct new knowledge and understanding.

Instructional Strategies

For the purposes of this study, the term *instructional strategies* will refer to those experiences in teaching that make knowledge and skill interesting, effective, and appealing to students.

Stating the Objective

Teachers may state the objective at the beginning of the class period. Teachers could tell the students what they have done in the past, how that relates to what they are working on today, and how that will lead into what they will learn tomorrow. This sets the stage for learning.

Manipulatives

Teaching with manipulatives is a technique that instructors use when helping students to learn concepts that are more abstract. Using an object that students can touch and manipulate such as geometric shapes, graphs, charts, number lines, or plastic pieces can help students to visualize representations and understand concepts in a more concrete way. Manipulatives can be commercial, or can be teacher-made or student-made. Virtual manipulatives also exist online.

Technology

Teaching using technology is another technique to engage learners in mathematical concepts. Technology may be used sparingly, such as when a teacher shows an animated clip that illustrates a concept, or technology may be used in place of teacher instruction. The use of a calculator can also be considered a use of technology. Courses could be completely online, courses could be hybrid and consist of both classroom and online experiences, or computers could aid only instructors and not students. The use of a SMART Board® or a student response system are also forms of teaching using technology. Many other possibilities also exist.

Games

Games can be paper-based, board games, manipulative-based, or technology-based. Games may encourage student engagement.

Graphic Organizers

Graphic organizers can be graphs, charts, trees, webs, flowcharts, diagrams, and more. Instructors may use graphic organizers with students to facilitate their learning and to keep students organized when there are many steps.

Student Engagement

Active participation of students can take many forms, such as using individual whiteboards to write on and holding up the correct answer for the teacher to see, indicating agreement or disagreement with the responses of other students by showing thumbs up or thumbs down, and using the technique of think-pair-share which allows students to discuss ideas with a partner. Some forms of active participation can be aided by technology. Equipment such as interactive whiteboards and pens and computerized student response systems are available.

Modeling

Behavioral modeling is when an instructor demonstrates to students how to perform the activities he or she is teaching and asks students for similar behaviors.

Cognitive modeling is when a teacher articulates what he or she is thinking to illustrate the reasoning that a learner should use while engaged in these activities.

A think-aloud is a teaching technique using explicit explanation of the steps of problem solving through teacher modeling and metacognitive thought. Instructors speak to the students about what they are doing as they work through problems at the board. This allows the students to know the teachers' thought processes more explicitly as he or she constructs solutions.

Scaffolding

Scaffolding is another teaching technique that uses a more systematic approach to supporting the learner. When a learner and teacher are performing a task together, the teacher provides temporary frameworks to support the learning and student performance. For example, the teacher may ask students to solve a problem, and may at first have the steps of the problem solving process written out for the student to follow. Later, the steps may not be written out, but there may be a hint. These hints and frameworks are eventually removed until the student can do the activity on his or her own. This differs from behavioral modeling in that the student is doing the work and is actively engaged, and not just watching the teacher.

The instructor focuses on the task, environment, and learner. To promote a deeper level of learning, students build upon the skills they have learned in the past. If the learning process is tailored to the needs of the student, students can be helped to achieve their goals. As the student progresses, the supports are removed until the student is completing the task on his or her own.

Humor and Fun

Teachers often search for ways to reach their students and hold their attention. One technique that teachers may use is humor. Telling a joke may serve to keep students engaged and to keep the mood lighthearted. Stress and frustration may be reduced when a teacher uses humor. Teachers with a sense of humor may leave a lasting impression in the students' minds. Students also remember teachers that they describe as "fun."

Positive Attitude

Teachers may exhibit a positive attitude toward their students and also the subject matter. A teacher who is upbeat and energetic may be able to more effectively motivate his or her students. Teachers may show their passion for their subject area, or may show that they enjoy their work. When teachers are excited about a topic, students tend to also be excited. The positive energy can be contagious.

Real-World Relevance

Instructors should explain to learners the reasons that the skills being taught in the classroom are important in the real world. Students want to know the answers to the questions, "Why is this important?" and "When will I need to use this information?" Instructors tell the students why the concept being learned is important in their lives. Giving students a reason to learn the upcoming lesson gives students relevance. The instructor may answer the students' questions of, "Why do we need to learn this?" and "How will I use this during the remainder of my college education and beyond?"

Appendix L

A Bias Awareness Tool for Coders

Ten Tips for Reflexive Bracketing

Source:
Ahern, K. J. (1999). Pearls, piths and provocation: Ten tips for reflexive bracketing. *Qualitative Health Research, 9*(3), 407-411.

PREPARATION
Start a reflexive journal in which you can write down the issues that will enhance your reflexivity and your ability to bracket:

1. Identify some of the interests that, as a researcher, you might take for granted in undertaking this research. This might include issues such as gaining access or obtaining a degree. Write down your personal issues in undertaking this research, the taken-for-granted assumptions associated with your gender, race, socioeconomic status, and the political milieu of your research. Finally, consider where the power is held in relation to your research project and where you belong in the power hierarchy.

2. Clarify your personal value systems and acknowledge areas in which you know you are subjective. These are issues to which you need to keep referring back when analyzing your data. This is an important strategy in developing a critical perspective through continuous self-evaluation.

3. Describe possible areas of potential role conflict. Are there particular types of people and/or situations in which you feel anxious, annoyed, at ease? Is the publication of your findings likely to cause problems with a group of people? Consider how this possibly could influence whom you approach or how you approach them. Make a mental note to recognize when anxiety, annoyance, or enjoyment arise in you during data collection and analysis.

4. Identify gatekeepers' interests and consider the extent to which they are disposed favorably toward the project. This can help you prevent potential role conflicts. The less conflict and anxiety you experience with regard to your research, the easier it is to maintain neutrality. Once you have started fieldwork, try to become attuned to the way in which your feelings are signaling a need for reflexive thought.

5. Recognize feelings that could indicate a lack of neutrality. These include avoiding situations in which you might experience negative feelings, seeking out situations

in which you will experience positive feelings (such as friendly and articulate respondents), feeling guilty about some of your feelings, blaming others for your feelings, and feeling disengaged or aloof. When you recognize feelings such as these, revisit your notes in your reflexive journal and try to determine the origins of these feelings. This will help you gain insight and separate your reactions from past events and your present research. If you cannot identify the origins of your feelings, you might need to consult with a colleague to ensure that your data collection and analysis techniques have not been colored by your feelings. Common antecedents of projections onto the data include researchers' unmet needs, reenactments of previous incidents that are associated with specific feelings and responses, and researchers' gender, social, and professional role identities.

6. Is anything new or surprising in your data collection or analysis? If not, is this cause for concern, or is it an indication of saturation? On occasion, stand back and ask yourself if you are "going native." Consult colleagues before you assume that you have reached saturation in your data analysis. You might be bored, blocked, or desensitized.

7. When blocks occur in the research process, reframe them. Instead of getting frustrated when things do not go as planned, ask yourself, "Are there any methodical problems that can be transformed into opportunities?" For example, is there another group of people who can shed light on this phenomenon? Would an additional form of data collection, such as document analysis or diaries, give a greater insight? Often, blocks that occur in research can turn out to be blessings in disguise.

POSTANALYSIS

8. Even when you have completed your analysis, reflect on how you write up your account. Are you quoting more from one respondent than another? If you are, ask yourself why. Do you agree with one person's sentiment or turn of phrase more than those of another? If so, go back to your analysis and check that an articulate respondent has not biased your analysis by virtue of making your analytic task easier. Did you choose to write up the account in the first or third person? Your reasons for reporting what you report and how you report need to be reflexively examined.

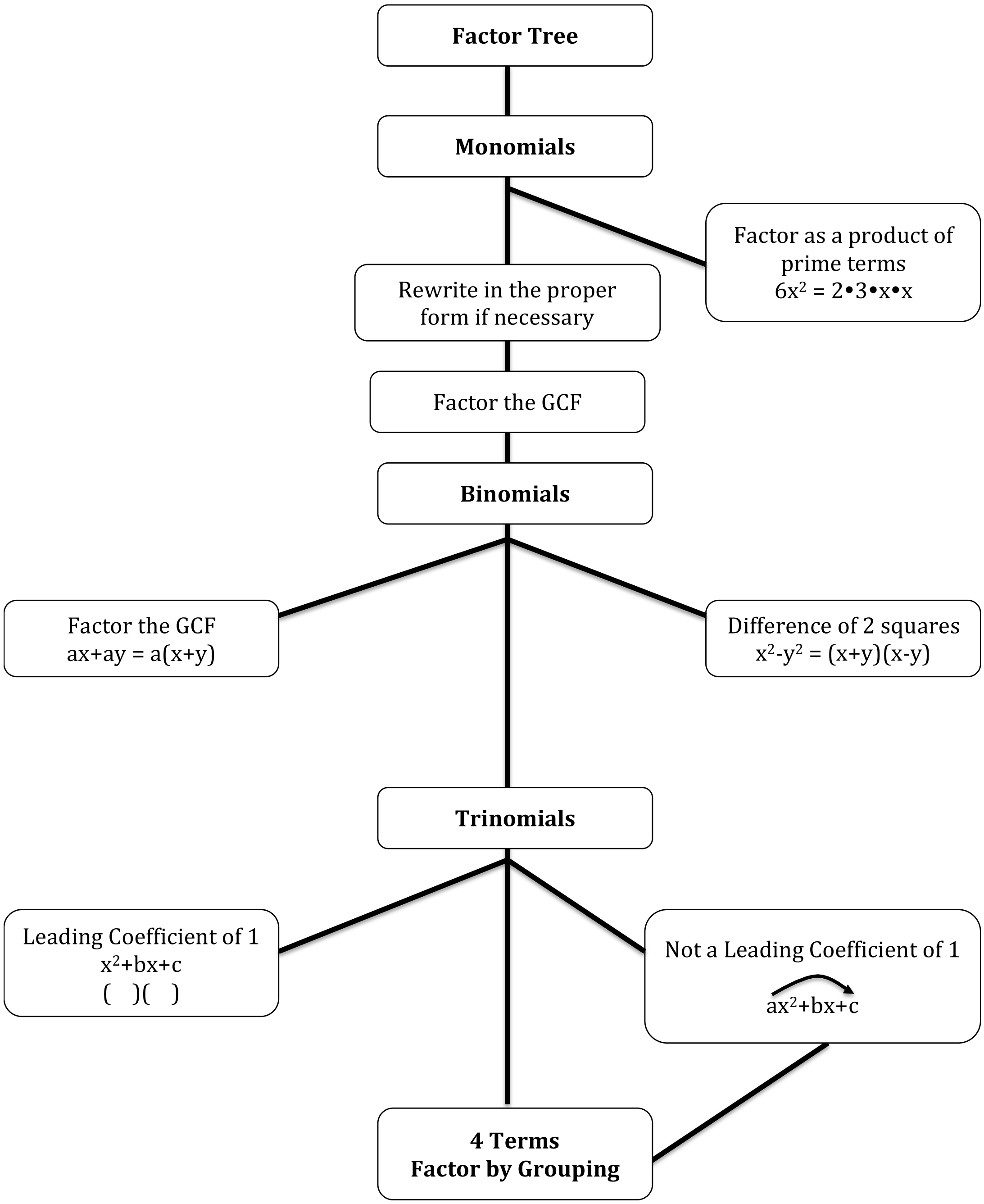
9. In qualitative research, the substantive literature review often comes after the analysis. The form of research literature is just as much the result of convention as any other cultural artifact. Consider whether the supporting evidence in the literature really is supporting your analysis or if it is just expressing the same cultural background as yourself.

FEEDBACK
Insight often occurs when you are able to make connections between your behavior and your underlying motives.

10. A significant aspect of resolving bias is the acknowledgment of its outcomes. Therefore, you might have to re-interview a respondent or reanalyze the transcript once you have recognized that bias in data collection or analysis is a possibility in a specific situation. It is also worth remembering that even if preconceptions and biases are acknowledged, they are not always easily abandoned. An indication of resistance to abandoning bias includes consistently overlooking data concerning a different analytical conclusion than the one you have drawn. Discussion with a co-coder should counteract this analytic blindness.

Appendix M

Instructor A's Factor Tree Handout



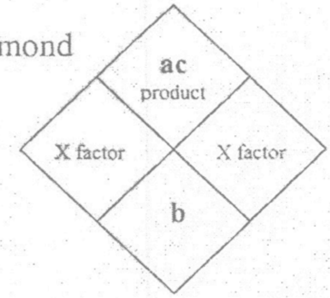
Appendix N

Instructor B's X-Box Handout

Diamond-Box Method of factoring Quadratic Trinomials LEAD COEFFICIENT NOT = 1

Given $2x^2 - 7x + 6$ remember: **a = 2, b = -7, c = 6**

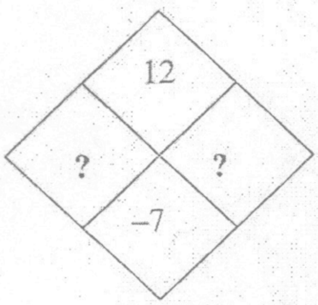
Diamond

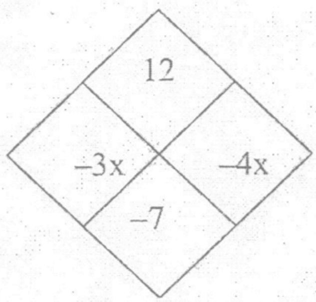


Box

Quadratic term	x Factor
x Factor	Constant

Complete the diamond below by finding the 2 missing "x" factors
Remember they must **multiply** to make the product **+12**
and they must also **combine** to make **-7**





Place the factors into the BOX

$2x^2$	$-3x$
$-4x$	6

The next strategy is to find the GCF of **each row** and **each column** in the box.

After that step (shown on the right):

The top row becomes a binomial factor $(2x-3)$

The 1st column becomes a binomial factor $(x-2)$

Their **product** is the factoring for the quadratic

$(2x-3)(x-2)$ use FOIL to check it!

$2x^2 - 7x + 6$

	$2x$	-3
x	$2x^2$	$-3x$
-2	$-4x$	6

Remember this: if **the lead x term** is negative, factor out a negative GCF from that row or column

Appendix O

Instructor C's Coordinate Grid Paper Handout