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An Examination of Standards-based Practices in College Algebra in the First Two Years of College

Laurn R. Jordan Dr.
Georgia State University

ACCEPTANCE

This dissertation, AN EXAMINATION OF STANDARDS-BASED PRACTICES IN COLLEGE ALGEBRA IN THE FIRST TWO YEARS OF COLLEGE, by LAURN R. JORDAN, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

_____
Christine D. Thomas, Ph.D.
Committee Chair

_____
Pier A. Junor Clarke, Ph.D.
Committee Member

_____
Mary B. Shoffner, Ph.D.
Committee Member

_____
Nikita Patterson, Ph.D.
Committee Member

_____
Iwan Elstak, Ph.D.
Committee Member

_____
Date

_____
Dana L. Fox, Ph.D.
Chair, Department of Middle-Secondary Education and Instructional Technology

_____
Paul A. Alberto, Ph.D.
Interim Dean
College of Education

AUTHOR'S STATEMENT

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Laurn R. Jordan

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Laurn R.Jordan
1430 Springleaf Circle
Smyrna, GA 30080

The director of this dissertation is:

Dr. Christine D. Thomas
Department of Middle-Secondary Education and Instructional Technology
College of Education
Georgia State University
Atlanta, GA 30303 - 3083

VITA

Laurn Reye Jordan

ADDRESS: 1430 Springleaf Circle
Smyrna, Georgia 30080

EDUCATION:

Ph.D.	2013	Georgia State University Teaching and Learning
M.S.	1995	East Tennessee State University Mathematical Sciences
B.S.	1993	East Tennessee State University Mathematics

PROFESSIONAL EXPERIENCE:

1998-Present	Assistant Professor of Mathematics Department of Mathematics Georgia Perimeter College, Dunwoody, GA
1995-1998	Instructor of Mathematics Department of Mathematics DeKalb College, Dunwoody, GA
1993-1995	Graduate Research Assistant Department of Mathematics, East Tennessee State University

PROFESSIONAL SOCIETIES AND ORGANIZATIONS:

1995-Present	American Mathematical Association of Two Year Colleges
1995-Present	Georgia Mathematical Association of Two Year Colleges

PRESENTATIONS

Jordan, L. (2008, March). *Issues and Engagement Strategies Promoting Excellence in Collegiate Mathematics.* Presentation at the annual meeting of the National Youth at Risk, Georgia Southern University.

Jordan, L. (2004, August). *Incorporating Computational Science Tools and Techniques into the Undergraduate Curriculum.* Presentation at National Computational Science Institute Curriculum Development Workshop, San Diego State University.

Jordan, L. (2003, February). *Integration of Computational Science into the Classroom with Stella*. Presentation at the 16th Annual Georgia Perimeter College Mathematics Conference, Clarkston, GA.

Jordan, L. (1995, April). *The Existence of Cycles in Recursively Defined Integer sequences.* A thesis presented to the Department of Mathematics at East Tennessee State University, Johnson City, TN.

Jordan, L. (1993, December). *Degree Difficulty.* Presentation at the Department of Mathematics at East Tennessee State University, Johnson City, TN.

ABSTRACT

AN EXAMINATION OF STANDARDS-BASED PRACTICES IN COLLEGE ALGEBRA IN THE FIRST TWO YEARS OF COLLEGE

by

Laurn Reye Jordan

Instructional practices in mathematics courses at two-year colleges include lecture as the predominant instructional form in 78% of two-year colleges, with class sizes averaging about 26 students (AACC, 2005). The National Assessment of Educational Progress (NAEP) indicates that there is a need for change in the practices of mathematics teachers because students are not being served well by the traditional pedagogical approaches (Burrill & Hollweg, 2003). The standards-based reform movement has had a positive impact on pedagogy but there are ongoing issues of alignment of teaching strategies to more student-centered practices (Barrington, 2004).

This study examined the standards-based teaching practices of college mathematics faculty in the first two years to answer the research questions: What alignment exists between two-year college mathematics instructor's knowledge and the instructional standards published by the American Mathematical Association of Two-Year Colleges in Beyond Crossroads? What are the components that characterize the instructional practices of two-year college instructors? What relationship exists between the alignment of Two-Year College mathematics faculty instructional practices with Beyond Crossroads? An interpretative qualitative methodology with an embedded survey was applied to examine how the American Mathematical Association of Two Year Colleges standards are currently being aligned with instruction in the first two years of college.

An analysis of the data revealed that standards-based teaching strengthens instructor delivery and accommodates diverse learning styles. Mathematics faculty use technology as a teaching tool and use a variety of student-centered activities to engage students to help them make meaningful connections. Findings from the study suggest there exist a strong relationship between the American Mathematical Association of Two Year College standards and instructor practice in the first two years. The findings indicate that mathematics faculty struggled in changing their instructional practice to meet the needs of their students. Furthermore, findings suggest that those invested in the mathematics education in the first two years constantly adjust their teaching through professional development opportunities. Additionally, mathematics faculty modified the curriculum to customize their instruction to align with standards-based teaching practices as their knowledge and awareness of standards develops as a professional.

AN EXAMINATION OF STANDARDS-BASED INSTRUCTIONAL PRACTICES IN COLLEGE ALGEBRA IN THE FIRST TWO YEARS OF COLLEGE by

Laurn Reye Jordan

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ABBREVIATIONS

AACC	American Association of Community Colleges
AMATYC	American Mathematical Association of Two Year Colleges
AMS	American Mathematical Society
CEMELA	Center for Mathematics Education of Latino/as
DFW	Drop/Fail/Withdraw
MAA	Mathematical Association of America
NAEP	National Assessment of Educational Progress
NCTM	National Council of Teacher of Mathematics
NRC	National Research Council
OECD	Organization for Economic Cooperation and Development
PASS	Proficiency-based Admission on Standards System
STEP	Standards-based Teacher Education Project
TIMSS	Third International Mathematics and Science Study

CHAPTER 1

INTRODUCTION

> "Mathematics is the gate and key of the sciences. Neglect of mathematics works injury to all knowledge, since he who is ignorant of it cannot know the other sciences or the things of this world. And what is worse, men who are thus ignorant are unable to perceive their own ignorance and do not seek a remedy."
>
> – Roger Bacon

Being taught mathematical knowledge is a democratic right (Tate, 1997). However, knowledge of mathematics is evasive and elusive for underrepresented and marginalized populations (Ajose, 1995). Mathematics education reform efforts in the United States include ambitious goals for schools, teachers, and students. Amidst the discourse of reform is the equally pervasive challenge of addressing unequal achievement outcomes and inequitable mathematical opportunities and access for students both nationally and internationally (Matthews, 2001). Those in the mathematics education reform movement have drawn their roots from the evolving nature of the discipline of mathematics, the advances of cognitive psychology, and the analyses of the changing needs of the U.S. society in an effort to establish a framework for changes in mathematics education (Mathematical Sciences Education Board, 1991; National Council of Teachers of Mathematics (NCTM), 1989, 1991, 1995, 2008; National Research Council (NRC), 1989). Accordingly, new images have been outlined for the nature and amount of mathematics that students should encounter in school. These changes impact the

activities and educational settings in which students encounter the material. These new images comprise the role that the classroom teacher should play in organizing and implementing these experiences (Peressini, 1998).

The reformers of the current standards-based mathematics movement in the United States list the teaching practices of mathematics teachers as an area of utmost concern (Kilpatrick, Martin, & Schifter, 2003). Mathematics scholars contend that if the United States is serious about improving students' mathematical learning, it has no choice but to invest in more effective and sustained opportunities for teachers to learn about their practices (Kilpatrick et al., 2003). According to the report from the Third International Mathematics and Science Study (TIMSS), mathematics teachers' practices have not changed greatly because teachers mimic the practices of their own teachers (Hiebert & Gallimore, 2002; Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008).

The recent standards movement in education and efforts of the National Council of Teachers of Mathematics (NCTM) (NCTM, 1989, 2001) as well as the American Mathematical Association of Two-Year Colleges (AMATYC) (AMATYC, 1995, 2005) introduced new terms to the literature: standards-based or standards-oriented curriculum. The terms standards-oriented or standards-based curriculum refer to the same concept (Schoen, Finn, Griffin, & Fi, 2001; Trafton, Reys, & Wasman, 2001) and will be used interchangeably in this research. In the literature, while explaining the standards-oriented curriculum, authors usually contrast it with a traditional teacher-prepared curriculum (Goldsmith & Mark, 1999). As the traditional curriculum for mathematics education emphasizes memorization and rote learning, well-designed standards-based curricula

emphasize critical thinking, comprehension, integration, consistency with assessment activities, and hands-on learning activities (Goldsmith & Mark, 1999; Trafton, Reys, & Wasman, 2001). With standards-based curricula, teaching content, teaching materials, and assessment tools are typically the same for all teachers and students. It is the teachers' responsibility to implement content in the best way possible using their pedagogical knowledge. In this way, standards-based curricula provide greater and more in-depth coverage of content with student engaging activities (Reys, Robinson, Sconiers, & Mark, 1999) leading to higher student achievement by more effectively fostering educational equality across different contexts (Von Secker & Lissitz, 1999).

McCaffrey, Hamilton, Stecher, Klein, Bugliari, & Robyn (2001) found that teacher practices in courses are greatly influenced by the curriculum of the courses. Although small but growing evidence indicates that students achieve more with standards-based curricula, no research has been done to understand how teachers experience the utilization of these curricula in their classrooms. Without understanding how teachers react towards a centrally developed standards-based curriculum, successful implementation of such efforts will be uncertain (McCaffrey et al., 2001). This study sheds light on college mathematics instructors' experiences with implementing standards-based practices in College Algebra in the first two years of college.

This study is on the teaching practices of college mathematics instructors. In particular, I am interested in examining how the American Mathematical Association of Two Year Colleges standards are currently being aligned with instruction in the first two years of college. The three standards on which I am focusing on are:

1. The use of technology in courses.

2. The use of multiple approaches --- numerical, graphical, symbolic, and verbal --- to help students learn a variety of techniques for solving problems.
3. The use of a variety of classroom activities (such as cooperative learning) instead of relying mainly on the lecture format.

The American Association of Community Colleges (AACC) states that the instructional practices in mathematics courses at two-year colleges include lecture as the predominant instructional form in 78% of two-year colleges, with class sizes averaging about 26 students (American Association of Community Colleges, 2005). The problem with teaching mathematics at the undergraduate level is that there exist high failure rates and withdrawal rates observed by traditional instructor-centered in introductory collegiate mathematics courses (Dunbar, 2003).

There is a need to improve the teaching of college mathematics in the first two years of college. Further, traditional instructor centered-teaching has shown to harm certain groups of students. The National Assessment of Educational Progress (NAEP) indicates that there is a need for change in the practices of mathematics teachers because students are not being served well by the traditional pedagogical approaches (Burrill & Hollweg, 2003). Research indicates that the mathematical proficiency of students in mathematics classrooms in the United States increases when instruction is multifaceted (Kilpatrick et al., 2003). This suggests that the traditional forms of instruction are not serving students in the United States. Consequently, efforts should be made to assist mathematics teachers in incorporating more pedagogical methods in their instruction, which could mean changing or augmenting their practices (Stinson, 2009). “Within standards-based reform, there exists a goal of increasing the intellectual rigor of curricula

and pedagogy based on the fact that classroom activity has traditionally been dull and disconnected from real life. The uniformity and equity that is central to the standards-based reform might serve as a check against local traditional practices that empower certain groups at the expense of others" (Massell, 2008). The standard-based reform movement has had a positive impact on pedagogy but there are ongoing issues of alignment of teaching strategies to more student-centered practices (Barrington, 2004). Some issues with unanswered questions include the use of technology in the teaching/learning process and attending to the needs of underrepresented students by using a variety of approaches (Wagner & Speer, 2009). Hence, there is a need to investigate the teaching practices of instructors of mathematics. There is a need to know more about the relationship between practice and teacher effectiveness. Effective teachers use a variety of methods and respond to the needs of the particular class and students they are teaching (Schifter, 1998). However, many students continue to be underserved by traditional mathematics teaching practices (Wells & Jones, 2005).

BACKGROUND INFORMATION

The literature suggests that the impact of standards-based reform on pedagogy is moderately positive. Standards-based reform has had a positive impact on pedagogy (Barrington, 2004; Bushnell, 1992, Kannapel, Aagaard, Coe, & Reeves, 2001) creating more coherent teaching practices (Wilson & Floden, 2001), resulting in pedagogy that is more organized and systematic (Preece & Skinner, 1999) and creating more student-centered approaches (Eng, 1992).

Central to the mission of standards-based reform is the goal of increasing the intellectual rigor of curricula and pedagogy based on the fact that classroom activity has

traditionally been dull, perfunctory, and disconnected from real life (Massell, 2008). Proponents of standard-based reform argue that teacher-directed, fact-based instruction must be replaced with a new model of "teaching for understanding" in which students engage in active problem solving in order to develop conceptual understanding of subject matter (Elmore, 1990; Fuhrman, Elmore, & Massell, 1993; Smith & O'Day, 1991, Center for Mathematics Education of Latino/as, 2007).

Standards-based reform is consistent with an emerging view of assessment for learning rather than assessment of learning (Black & William, 1998; Crooks, 1998; Wagner, Speer, & Rosa, 2007; Loeb, Knabb & Elfers, 2008). Standards-based reform calls for deep changes both in teachers' perceptions of their role in relation to their students and in their classroom practice. In particular, it suggests a move to a more student-centered pedagogical approach, placing students in a more active role in the learning, teaching and assessment cycle, thus creating a partnership between student and teacher. Assessment standards help teachers provide students with information of what they know and can do and, more importantly, a clear picture of what they need to do to improve so they can take charge of their own learning (Black & William, 1998; Crooks, 1998; Weimer, 2002). The intent of standards-based reform is to implement practices that describe what students should know and be able to do (Fuhrman, 2001). Standards-based mathematics instruction emphasizes the need for students to read mathematics and explain their mathematical thinking both orally and in writing (Lecroy et. al, 2009). These standards provide a new vision for introductory college mathematics whereby students develop intellectually by learning mathematical concepts in settings that employ a rich variety of instructional strategies (AMATYC, 2005).

HIGHLY EFFECTIVE TEACHING IN UNDERGRADUATE MATHEMATICS

The growing body of research related to mathematics teaching (Grouws, Cooney, & Jones, 1988; Wilson, Cooney, & Stinson, 2005) indicates that effective mathematics teachers use their time wisely and efficiently, both in and out of class; they present well organized lessons; and they know their subject. Effective instructors are reflective; they think about their teaching before they teach, while they teach, and after they teach (Latterell, 2008). They are creative, resourceful, and dedicated (McKinney, 1986). They use a variety of methods and respond to the needs of the particular class and students they are teaching (Schifter, 1998). Effective mathematics teachers are skilled questioners who encourage and challenge their students (Chickering & Gamson, 1987). They are clear and careful communicators who recognize the importance of language in mathematics, and mathematics as language (Ma, 1999). They model the behaviors they wish their students to exhibit, especially problem solving, exploration, and investigation (Cohen & Seaman, 1997).

Effective mathematics instructors know a great deal of mathematics and understand the interconnections among its various branches as well as applications to other disciplines (Ma, 1997). They are continually developing their knowledge and understanding of mathematics, of teaching, and of how students learn (Reynolds & Muijs, 1999). They are independent learners who can adapt and contribute to changes in collegiate mathematics curriculum and instruction (AMATYC, 2005). Effective mathematics instructors are active professionals (AMATYC, 2005). They read journals, attend professional meetings, and engage in other professional activities. Impagliazzo, Ayers, Lindstrom, & Smith (1985) further elaborated on the activities and characteristics

of professionally active mathematics instructors in *The Two-Year College Teacher of Mathematics*. The report outlines the academic preparation and continuing education necessary for a person to be an effective mathematics teacher at the two-year college level.

STATEMENT OF THE PROBLEM

Prior research on mathematics teaching has made it very clear that over half of students do not persist or achieve to their potential in College Algebra. Herriot and Dunbar (2003) report based on a study at a variety of private and public universities that students in traditional instructor-centered College Algebra courses frequently observe high drop/fail/withdraw (DFW) rates often in excess of 50%. The DFW rate is defined as the percentage of students who register for College Algebra and at the end earn a grade of D, F, or W (drop¸ fail, or withdraw) in the course. This means that over half of the students who take College Algebra will earn a grade of D or a grade of F or will withdraw from the course. As such, the college algebra course becomes the terminal mathematics experience for many students (Ganter & Barker, 2003). Moreover, even when mathematics arises in other disciplines, it does not look like the mathematics that students said in introductory college mathematics courses – implying that most students do not make the connections that would allow them to apply mathematics they may have learned (Ganter & Barker, 2003). Thus, the introductory mathematics courses rarely provide any long term benefits to the majority of students (Ganter & Barker, 2003). In addition, the introductory mathematics courses do not adequately prepare students for study in other disciplines (Ganter & Barker, 2003). And, ironically, because introductory college mathematics courses at many institutions have remained unchanged, they no

longer accomplish even their original goal: to motivate and prepare students to take subsequent mathematics courses (Ganter & Barker, 2003). Therefore, the goals of introductory college mathematics need to be reassessed in light of the changing mathematical needs of students – including quantitative literacy, the mathematical skills now required by other disciplines, and other contemporary needs of all citizens (Ganter & Barker, 2003).

Despite our increased understanding of how students learn, how teachers teach, and improved methods of assessing teachers and students, mathematics educators have yet to offer compelling accounts as to why these trends have persisted (Martin, 2000). There is a void in effective college teaching and traditional instructor-centered teaching at the college level is problematic (Dunbar, 2003). According to the report from the Third International Mathematics and Science Study (TIMSS, 2007), mathematics teachers' practices have not changed greatly because teachers mimic the practices of their own teachers (Hiebert & Gallimore, 2002). The National Assessment of Educational Progress (NAEP) (NAEP, 2005) indicates that there is a need for change in the practices of mathematics teachers because students are not being served well by the traditional pedagogical approaches (Burrill & Hollweg, 2003).

Additionally, many students are entering college with poor skills in mathematics. Many students are entering the mathematics "pipeline" at a point below the level of Calculus (Albers et al., 1992). The reasons for their math inadequacies are varied, but the fact remains that more and more students are enrolling in remedial algebra at the college-level and the university-level, and the crux of the problem is that traditional instructor-centered College Algebra is the most dropped and/or failed course on many campuses

(Dunbar, 2003). The Mathematical Association of America's committee on undergraduate performance refers to College Algebra as a terminal course. This results in introductory collegiate mathematics especially College Algebra being a student's terminal college experience (Ganter & Barker, 2003).

The problem addressed in this study is to describe standards-based instructional practices in College Algebra by examining how mathematics faculty implement standards-based teaching and facilitate intellectual development in introductory collegiate mathematics. In addition to describing and analyzing standards-based instructional practices, the goal is to improve the teaching practices in the first two years of college.

GUIDING QUESTIONS

To achieve this end, the following questions guide this study.

1. What alignment exists between two-year college mathematics instructor's knowledge and the instructional standards published by the American Mathematical Association of Two-Year Colleges in Beyond Crossroads?
2. What are the components that characterize the instructional practices of two-year college instructors?
3. What relationship exists between the alignment of Two-Year College mathematics faculty instructional practices with Beyond Crossroads?

SIGNIFICANCE OF THIS STUDY

As the reports of the National Research Council (NRC) (NRC, 1999) and the National Council of Teachers of Mathematics (NCTM) (NCTM, 2001) attest, America is experiencing a growing sense of crisis about the future of mathematics education and about the education of future underrepresented populations. They warn that communities

whose members are lacking in mathematical literacy risk becoming a permanent underclass who generation after generation, live on the margins of the nation's economic and political institutions. Quantitative literacy is "the capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to engage in mathematics in ways that meets the needs of that individuals' current and future life as a constructive, concerned, and reflective citizen (OECD, 2000)

The need for change in mathematics education has been documented in several national reports stimulating significant change on several levels. Moving Beyond Myths (NRC, 1991) calls for dramatic changes to revitalize undergraduate education; and Everybody Counts (NRC, 1989) makes specific recommendations for changes in mathematics programs from kindergarten through graduate school.

Reports such as *Everybody Counts, A Report to the Nation on the Future of Mathematics Education* (NRC, 1989) document deep-rooted problems concerning mathematics education in the United States. Among these problems is the need to teach meaningful mathematics to individuals from all social, economic, ethnic, and racial backgrounds. This is imperative if our nation is to maintain a leadership role in the world of the future. The mathematics community should especially strive to increase participation of groups that are underrepresented in mathematics.

MATHEMATICS FACULTY AND TWO YEAR COLLEGES

Two-year colleges can play a major role in turning our country around in this regard. Steen, Goldstein, Jones, Lutzer, Treisman, & Tucker (1990) reports that, "One-third of the first and second year college students in the United States are enrolled in two-year colleges, including over two-thirds of African-American, Hispanic, and Native

American students" (p. 13). Two- year colleges are critical to the national effort to recruit and retain minority students and women as majors in mathematics and mathematics-dependent fields. Two-year college mathematics teachers must be prepared to help and encourage students from these underrepresented groups. Two-year colleges continue to serve a student body with varied characteristics and academic needs (AMATYC, 2005). There is a rich supply of students at the more than 1,150 two-year colleges that serve 11.6 million (AACC, 2005). Two-year college enrollments account for about 45% of all undergraduate postsecondary enrollments in the United States (AACC, 2005).

Collaborative efforts to implement standards-based mathematics can be an initial step in minimizing the need for remediation in postsecondary mathematics education, addressing the critical need for students to complete algebra (AMATYC, 2005). Mathematics teachers have a responsibility to direct and shape the learning opportunities of their students. Evidence is now emerging that curricula and teaching practices consistent with some recent efforts toward educational reform show promise of improving students' learning of mathematical skills with deeper conceptual understanding (Briars, 2001; Briars & Resnick 2000, Fennema et al., 1996, Schoenfeld, 2002).

Movement toward widespread mathematics reform, however, is slowed because of significant changes that teachers may face when teaching in reform-oriented ways (Ball, 1993; Chazan & Ball, 1999, Cohen, 1990; Heaton, 2000; Wagner, Speer, & Rossa, 2007; Williams & Baxter, 1996). Very little research has been conducted studying attempts to change the practices of college mathematics instructors toward reform-oriented teaching (Wagner & Speer, 2009). According to the TIMSS report, mathematics

teachers' practices have not changed greatly because teachers mimic the practices of their own teachers (Hiebert & Gallimore 2002).

The standards-based reform movement has led to increased efforts to remedy the problem of inequitable mathematics educational opportunities directly by addressing the content of instruction and the equity of outcomes. The standards are not intended to be a prescription for action used identically by each mathematics faculty member. Rather, they are to be used as a starting point for dialogue, reflection, experimentation, evaluation, and continuous improvement. Used in this way, standards-based reform can work to promote effective instructional strategies and help students' maximize their potential in every college mathematics course.

Characterization or descriptions from the literature on standards-based education are as follows. First, standards-based education entails implementing strategies (related to learning, assessment, curricula, teaching, and professionalism) and policies of what students should know and be able to do (Fuhrman, 2001). Second, standards-based education implies a greater coherence, or alignment, among the parts of the educational systems (Smith & O'Day, 1991). These definitions imply that greater coherence among components of the educational system linked with instructional strategies that are aligned with standards-based instructional practices are more likely to be successful in facilitating students' intellectual development and maximizing their students' mathematic potential.

The environment for learning and teaching mathematics in higher education continues to change (AMATYC, 2005). Mathematics in the first two years of college holds the promise of opening paths to mathematical power and adventure for a segment of the student population whose opportunities might otherwise be limited. Mathematics

education at this level plays such a critical role in fulfilling people's careers in our global, technological society, that its improvement is essential not only to each individual, but also to our nation's vitality (AMATYC, 2005). Two-year colleges serve a student body with varied characteristics and academic needs (AMATYC, 2005). Effective mathematics instruction requires a variety of resources, materials, technology, and delivery systems that take into account students' different learning styles and instructors' different teaching styles (Schifter, 1998). The standards-based curricula provide greater and more in-depth coverage of content with student engaging activities (B. Reys, Robinson, Sconiers, & Mark, 1999), leading to higher student achievement by more effectively fostering educational equality across different contexts (Von Secker & Lissitz, 1999). Using multiple strategies in the classroom will increase the level of engagement of students and open opportunities for more students to be actively involved in the learning of mathematics (AMATYC, 2005).

PURPOSE OF THIS STUDY

The purpose of this study was to describe and analyze the teaching practices of college mathematics instructors who have been identified as those who use standards-based practices to facilitate instruction in introductory collegiate mathematics. The objective of this research was to make standards-based teaching more explicit and investigate what instructional strategies mathematics faculty employ to facilitate their student's intellectual development.

This study examined the standards-based teaching practices of college mathematics faculty in the first two years. An interpretative qualitative methodology with an embedded survey was applied to examine how the American Mathematical

Association of Two Year Colleges standards are currently being aligned with instruction in the first two years of college. I administered a survey instrument and conducted interviews form three purposely selected mathematics faculty. An analysis of the data revealed that standards-based teaching strengthens instructor delivery and accommodates diverse learning styles. Mathematics faculties use technology as a teaching tool and use a variety of student-centered activities to engage students to help them make meaningful connections. Findings from the study suggest there exists a strong relationship between the American Mathematical Association of Two Year College standards and instructor practice in the first two years. The findings indicate that mathematics faculties struggled in changing their instructional practice to meet the needs of their students. Furthermore, findings suggest that those invested in the mathematics education in the first two years constantly adjust their teaching through professional development opportunities. Additionally, mathematics faculty modified the curriculum to customize their instruction to align with standards-based teaching practices as their knowledge and awareness of standards develops as a professional.

Three mathematics faculty who implement standards-based teaching were purposively chosen from a web-based survey to participate in the study. Their participation in this study provided a glimpse of the perceptions teachers have concerning the use of standards-based teaching. My goal was to contribute to the understanding of effective instructional practices in College Algebra by examining how faculty implement or communicate standards-based instruction to facilitate intellectual development in introductory collegiate mathematics.

RATIONALE

Recommendations for mathematics instruction have been offered by numerous organizations, including the Mathematical Association of America (MAA) and the American Mathematical Society (AMS), yet little research exists on standards-based instruction in college mathematics. There is very little studied concerning attempts to change the practices of college mathematics instructors toward reform-oriented teaching (Wagner & Speer, 2009). There is scant research on college mathematics teaching aligned with contemporary reform curricula (Wagner & Speer, 2009). Traditional teaching dominates as the primary mode of instruction even though recommendations exist that call for multiple approaches (AACC, 2005). This study contributes to research on college mathematics teaching aligned with standards-based practices. This study advances knowledge of implementing standards-based instructional practices in the first two years of college.

THEORETICAL FRAMEWORK

The theoretical framework chosen for this study was based on a theoretical construct known as the theory of action. The theory of action is a set of assumptions that guided this study on how the phenomenon of standards-based teaching will be analyzed and used to assist the researcher to describe mathematics teaching practice in the first two years of college. The theory of action provided an effective lens for analyzing standards-based teaching alignment in particular on mathematics faculty usage of technology in the teaching and learning process linked with varied instructional strategies to facilitate intellectual development of underrepresented populations. To shed light on the potential impact of standards-based reform on improvements in teaching and learning, the theory

of action assumes how teachers attend to, interpret, and act on reform messages or requirements (Loeb, Knapp, & Elfers, 2008).

Five assumptions about the connections between reform and improved teaching reside in the theory of action that underlies standards-based reform (Loeb, Knapp, & Elfers, 2008). The assumptions are as follows:

1. Assumption one: Teachers will pay attention to the reform and become familiar with the standards and what they imply for practice (Wilson & Floden, 2001).
2. Assumption two: Teachers will take the reform seriously, as will their supervisors and other local leaders, who will exhort teachers to meet demands of the policy, and offer support, as needed (Stecher, Chun, Barron, &Ross, 2000).
3. Assumption three: Teachers will adjust their instruction to align with the standards and associated assessments (including preparation for assessment) (Stecher et al., 2000).
4. Assumption four: Teachers will expect all of their students to succeed-and believe that they are capable of succeeding (Orfield & Kornhaber, 2001). Where students are likely to struggle, teachers will adjust their teaching practice to maximize the students' chances of success (Kannapel, Aagaard, Coe, & Reeves, 2001).
5. Assumption five: Teachers will have access to appropriate professional learning opportunities (Dutro, Fisk, Koch, Roop, & Wixson, 2002); Thompson & Zeuli, 1999).

Those teachers who are not fully prepared to teach to the ambitious learning standards will take advantage of these learning opportunities, thereby developing the requisite knowledge, skills, and commitment, and their teaching practice will improve accordingly.

The theoretical framework defined the variables of this study. The dependent variable of student achievement is improved when instruction is multifaceted. The independent variables were the teaching practices of faculty in the first two years. The independent variables were the instructional strategies, the knowledge and skills that are necessary to align instruction with a standards- oriented curriculum. These variables were defined as instructional strategies, curriculum development, assessment of student learning, professionalism, and the learning environment. The research questions that guided the study focused on mathematics teaching alignment and adjustment of instructional strategies. By scrutinizing these assumptions, I described the teaching practices of three purposely selected mathematics faculty in the first two years of college who have aligned their instructional strategies with standards-based teaching practices. These assumptions were the lens to view the data of the interview questions for the purposely selected participants. The net effect of these responses, so the theory goes, will be improvement in student learning (Loeb, Knapp, & Elfers, 2008). This intended effect supports the goal of improvement of student learning. In short, the assumed teachers' responses rested on the further assumption that students had access to appropriate learning opportunities and support, and performed accordingly, culminating in demonstrated mastery of knowledge and skills which the reform initiatives promoted (Orfield & Kornhaber, 2001; Powell, 1996).

The theory of action underlies the standards-based reform measures and develops the capacity of teachers to assist improvement efforts (Loeb, Knapp, & Elfers, 2008). The theory of action underlying standards-based reform has implicit assumptions about how teachers will teach in response to the reform are especially important (Loeb, Knapp, & Elfers, 2008). The theory of action assumes how teachers will respond after enactment of standards-based reform.

To this end, this section describes the scholarship and theory that informed the research design and data analysis.

SUMMARY

This chapter provides a general background to the study. An investigation in to the teaching practices of college mathematics instructor is needed to determine practices associated with effective mathematics teaching. The statement of the problem and the guiding questions to the study are introduced. Traditional teaching is the dominant mode of delivery in introductory collegiate mathematics and is problematic because it is teacher-centered. Standards-based teaching is characterized as exhibiting more learner-centered instructional practices to facilitate intellectual development. This study was an investigation into the practice of mathematics instruction in the first two years of college to determine alignment with standards-based instructional practices.

The overall purpose of this research was to make standards-based teaching more explicit and investigate what instructional strategies mathematics faculty employ to facilitate their student's intellectual development. The goal was to improve the mathematics teaching in the first two years of college.

In summary, underrepresented populations continue to be underserved by

traditional instructor-centered lecture based course especially in College Algebra. This research is examining learner-centered mathematics teaching practice in the first two years of college. This was a study about mathematics instructors who aligned their instructional practice with the AMATYC standards. In this study, the audience will learn about standards-based teaching in the first two years of college. This study advances knowledge of implementing standards-instructional practices in the first two years of college.

CHAPTER 2

LITERATURE REVIEW

This study examined the practice of college mathematics educators in the first two years of college. The literature review focuses two areas of scholarship that are instrumental in framing my dissertation study. First, I investigated the literature regarding effective mathematics teaching and in the first two years of college. I then examined the literature on standards-based reform and their proposed alignment of instructional practices. Finally, I conclude the literature review by linking effective mathematics teaching practice and standards-based reform and their implications on mathematics teaching practice. Linking these areas of scholarship will provide a lens for analyzing effective mathematics teaching.

RESEARCH ON EFFECTIVE OR GOOD MATHEMATICS TEACHING

The set of all college mathematics professors who are good at teaching is ill defined (Latterell, 2008). Yet, it seems that there is often agreement on who is a good teacher and who is not. Some researchers even suggest that although it is difficult to define good mathematics teaching, one knows it when one experiences it (Cohen & Seaman, 1997). Other researchers have such general definitions that their usefulness is questionable (Latterell, 2008). Cashin (1989) defines effective teaching as “all of those instructor behaviors which help students learn” (p.4).

This review attempts to give a more definitive answer of how researchers have defined effective or good mathematics teaching. Attempting to define good teaching has gone on for years. Polya (1962) gave ten commandments for good college mathematics teaching.

1. Be interested in your subject.
2. Know your subject.
3. Know about the ways of learning: The best way to learn anything is to discover it by yourself.
4. Try to read the faces of your students, try to see their expectations and difficulties, put yourself in their place.
5. Give them not only information, but "know-how" attitudes of mind, the habit of methodical work.
6. Let them learn guessing.
7. Let them learn proving.
8. Look out for such features of the problem at hand as may be useful in solving problems to come – try to disclose the general pattern that lies behind the present concrete situation.
9. Do not give away your whole secret at once – let the students guess before you tell it – let them find out by themselves as much as feasible.
10. Suggest it; do not force it down their throats.

Rosenshine and Furst (1971) concluded that effective teaching involved such variables as clarity, variability, enthusiasm, task-oriented behavior, opportunity to learn, and involvement of students. Brophy (1982) stated that effective teachers are smarter than non-effective teachers and extensively plan out their classroom tasks.

McKinney (1986) compared expert teachers to novice teachers and concluded that expert teachers were more organized, had more content knowledge, were more clear in their explanations, and “were more adept at explaining why, how, and when mathematical concepts are used”.

Chickering and Gamson (1987) compiled education research to form the seven principles of good practice.

1. Encourage student-faculty contact.
2. Encourage cooperation among students.
3. Encourage active learning.
4. Give prompt feedback.
5. Emphasize time on task.
6. Communicate high expectations.
7. Respect for diverse talents and ways of learning.

Whitman and Lai (1990) conducted a study in which the beliefs about effective teaching of mathematics held by teachers from Japan and Hawaii were compared. The conclusion was that effective teaching may depend on the culture.

The Third International Mathematics and Science Study (TIMSS) defines effective teaching as a “complex endeavor requiring knowledge about the subject matter of mathematics, the ways students learn, and effective pedagogy in mathematics” (Beaton, Mullis, Martin, Gonzalez, Kelly, and Smith, 1996, p.131). Interestingly, TIMSS does not reveal a best methodology, as “teachers can adopt a variety of organizational and interactive approaches in mathematics class (Beaton et al., 1996, p.151) and many of them can be very efficient.

Cohen and Seaman (1997) examined good teachers for common characteristics. They concluded that good teachers have the following traits:

1. Confidence in knowledge of subject matter
2. High-quality explanations
3. Attention to individual differences
4. Sense of humor
5. Management through high awareness of student difficulties
6. Students engaged in active learning

Some researchers argue that good teaching is a matter of engaging students and thus, while content knowledge is important, pedagogical content knowledge is crucial (Mapolelo, 1998) and good teachers reflect on both their own understandings and students' understandings (Schifter, 1998). Ma (1999) finds that effective teachers have profound understanding of fundamental mathematics. That is, they understand the concepts behind the mathematical procedures.

Reynolds and Muijs (1999) summarize United States research on effective mathematics teaching by saying it contains the following elements.

1. Students have many opportunities to learn; that is, the amount of time children are actively engaged is large.
2. Teachers are academically oriented (versus socially orientated or other orientations).
3. Teachers manage the classroom well.
4. Teachers have high expectations.
5. Students do not spend much time on their own (without the teacher leading).
6. The teaching is heavily interactive.

Wilson, Cooney, and Stinson (2005) interviewed nine teachers to gain their views of good mathematics teaching. The teachers thought that a good teacher had knowledge of the subject, is able to engage and motivate students, has effective management skills, and emphasizes understanding over rote procedures.

The National Council of Mathematics (NCTM) has defined good mathematics teaching in numerous documents (NCTM, 1989, 1991, 1995, & 2000). In the latest document (NCTM, 2000), they have a teaching principle, which states: "Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (p.16).

Next, I examine the literature on standards-based reform and their proposed alignment of instructional practices to facilitate intellectual development in mathematics.

BENEFITS OF STANDARDS-BASED TEACHING

Advocates of standards stress more stability and robustness of teacher judgments from diverse assessment methods (Pitman, 1985) and the potential democratization of learning and the erosion of traditional barriers (Baker in Peddie & Tuck, 1995). Gipps (1994) argues that standards-based reform ameliorates competition, reduces anxiety, increases intrinsic motivation, and promotes achievement, cooperation, self-efficacy, metacognition and deep learning.

The literature suggests that the impact of standards-based reform on pedagogy is moderately positive. Standard-based reform has had a positive impact on pedagogy (Barrington, 2004; Bushnell, 1992, Kannapel et al., 2001) creating more coherent teaching practices (Wilson & Floden, 2001), resulting in pedagogy that is more organized and systematic (Preece & Skinner, 1999) and creating more student-centered approaches (Eng, 1992).

Central to the mission of standards-based reform is the goal of increasing the intellectual

rigor of curricula and pedagogy based on the fact that classroom activity has traditionally been dull, perfunctory, and disconnected from real life. Proponents of standard-based reform argue that teacher-directed, fact-based instruction must be replaced with a new model of "teaching for understanding" in which students engage in active problem solving in order to develop conceptual understanding of subject matter (Elmore, 1990; Fuhrman, Elmore, & Massell, 1993; Smith & O'Day, 1991).

Standards-based reform is consistent with an emerging view of assessment for learning rather than assessment of learning (Black & William, 1998; Crooks, 1998). Standards-based reform calls for deep changes both in teachers' perceptions of their role in relation to their students and in their classroom practice. In particular, it suggests a move to a more student-centered pedagogical approach, placing students in a more active role in the learning, teaching and assessment cycle. Assessment standards help teachers provide students with information of what they know and can do and, more importantly, a clear picture of what they need to do to improve so they can take charge of their own learning (Black & William, 1998; Crooks, 1998). The intent of standards-based reform is to implement practices that describe what students should know and be able to do (Fuhrman, 2001). Standards-based mathematics instruction emphasizes the need for students to read mathematics and explain their mathematical thinking both orally and in writing (LeCroy et al., 2009).

The table on the following page summarizes the desired characteristics of college mathematics teachers that implement a more learner-centered approach. These standards provide a new vision for introductory college mathematics-a vision whereby students develop intellectually by learning central mathematical concepts in settings that employ a rich variety of instructional strategies (AMATYC, 2005).

Table 1 *GUIDELINES FOR PEDAGOGY*

INCREASED USE	DECREASED USE
Active involvement of students	Passive listening
Technology to aid in development	Paper-and-pencil drill
Problem solving and multistep problems	One-step single-answer problems
Mathematical reasoning	Memorization of facts and procedures
Conceptual understanding	Rote manipulation
Realistic problems encountered by adults	Contrived exercises
An integrated curriculum with ideas developed in context	Isolated topic approach
Multiple approaches to problem solving	Requiring a particular method for solving a problem
Diverse and frequent assessment both in class and outside of class	Test and a final exam as the sole assessment
Open-ended problems	Problems with only one possible answer
Oral and written communication to explain solutions	Required only short, numerical answers, or multiple responses
Variety of teaching strategies	Lecturing

These guidelines for pedagogy helped the researcher design items for the interviews.

LEARNER-CENTERED TEACHING

Learner-centered teaching (Billimoria & Wheeler, 1995; Weimer, 2002) represents a paradigm shift of how teachers teach. Thus, the model's conceptual underpinning is rooted in learning, challenging us to ask the rarely heard question, "How can I improve my students' learning?" instead of the often asked "How can I improve my teaching?" (Weimer, 2002). Weimer outlines the key premises of learner-center teaching as:

1. Assume that students are capable learners who will blossom as power shifts to a more egalitarian classroom.

2. Use content not as a collection of isolated facts, but as a way for students to critically think about the big questions in the field.
3. Change the role of teacher from sole authoritarian to fellow traveler in search of knowledge.
4. Return the responsibility for learning to the students, so that they can understand their learning strengths and weaknesses and feel self-directed in their knowledge quest.
5. Utilize assessment measures not just to assign grades, but as an effective tool to promote learning.

The result of this paradigm shift is that teachers become co-learners with students, thus blurring the categorical distinction between two groups. The broad learner-centered paradigm encapsulates our current understanding of the "best practices" in teaching, including an emphasis on active learning (McKeachie & Svinicki, 2006; Thompson, Licklider, & Jungst, 2003), problem-based learning (Blumberg, 2007) and, more generally, a thoughtful understanding of what the best teachers actually do in their classrooms (Bain, 2004). Of particular relevance to the present discussion, Bain notes that excellent teachers foster critical thinking, have a strong trust in students, and are life-long learners themselves.

The learner-centered paradigm has become a popular pedagogical tool in education; several researchers have explored learner-centered concepts with promising early results. For example, Wells and Jones (2005) examined how teaching informational systems development to students improved by using a more collaborative, mentoring style of teaching instead of a traditional lecture-based style. They utilized small work groups, personal work portfolios, and student-driven classroom experiences, and reported higher grades among the students in the more collaborative classrooms. They also suggest that students learned less measurable but still

important skills, such as the ability to work collaboratively and take responsibility for their own learning.

Two important areas of learning-centered practices are self-regulation and motivation. Self-regulation is defined as the ability of students to control the factors or conditions that affect their learning (Dembo, 2004). When motivation is discussed, the focus is on how to develop incentives or reinforcers to encourage students' self-regulation (Dembo, 2004). Research indicates that students' self-regulatory beliefs and processes are highly correlated with academic achievement (Zimmerman & Martinez-Pons, 1990; Zimmerman & Risember, 1997).

Next, I review studies that were influential in framing my research study as they relate to collecting data from college mathematics teachers regarding standards-based teaching.

STANDARDS-BASED INSTRUCTIONAL PRACTICE

The Standards represent a major effort to develop mathematically literate citizens. They are intended "to ensure quality, to indicate goals, and to promote change" (NCTM, 1989, p.2). They stress the need to provide all students with "opportunities to share the new vision of mathematics and to learn in ways consistent with it. Students should be encouraged and enabled to explore, reason logically, draw inferences, and employ a variety of mathematical methods to become mathematically literate" (NCTM, 1989, p.6). NCTM and AMATYC developed their standards in response to a recognized need for change in the teaching and learning of mathematics. Many will argue the change is needed because our world is becoming more mathematical and more technological.

Mathematics educators should understand not only why these changes are needed, but also how change is taking place in their institution. Therefore, knowledge about the process of change can help mathematics educators make decisions and build their capacity to influence

change in local contexts.

During the last two decades, the U.S. education community witnessed a proliferation of standards-driven reform efforts. The primary objectives of these efforts have been to increase student achievement to a level that is competitive with that of other industrialized nations (Shanker, 1994), to restore public confidence in education (Edmundson, 1993) and to provide a brief overview of the work of several influential standards-setting bodies and summarizes the primary ways in which mathematics educators are involved.

The U.S. Department of Education has made grants available to states to develop standards and curriculum frameworks in certain critical subjects (Federal Initiatives, 1994). There are three types of national standards that are receiving attention: content standards, which focus on curriculum; performance standards, which focus on student work and assessment; and school delivery standards, which focus on resources and support for schools, teachers, and students (O'Neil, 1993).

Since the widespread implementation of state standards, there has been considerable discussion about the potential of standards to reform classroom instructional practices (Rowan, 1996). Paule (2000) states that reformers have maintained, the standards and the assessments that determine if students have mastered the standards, provide a powerful framework that teachers can use to make more effective decisions about curriculum and instruction. It is expected that standards-based reform will lead to changes in classroom practices. Changes in instructional practices are then predicted to result in higher levels of student performance. However, there is very little studied concerning attempts to change the practices of college mathematics instructors toward reform-oriented teaching (Wagner & Speer, 2009). In relation to my study, there has been little documentation that implementation of standards will promote

substantive changes in instructional practices and the ways student's knowledge and skills are assessed

Ross, McDougall, Hogaboam-Gray& LeSage (2003) reveal that implementation of standards-based teaching contributes to improved student achievement of traditional objectives (e.g., computational skills) and reform expectations (e.g., problem solving). Ross, McDougall, Hogaboam-Gray& LeSage (2003) surveyed 80 Grade 7 and Grade 8 teachers identified as exemplary implementers of the National Council of Teachers of Mathematics (NCTM) 1989 Standards by the *Impact Math* project. The authors participated in an intensive case study of measuring elementary teachers' instructional practices. The authors identified four levels of implementation from traditional teaching to full implementation (with two intermediary levels) of reform in nine dimensions of elementary reform that included program scope, student tasks, discovery, teacher's role, manipulative and tools, student-centered interaction, student assessment, teacher's conceptions of mathematics as a discipline, and student confidence. Each teacher was sent 12 to 18 items from the two to nine dimensions several days prior to an individual telephone interview. Each was a likert-type item with a 6-point response scale from strongly agree (6) to strongly disagree. Fourteen teachers scoring in the top and bottom of the quartiles of standards-based teaching survey (nine high and five low) were invited to participate in interviews and observations. Each 40 minute interview was audio-recorded, and the audiotapes were used to compile detailed notes. The teachers surveyed were then observed how four high reform teachers and one low reform teacher used the text in their classrooms. The teacher codes used to analyze and transcribe consisted of two digit teacher identification numbers, the interview group assignment based on scores on both surveys and the source of data as the interview or the observation. The observations were selected disproportionately from the

high reform volunteers because authors were more concerned about teachers overestimating the extent to which they were implementing standards-based instructional reform.

The interviews and observations showed that the two groups differed consistently in how they used the text in their classrooms. The high reform teachers used the text to amplify their implementation of standards-based teaching, compensating for the text's perceived inadequacies in ways consistent with the standards. These teachers exemplified the effective uses of rich textbooks in that they did not implement the text verbatim but drew from it an overview of the domain and used it as a source of materials to build on their own ideas. The low reform teacher used the text to justify traditional practices, modifying the text or replacing key sections to redirect its emphasis away from the standards. The findings from the low reform teacher was similar to the 11 teachers observed by Spillane and Zeuli (1999) who made peripheral changes to their practice in response to reform initiatives but maintained continuity at the substantive core of their teaching. The low reform teacher was also similar to the two cases reported by Prawat and Jennings (1997) who found that the contribution of rich textbooks to implementation of reform was muted by teachers' beliefs about mathematics and mathematics teaching that conflicted with the conceptions embedded in the text.

Three types of longitudinal data revealed evidence of effects of such interventions. First, evidence of changes in student performance on mandated assessments were congruent with student standards. Second, evidence from small, purposely chosen observation samples revealed and demonstrated increased implementation of standards-based teaching. Third, evidence from every-teacher survey of self-reported practices strengthened the claim that findings from small observational samples can be generalized to the populations from which they were drawn. This study is related to my study in the area of standards-based implementation. Although, the

researchers were overly concerned with overestimation of implementation, this study assisted me in learning how to identify standards-based instruction in introductory collegiate mathematics classes and to what dimension (low or high) that teachers are implementing standards-based instruction.

Addie, Bodone, & Tell (1999) present some of the initial findings from a two-year study to identify the core knowledge and skills necessary to teach in a standards-based system. This study was part of the Standards-based Teacher Education Project (STEP) which focused on development of a framework and materials for pre-service and practicing teachers. High-school teachers and higher education faculty formed “co-development teams” in each of six disciplines committed to the implementation of standards-based instruction and assessment in one or more of their classes. In collaborative work groups, they shared pedagogical practices, broadened their content knowledge, and learned new ways to engage students in learning. Statewide initiatives in Oregon for the co-development teams provided the opportunity for the co-development teams to evaluate classroom performance assessments, determine levels of student proficiency and verify one another’s judgments of proficiency. The authors summarize initial findings from participants’ reflective inquiry and suggest implications for policy makers, teacher educators, professional developers, and educational researchers who are involved in standards-based reform. Oregon’s reform movement is driven by a policy framework that links the implementation of standards and assessment with teacher pre-service preparation and continuing professional development. The state has a unique K-16 perspective, as the only state in the U.S. with board adopted standards aligning student performance in elementary, middle, and high school with college admissions.

The methodology drew upon principles of action research and qualitative research

methods. The Standards-based Teacher Education Project (STEP) focused primarily on the collection of teacher's thoughts and learning about the implementation of standards-based reform in their classrooms and schools, and solicited their suggestions for improving teacher education programs. The successful reform described the coherence between educational theories and educational practice as a movement development from the ground up. The data collection methods used were via focus groups, individual interviews, journals, observations, document review, and e-mail questions. The researchers identified knowledge skills, approaches, and strategies used by teachers in the process of transitioning from traditional teacher centered classroom to a learning environment which is designed and focused on student learning. The research was 'with' and not 'on' the participants drawing on action research to change practice. The teachers were learning through educative research using theoretically-based knowledge to enhance experiential-expertise documented through professional development. The co-development teams numbered from three to eight members. The interdisciplinary groups included members from english, mathematics, science, social science, and second languages. The interdisciplinary groups included beginners with two to five years experiences and they were matched with veterans with up to thirty years experience. The teams offered focused concentration of standards-based instruction through the collaborative working groups. The focus of inquiry was on what knowledge and skills were needed for teaching in a standards-based system. The STEP project recommended that teacher development be designed to support implementation of standards based instruction and went on to acknowledge that teachers are primary agents of school reform. The professional development includes training and support in the cycle of activities including targeting standards, planning instruction that includes a variety of teaching strategies, verifying assessment, and reflecting on experiences. The implementation

successes and failures of this research project provided a reference for planning and development efforts of my research project in the area of implementation.

Lynde Paule (2000) reviews standards-based implementation and discusses the experience in standards-based teaching and learning environments. Proficiency-based Admission on Standards System (PASS) require Oregon students entering Oregon's public universities be able to demonstrate that they are proficient in six content and nine process areas. This policy effectively moved the focus of the admissions process form students' grades and test scores to the knowledge and skills they have acquired and mastered in the content areas. PASS links Oregon's K-12 standards-based initiatives with higher education to form a coordinated and interrelated K-16 system. PASS is particularly interested in the impact of its standards in the three content areas of English, Mathematics, and Science on students' classroom experiences. During the last six years, PASS has been evaluating the impact of its training on changes in classroom practices from the perspectives of both teachers and students. Survey data from teachers and from students suggest that there have been changes in only small and moderate degrees but slow and consistent changes noted by teachers have been promising. Paule (2000) states that conversations with teachers are excellent sources of information about what they are doing in their classrooms to fulfill the promise associated with standards implementation.

Focus groups were conducted with groups of 10-12 students and 2 teachers from six high schools. A total of 53 students participated in the focus groups, which lasted approximately 45-60 minutes. Signed parent/guardian permission forms were collected for each student. The project evaluator and a graduate assistant conducted the discussions, and each session was taped and transcribed. The findings of the study included that the extent to which the student knew about and understood the standards depended on the number of years their teacher had been

working with PASS and the type of class in which the standards were being targeted. Students' knowledge ranged from name recognition only to knowledge and information about how the standards were to be used for college. As students talked and listened to one another during the group discussions, they began to compare what they knew about PASS and other school requirements. Through these discussions, they began to clarify what PASS was and how it was different from other requirements. Students noted that the work they did was harder, it was more open-ended and thus required more independent thinking, and it required them to demonstrate what they knew using different assessment formats. The level of learning in students was different in open-ended labs compared to prescribed labs. In relation to my research, this study helped me to identify practices consistent with the rigor associated with learner-centered teaching in the first two years. This study was influential in selecting the data collection methods for my proposed study.

In a study by Firestone, Mayrowetz, and Fairman (1998) on the effects of performance-based testing on teaching practices in Maine and Maryland found that state testing, while generating considerable focus on the test, resulted in very little change in basic instructional practices. The new standards assessments did not always significantly alter teachers' classroom behaviors in ways that affected student learning. Implementing the standards in the manner in which they are intended is important and teaching to tests can lead to unanticipated results. The problem-solving pedagogy results in deeper levels of student understanding and a more challenging curriculum. The central role of the teachers in curriculum frameworks provides insight on how the content is taught. The importance of the teachers' perspective impacts how they deliver the material. The flaw was in the assumption that the standards-implementation were delivered with fidelity. In relation to my research, this study has shown the importance of

implementing standards with fidelity. Teaching the way that is supposed to be taught has a positive effect on student learning. This study relates to my study with regard to instructional change.

A study by Adger and Clair (2002) reveals the strategies for long term collaborative professional development. During this three year-project, several researchers and more than 100 educators worked together to explore issues in implementing standards. Standards-based teaching in culturally diverse schools grew out of several years of applied research on professional development for standards implementation in Massachusetts. The research design was based on previous research on professional development (Renyl, 1996); and the professional development approach emphasized research on second language acquisition (Pica, 1987) and instruction for English language learners (Garcia, 1991). The research design focused on teachers' perspectives in analyzing standards, examining student work, and discussion of professional literature that can be used to maintain collaborative professional development. This approach is consistent with recent research showing that professional development is most likely to change teaching when it is linked to teachers' professional experiences, aligned with school reform efforts, and characterized by communication among teachers (Garet, Porter, Desimone, Birman, & Yoon, 2001). The study revealed that teachers professional comfort with standards implementation eased the change process as teachers struggled in changing and modifying their instruction. The teacher's knowledge of standards implementation has an effect on how the reform is initiated and maintained. Mathematics faculty modify the curriculum to customize their instruction to align with standards-based teaching practices as their knowledge and awareness of standards develops as a professional.

The previous studies helped in framing my qualitative research study. In particular, the

findings from previous literature have influenced my study on how I collected and analyzed my data.

STANDARDS-BASED CURRCIULUM AND TEACHER EXPERICENCES

The studies that examined student and teacher attitudes towards standards oriented curriculum reports are very rare in the literature. Available studies conducted their research on custom designed mathematics curriculum, advanced placement courses or International Baccalaureate programs. Schoen and Pritchett (1998) examined student perceptions about a standards-based mathematics curriculum. Despite the perceived challenging nature of the curriculum, they reported positive results related to students' attitudes towards the curriculum. Students were especially satisfied with the mathematics topics and ideas that were anchored in the real life experiences, this was accepted as the strongest contributor to increase students' interest in the mathematics and the standards-based curriculum.

The studies that examined teacher experiences in other subjects also reported attitude change in teachers about standards oriented curriculum. Nagy, Collins, Duschl, & Erduran (1999) studied teacher attitude and belief changes about science teaching with a standards oriented science curriculum unit. They concluded that teachers' beliefs and attitudes about standards based assessment practices and their understanding of nature of science have evolved. They shifted their view of assessment from a tool to measure knowledge to a tool to help students' learning process. They also changed their view of science from a fixed body of knowledge to a continual process of seeking the knowledge. Although this study was conducted with small number of teachers, it is an important study to show how well-designed curriculum can change teachers' attitudes and beliefs about a subject that they are teaching.

Well-designed standards oriented curriculum help teachers support their students

learning process. Kyburg, Hertberg-Davis, and Callahan (2007) concluded that it is essential for teachers to have some flexibility in order to modify course content during the implementation of the courses. Previously, similar conclusions were reported by Knudson and Wiley (1997) related to interpreting the educational standards. In another study, Scahill, Melican, and Walstad (2005) examined the experiences of 296 economics instructors. They concluded that the teachers in the economics courses were dedicated and self-motivated individuals who sought opportunities to interact with their peers to improve their teaching. However, due to low number of opportunities to achieve this interaction and geographically dispersed nature of the course, instructors have difficulties to organize and join professional development opportunities to improve their teaching.

Although the literature includes some research studies regarding standards-oriented curriculum and student achievement, very little is known about teacher experiences in learning environments with a well-designed, standards-oriented curriculum. Hiebert et al.(1997) found that teacher practices in a well-designed, standards-oriented curriculum are substantially different from traditional teacher designed curricula. Moreover, standards-based movement in education is favored by many administrators and teachers; however, the majority of teachers are not prepared to operate in an educational system with standards-oriented curricula which emphasize critical thinking and hands-on activities (Cohen, 1990; Darling-Hammond & McLaughlin, 1995; Grant, Peterson, & Shojgreen-Downer, 1996; Porter & Brophy, 1988).

STANDARDS-BASED REFORM ON LEARNING

The literature suggests that standard-based reform, and its pedagogical changes, have a positive impact on student learning and achievement (Black & William, 1998; Bushnell, 1992; Clune, 2001; Gipps, 1994; Hipkins, 2004; Hipkins et al., 2004; Kannapel et al., 2001). Creating

standards-based education systems is a challenging process guided by a commitment that every student gains the knowledge and skills needed to succeed in life and participate effectively in society. The focus in a standards-based education system is to keep the focus on learning and keeping the focus on learning offers guidance to help educators achieve the fundamental goal of improved teaching and learning for all.

STANDARD-BASED REFORM ON DIVERSITY

The academic achievements of diverse learners within standards-based assessment systems have been mixed. The research suggests that although diverse students perform better there is still a significant gap between the achievement of minority students and those from low income households (Kannapel et al., 2001; Madaus & Clarke, 2001).

Joseph Murphy (1993) identifies educational equity as a fundamental principle of the standards-based movement through its stance that all students can learn, that teachers and schools are co-responsible for ensuring that this learning occurs, and that they should do so through adapting instructional approaches within the regular curriculum rather than isolating disadvantaged students in remedial programs.

This review provides a background for the proposed research in standards-based teaching and their implications for faculty teaching introductory collegiate mathematics. Next, I conclude by providing a synthesis based in the literature for why standards-based practices should permeate undergraduate mathematics instruction.

STANDARDS-BASED REFORM AND PROFESSIONAL DEVELOPMENT

The standard-based reform movement has significantly impacted pedagogy but there are ongoing issues of alignment of teaching strategies to more student-centered practices. The standards-based reform movement incorporates the theory and research generated by the learner-

centered approach and uses that knowledge to improve the implementation of standards-based teaching strategies.

Standards-based reform provides for more equitable educational opportunities. Jennings (2000) suggests that future research should identify barriers and facilitators to the linkage of standards-based reform with reform curricula, including professional development and technical assistance that help teachers link the two. Standards-based reformers and school improvement advocates could begin to work together to resolve some issues, including teacher professional development:

1. What kinds of assistance and time do teachers need to develop experiential curriculum?
2. How do they tie them to standards centered on the community?
3. How can teachers create standards that are uniformly high for all students?

The uniformity and equity that is central to the standards-based reform might serve as a check against local traditional practices that empower certain groups at the expense of others (Rowan, 1996).

MAJOR STRENGTHS OF STANDARDS-BASED REFORM

Teachers were interviewed for a report asking a series of questions about the impact of standards reforms on practice, and on learning opportunities, the quality of education, and resources in particular. Their responses suggest that they perceived more equitable learning opportunities for traditionally underserved populations as the most positive outcome and the most promising potential of standards-based reform and accountability (Center for Education Policy, 2006). Indeed, when asked about the effects of standards on quality of education, most immediately began discussing equity. At the same time, they say improving learning

opportunities and continuing to make achievement gains as some of the most difficult challenges they faced (Massell, 2008).

Specifically, they believed that five types of equity had improved under the regime of standards-based reform:

1. Greater awareness and attention to the academic performance of underserved students.
2. Higher expectations that all students will achieve to more rigorous standards.
3. Reductions in achievement gap.
4. A more uniform educational system
5. Instruction tailored to the needs of different students.

DISCUSSION

Most college and university faculty spend much of their time and energy teaching, and most take teaching seriously, often asking questions about how and why students do or do not learn. An area addressed in this study includes the effectiveness of different teaching approaches in introductory collegiate mathematics. Some issues with unanswered questions include the use of technology in the teaching process, using a variety of instructional approaches, and attending to the needs of underrepresented students.

Cross (1986) argues that faculty across the nation should undertake research on teaching and learning in their own college classrooms in order to discover more effective teaching methods and establish a body of knowledge about college teaching that would maximize learning. At the heart of teaching is the core challenge of getting learners engaged in productive work. This may occur through listening to a finely designed lecture, participating in a well-orchestrated discussion, working collaboratively with a few peers, or thinking intently on one's

own (Ball, 2000).

SUMMARY

The examination of the literature on effective mathematics teaching, standards-based reform, and learner-centered practices has been the primary focus of my literature review. The purpose of my study was to describe the ways that mathematics faculty are implementing standards-based instruction and facilitating intellectual development in the first two years of college. This study examined the practice of college mathematics educators in the first two years of college. The literature review discusses a variety of instructional approaches as opposed to the traditional lecturing and emphasizes learner-centered practices. The review includes a discussion of research that was instrumental in helping me frame my research study. The key areas of review contribute to a better understanding of effective mathematics teaching practice in the first two-years of college.

I am linking standards-based teaching with effective mathematics teaching practice to improve the teaching of college mathematics in the first two years. Linking these areas of scholarship provided a lens for analyzing standards-based mathematics teaching.

This chapter provided an overview of literature pertinent to this study. A discussion of what is meant by effective teaching in undergraduate mathematics is included and the need for or influence of standards-based instruction is also included. Research findings and issues pertinent to the study of teaching and learning at the college level are presented. The overall purpose of this research is to describe standards-based teaching and investigate what instructional strategies mathematics faculty employ to facilitate their students' intellectual development.

CHAPTER 3

METHODOLOGY AND RESEARCH DESIGN

> "Education-research methods are specific and concrete approaches.
> In contrast, educational-research methodology is a theory of methods
> – the underlying theoretical framework and the set of epistemological and
> ontological assumptions that determine the way of viewing the world
> and hence, that underpin the choices of research" (Ernest, 1997, p.35).

This chapter describes the methodological design to be used to conduct this study. The purpose of this study was to describe the teaching practices of college mathematics instructors who have been identified as those who use standards-based practices to facilitate instruction in introductory collegiate mathematics by answering the questions: What alignment exists between two-year college mathematics instructor's knowledge and the instructional standards published by the American Mathematical Association of Two-Year Colleges in Beyond Crossroads? What are the components that characterize the instructional practices of two-year college instructors? What relationship exists between the alignment of Two-Year College mathematics faculty instructional practices with Beyond Crossroads?

The central question of this research is about understanding teachers' knowledge and skills who have aligned their instructional strategies with a standards-oriented curriculum. This central question can be divided into sub-questions. How does a standards-oriented curriculum and testing impact their teaching? How do teachers modify the content/material to customize

their instruction and align with standards-based practices? How does a standards-oriented curriculum impact their teaching? How do teachers modify the content or material to customize in their classes? How does teaching in a standards-oriented environment affect the teaching of other courses? What do teachers think about applying this curriculum to other classes?

Teachers' interactions with well-designed, standards-oriented curricula have not been well documented (Hiebert, Gallimore, & Stigler, 2002). This study described and analyzed mathematics teaching practice in a learning environment where a standards-oriented curriculum was utilized.

To answer the research questions a qualitative approach to data collection with an embedded quantitative analysis was chosen due to its applicability in answering the research questions. The quantitative analysis contrasts traditional teaching with standards-based teaching. The qualitative analysis allowed me to analyze and synthesize their technological usage, their usage of multiple instructional strategies, and their usage of a variety of classroom activities instead of relying mainly on the lecture format. In this study, I want the reader to gain a deeper understanding of standard-based instructional practices and what instructional strategies mathematics' faculties employ to facilitate their student's intellectual development.

I used a primarily interpretive approach to answer the research questions. I described how standards-based instruction was being implemented by purposively chosen mathematics' faculty. The design was primarily an interpretive research methodology including an embedded quantitative analysis. In particular, this data analysis allowed the researcher to use the strengths of both quantitative analysis techniques and qualitative analysis techniques so as to understand the phenomenon of standards-based mathematics instruction in the first two years.

Three mathematics' faculty who implemented standards-based teaching were purposively

chosen from the web-based survey to participate in the study. Their participation in this study provided a glimpse of the perceptions these mathematics teachers had concerning the use of standards-based instruction. The study embarked on an effort to determine what can be known about standards-based teaching from the mathematics teaching workforce. The objective was to describe the ways that mathematics faculty are implementing standards-based instructional practices.

DATA ANALYSIS

The survey allowed me to gain information from a broad group of mathematics faculty on the knowledge and skills necessary to teach in a standards-oriented environment. The survey also allowed me to purposively sample three mathematics' faculty who aligned their instructional practice with standards-based practices. The quantitative analysis contrasts traditional teaching with standard-based teaching.

The interviews allowed me to examine inner perspectives about the components that characterize their instructional practice. The qualitative analysis allowed me to analyze and describe their technological usage, their usage of multiple instructional strategies, and their usage of a variety of classroom activities instead of relying mainly on the lecture format. Findings from the study suggest there exists a strong relationship between the American Mathematical Association of Two Year College standards and instructor practice in the first two years. The findings indicate that mathematics faculty struggled in changing their instructional practice to meet the needs of their students. Data was collected as narrative and transformed into a standards-based characteristic code. This manual process involved coding the responses into numerical coding (Jaeger, 1997). I interpreted the standards-based characteristic codes into themes associated with alignment of standards-based teaching.

METHODS AND SOURCES

To understand teachers' work and how to support it in greater depth, it helps to get information directly from teachers and from the sites of their daily practice. As a means of hearing directly from teachers on various matters, including the issues discussed in chapter one, a survey system was constructed. Quick turnaround of surveys (approximately three-four weeks) and high responses rates make this kind of system especially useful for gathering accurate and representative survey data from mathematics teachers (Loeb, Knapp, & Elfers, 2008).

Instruments were prepared in a web-based format. Recognizing that web-based surveys offers faster turnaround times, simple branch logic, and less data entry, I wanted to use this format as an efficient means for gathering information from teachers.

The survey served several purposes:

1. Collect information about mathematics faculty,
2. Collect descriptive, low-inference baseline data and build on that information through further interviewing, and
3. Allowed me to purposive select three faculty to interview.

The data for this study came primarily from surveys and interviews, administered during the fall 2011 term and spring 2012 term. After completing the consent to be a research participant was signed, the study was conducted in two phases. In phase I, each faculty member completed a self-report survey on commitment to standards-based teaching. The survey served as the quantitative analysis and was used to purposely select three mathematics faculty that where high implementers of standards-based teaching. In phase II, I interviewed three purposively sampled mathematics faculty. The interviews yielded additional information about the background of each participant's teaching experience, level of education, professional

affiliations as well as their commitment to mathematics education reform. The structured interviews took approximately several hours to complete. The structured interviews were the qualitative analysis and asked probing questions in the areas of the learning environment, instructional strategies, assessment, professionalism, and curriculum development. The faculty were asked to follow-up with the researcher for the purpose of member checking to confirm the accuracy of my findings as well as attempt to provide the faculty with an opportunity to share with me their knowledge and understanding of standards-based teaching.

I instilled trustworthiness with member checks to verify interpretations. After analyzing the data, data was transcribed to locate ways in which mathematics faculties were aligning their instruction with standards-based instructional strategies in College Algebra to facilitating students' intellectual development.

This interpretive research involved gathering evidence from faculty over two semesters. This study provides rich, descriptive data about the ways in which mathematics faculty are aligning with standards-based instructional strategies in College Algebra. I believe that the best way to comprehend the complex world of teaching mathematics is to draw information from the point of view of the mathematics faculty who experience the phenomenon of standards-based instruction. This type of focus required qualitative approaches and quantitative approaches in order to describe the mathematics faculty experience within their context specific settings. The methods of inquiry relied on survey analysis and interviews. Three mathematics faculties were purposefully chosen to understand and make sense of the world that teachers refer to as standards based-instruction. I chose an interpretive methodology because I felt it allowed me to best describe the different ways that mathematics faculty implemented standards-based instruction in the first two years.

RESEARCH CONTEXT AND PARTICIPANTS

The subjects in the study are mathematics faculty at two-year colleges. I am an Assistant Professor of Mathematics at a two-year college. The College is a metropolitan two-year public college in a southeastern state whose enrollment exceeds 20,000, with 65% female and 35% male. The mean age of the students is 25 years while the median age is 22 years. Many of these students are non-traditional students, nearly half or 44% of whom work part-time, if not full-time. My institution defines non-traditional students as those students who are three or more years removed from high school graduation upon admittance to college. The college student population is 44% white, 34% African-American, 10% Asian, 5% Hispanic, and 7% multi-racial.

The college whose faculty will participate in the study has a diverse student population. The goal was to describe the ways that mathematics faculty are aligning with standards-based instructional strategies. Since inner perspectives and decision making were difficult or impossible to observe directly, this study depended heavily on interviewing of faculty and on the researcher's ability to interpret the faculties' ability to express themselves effectively. Three mathematics faculty were interviewed via telephone in their offices about the knowledge and skills necessary to teach in a standards-oriented environment. An analysis of the data revealed that standards-based teaching strengthens instructor delivery and accommodates diverse learning styles.

"Beyond Crossroads", developed by the American Mathematical Association of Two-Year Colleges (AMATYC), states that in recent years, two-year colleges have provided increased access to higher education, currently enrolling close to half of all students who are women, African American, and persons with disabilities, as well as more than half of Hispanic and American Indian students (AMATYC, 2005). Two-year colleges represent a rich source of

potential mathematics, science, engineering, and technology talent that is too often ignored.

Purposive sampling was employed in order to select faculty from which I could learn a great deal about the issues of central importance to this study (Patton, 1990). Purposive sampling enabled me to identify informed faculty who were thoughtful, articulate, and willing to talk with me about teaching College Algebra using standards-based teaching strategies. I obtained informed consent from all research participants and gained approval from the Georgia State University's research board prior to beginning this study.

INSTRUMENTS AND MATERIALS USED

This study employed a variety of data gathering techniques such as surveying and interviewing faculty in order to strengthen the validity of the research findings through multiple sources. The quantitative analysis contrasted traditional teaching with standards-based teaching. The qualitative analysis allowed me to analyze and describe their technological usage, their usage of multiple instructional strategies, and their usage of a variety of classroom activities instead of relying mainly on the lecture format.

The participants were asked to respond to 20 true-false questions within different dimensions of standards-based teaching. Interviewing was used throughout the study as a primary method for collecting data that was descriptive of the inner perspective of mathematics faculty. Qualitative interviewing begins with the assumption that the perspectives of others are meaningful, knowable and able to be made explicit (Patton, 1990).

Throughout the study, inductive data analysis was employed as a process for making sense of the field data. This strategy involved the scanning of data for categories and for relationships among these categories. Categories are patterns in the data that may be a description of observable information or interpretations of underlying phenomena (Boyatzis,

1998). Data analysis began with surveys and then interviews. Surveys were collected prior to the interviews. Interviews were recorded using digital recorders. Confirmation of interpretation via member checking followed the interviews. Initial survey analysis focused on the selection of key participants of the study as well as pertinent background information of the participants. As information was obtained through surveying, interviewing, and member checking, data was analyzed inductively with the expectation that patterns emerged from the data. Each set of data from the surveys and interviews were analyzed prior to the onset of the next phase of member checking.

My investigation into the instructional practices of two-year college mathematics faculty and the relationship of these instructional practices to the instructional standards published by the American Mathematical Association of Two-Year Colleges in Beyond Crossroads is guided by these research questions: What alignment exists between two-year college mathematics instructor's knowledge and the instructional standards published by the American Mathematical Association of Two-Year Colleges in Beyond Crossroads?; What are the components that characterize the instructional practices at two-year college instructors?; and What relationship exists between the alignment of Two-Year College mathematics faculties' instructional practices with Beyond Crossroads?

ROLE OF RESEARCHER

At the time of this research, I am an Assistant Professor of Mathematics at a two-year college in a southeastern state. I began teaching introductory collegiate mathematics over seventeen years ago. During this time, I have changed from primarily a traditional lecture-centered teacher to more of a teacher as facilitator in a more student-centered learning environment. Although I have made use of more student-centered practices, the majority of

mathematics faculty lecture as their primary tool for delivery (Dunbar, 2003). All faculty are required to attend a national conference and a regional or local conference annually to stay abreast of issues in the first two years of college. More student centered-practices are called for in the classroom at these conferences yet the lecture remains the primary mode of delivery for mathematics' faculty in the first two years of college.

I was talking with a peer at a regional mathematics conference when the phenomenon of standards-based teaching was revealed to me. Shortly after this encounter at a professional meeting, I obtained a copy of Crossroads published by the American Mathematical Association of Two-Year Colleges (AMATYC, 1995). This document recommends standards-based instruction within the first two-years of college. A follow-up document Beyond Crossroads published by AMATYC was intended to further the causes of standards-based mathematics teaching in the first two-years (AMATYC, 2005). These documents have influenced my instructional practice and influenced the manner in which I analyzed the themes associated with standards-based mathematics instruction.

My role as a researcher is that of a data collector. I served as the data collection instrument, conducting surveys and interviews. The surveys allowed me to locate and interview three purposively selected mathematics faculty. I used standards-based instruction as a lens to analyze effective mathematics teaching throughout the interviewing. As the principal investigator, the researcher acted as instrument of data collection.

As the researcher in this study, my own bias and subjectivity influenced the gathering and interpreting of data. My interpretive framework is in line with qualitative inquiry and this predisposition influenced the manner in which I collected and interpreted the data. The researcher was interested in specific facts that describe and identified the knowledge and skills

associated with standards-based instruction in College Algebra.

VALIDITY

This study utilized the techniques of triangulation, discrepant evidence, participant feedback and rich description (Guba & Lincoln, 1985) in an attempt to strengthen the credibility of the findings. Triangulation is a basic component of ethnographic research that relies on multiple sources of evidence to help establish the confirmability of research findings. According to Fetterman (1998), triangulation 'is at the heart of ethnographic validity, testing one source of information against the other to strip away alternative explanations and prove a hypothesis' (p.495). Triangulation also reduces the risk of systematic distortions that often result when only one method of analysis is utilized (Maxwell, 1998). Triangulation helps to strengthen certain assertions when multiple sources of data coincide. In this study, I looked for recurring patterns in the data that were obtained from different people at different times through similar means. While such relationships can be found, the patterns observed rarely form a single consistent picture and, according to Patton (1990), it is also important to understand and give reasonable explanation for differences that are observed in the data. When adequate explanation of differences is combined with a consistency in the overall data from multiple sources, the credibility of the findings is enhanced.

Another step toward building credibility involved obtaining feedback from the participants in the research. The purpose of my study was to describe and analyze the ways in which mathematics faculty are implementing standards-based instruction in College Algebra. It was critical for me to check my interpretations with them in a regular and ongoing manner. When the views of participants are solicited regarding the data and conclusions of a study, "member checks" are performed to help validate the assertions being made (Miles & Huberman,

1994). Maxwell (1998) claims that this type of process is the single most important way of ruling out the possibility that you have misinterpreted the perspective of your participants. Member checking provided the chance for faculty to react to assertions that I have made as the researcher. After member checking, I allowed the mathematics faculty to respond to the correctness of my interpretations. In doing so, they helped me to frame and strengthen my constructions of their perspectives as implementers of standards-based instruction.

Finally, it is important to recognize that this study is note value-free or bias-free. In my role as a researcher, I occupy a unique position as a gatekeeper and my perspective adds another way of looking at the world. With my attitudes, perceptions, beliefs, and history, I bring my own bias and values into the situation. During this research, I attempted to look at the situation from the faculty's viewpoint. As a qualitative researcher, it is my responsibility to be open and honest regarding the values and inclinations that I bring to the table.

LIMITATIONS

There were several limitations of the study. The faculty in the study did not constitute a random sample. The faculty were purposively selected. As a researcher, I must divulge any biases that will limit the generalizeabilty of the study. The rich description that qualitative research provides was triangulated via interviews and validated by member checks to ensure authenticity of the data.

As the researcher in this study, my own bias and subjectivity influenced the gathering and interpreting of data. My interpretive framework influenced the manner in which I collected and interpreted the data. Although bias cannot be eliminated, I worked to limit its effect by openly acknowledging it. In order to minimize the impact, I included field notes that monitored researcher subjectivity and participant member checking to help validate the assertions of the

study.

SUMMARY STATEMENT OF METHODOLOGY

I surveyed thirty mathematics faculty and interviewed three full-time faculty in regards to implementation of standards-based teaching. Data was analyzed and transcribed to locate ways that faculty were implementing standards-based teaching. The purpose of this study was to describe and analyze the ways in which mathematics faculty at a two-year college are aligning their teaching practice with a standards-oriented curriculum in College Algebra. An interpretive methodology was chosen in order to provide rich, descriptive data regarding the mathematics educators' viewpoints of these phenomena. The inquiry was carried out within the natural setting of the faculty and data collection relied on surveying and interviewing of mathematics faculty. The goal was to describe the ways that mathematics faculty are implementing standards-based instructional practices. This study was designed to address our knowledge of mathematics teaching and knowledge of student difficulties in College Algebra, and the influence of those variables on instructional practices.

The systematic investigation of teaching has resulted in many explanations of how people learn. The Mathematical Association of America (MAA) recommends to continually strengthening courses that align with student needs and assess the effects of such efforts. My study describes the themes associated with standards-based teaching in introductory level collegiate mathematics.

CONCLUSION

In this chapter, I discussed the methodological procedures and instrumentation of the study. I included studies that were instrumental in influencing this study. I administered a survey to thirty mathematics faculty and conducted three structured interviews with three purposely

chosen mathematics faculty. These methodological procedures were employed to further understand the phenomenon of standards-based teaching. The next chapter is organized by the research questions and the theories of action used to describe standards-based teaching in the first two years.

CHAPTER 4

PARTICIPANTS AND FINDINGS

As stated in chapter one, the study reported here examined standards-based teaching in the first two years of college. The chapter is organized by the research questions and the theories of action used to describe standards-based teaching.

This chapter begins by analyzing the interview and the survey data. Next, I review the purpose and research questions guiding the study, then I describe the mathematics faculty included in this study based on the information they provided on surveys and during interviews. I complete this chapter by presenting the findings from the interviews organized by research questions and survey data organized by dimensions of standards-based teaching. Quotes from the mathematics faculty are included to describe standards-based teaching in the first two years of college.

PURPOSE AND RESEARCH QUESTIONS FOR STUDY

The purpose of this study is to describe the teaching practices of college mathematics instructors who have been identified as those who use standards-based practices to facilitate instruction in introductory collegiate mathematics by answering the questions: What alignment exists between two-year college mathematics instructor's knowledge and the instructional standards published by the American Mathematical Association of Two-Year Colleges in Beyond Crossroads? What are the components that characterize the instructional practices of

two-year college instructors? What relationship exists between the alignment of Two-Year College mathematics faculty instructional practices with Beyond Crossroads?

The central question of this research is about understanding what instructional strategies mathematics faculty use to facilitate their students learning and problem solving skills. Teachers' interactions with well-designed, standards-oriented curricula have not been well documented (Hiebert, Gallimore, & Stigler, 2002). Very little research has been conducted studying attempts to change the practices of college mathematics instructors toward reform-oriented teaching (Wagner & Speer, 2009). Although small but growing evidence indicates that students achieve more with standards-based curricula, no research has been done to understand how teachers experience the utilization of these curricula in their classrooms. Without understanding how teachers react towards a centrally developed standards-based curriculum, successful implementation of such efforts will be uncertain (McCaffrey, Hamilton, Stecher, Klein, Bugliari, & Robyn, 2001). This study sheds light on college mathematics instructors' experiences with implementing standards-based practices in College Algebra in the first two years of college. This study will analyze and describe mathematics teaching practice in a learning environment where a standards-oriented curriculum is utilized.

To answer these questions a qualitative approach to data collection with an embedded quantitative analysis was chosen due to its applicability in answering the research questions. The quantitative analysis depicts standard-based teaching contrasted with traditional teaching. The qualitative analysis allowed me to analyze and synthesize their technological usage, their use of multiple instructional strategies, and their use of a variety of classroom activities instead of relying mainly on the lecture format.

In this study, I want the reader to gain a deeper understanding of standards-based

instructional practices and what instructional strategies mathematics' faculties employ to facilitate their student's intellectual development.

PARTICIPANTS AND CONTEXT

The participants for this research study are mathematics faculty from colleges within the southeast United States of America. The full-time permanent faculty teaching mathematics in the first two years have the following characteristics: 44 percent are women, 14 percent are ethnic minorities, 46 percent are above the age of 50, 82 percent have a master's degree, and 16 percent have a doctorate (AACC, 2005). Mathematics faculty in the first two years are knowledgeable about standards-based teaching and are a good place to begin to analyze the practice of standards-based teaching.

One hundred nineteen faculty were asked to respond to a 20 question web-based survey. The survey ranks the mathematics faculty from low implementers of standards-based teaching to high implementers of standards-based teaching. The survey was then used to purposely select three mathematics faculty that were implementing standards-based teaching. Three mathematics faculty were asked to participate in further interviews to examine their implementation on standards-based teaching in the first two years of college. Findings from the study suggest there exist a strong relationship between the American Mathematical Association of Two Year Colleges standards and instructor practice in the first two years. Findings indicate that mathematics faculty are aligning their practice with standards-based teaching. Findings indicate that standards-based teaching strengthens instructor delivery by accommodating diverse learning styles. Mathematics faculty modified the curriculum to customize their instruction to align with standards-based teaching practices as their knowledge and awareness of standards developed as a professional.

The three participants were assigned pseudonyms of Alvin, Barry, and Carl. Next, I will describe the personal characteristics, professional titles, teaching experience, and education of the participants.

ALVIN

Alvin is a white male over 70 years of age. Alvin is a Professor of Mathematics at a two-year college in the southeast United States of America. He has 47 years of teaching experience having taught middle-school, high-school, and college. His education consists of a Bachelor of Science in Mathematics, a Master of Science in Human Services, and additional graduate study in graduate mathematics. He has completed all graduate work towards a Ph.D. but lacks the dissertation.

BARRY

Barry is a black male over 50 years of age. Barry is an Assistant Professor of Mathematics at a two-year college in the southeast United States of America. He has nearly two decades of teaching experience having taught high-school and college. His education consists of a Master of Science in City and Regional Planning including 21 credit hours of additional graduate mathematics.

CARL

Carl is a white male over 60 years of age. Carl is a Professor of Mathematics at a two-year college in the southeast United States of America. He has over four decades of teaching experience having taught high school and college. His education consists of a Bachelor of Science in Engineering, two Master's degrees, and additional graduate work in mathematics. He has completed all graduate work towards a Ph.D. but lacks the dissertation.

DATA COLLECTION AND MEASURES

The data collection period for the survey started September 1, 2011, and ended on February 27, 2012. This seven month time period covered the instructors who taught during fall and spring semesters. The survey was web-based and administered online. I sent the online survey along with an email requesting their participation in the survey. It is common practice to send three invitation e-mails to each potential survey participant in regular survey administrations. Only one invitation e-mail and two follow-up reminders to non-respondents were sent. The ratio between active instructors during the survey administration period and completed surveys provided the participation rate. Thirty instructors out of 119 returned the online survey, yielding a return rate of 25.21%.

The credibility of the study was maintained through multiples strategies. I triangulated between data sources (interviews and surveys). The participants confirmed my interpretations with member checks (i.e., I asked the interviewees to comment on my interpretations of them), and the researcher maintained an audit trail (i.e., a record of how I aggregated the data into themes and interpreted these themes as a set of study conclusions). I also used accurate recording devices (audiotapes were transcribed verbatim) (Cresswell, 1998). Codes were used to identify the source of the data (Surveys [S] or Interviews [I]) and mathematics faculty identification (Alvin [A], Barry [B], or Carl [C]).

Data was collected and used from multiple sources for this study's analysis. All sources of data were reviewed and analyzed together so that the study's findings would not be solely based on one source of data, but instead on the convergence of information from different sources (Yin, 2003). Information from one source was compared with information from another source of data throughout the data analysis process (Paterson & Graham, 2000).

Informal data analysis occurred simultaneously with data collection. I used field notes as a running commentary about what was happening in the research to help with the overlap of the data collection and analysis. I made notes when instances occurred that were related to the research questions and would help with the identification of themes.

After transcribing the interview data, I undertook open coding of the data and the field notes, from which themes emerged. This manual process involves coding the responses into a standards-oriented characteristic code. The data was collected as narrative and transformed into a standards-oriented characteristics code. I then interpreted this characteristics code into themes associated with standards-based teaching in the first two years of college.

The audio-recorded data were downloaded and stored on a secure server at a Georgia state college. Backup recordings were stored securely in the researcher's office. The recorded data will be retained indefinitely, as the data may be re-examined later for insights into additional research that arise subsequent to this study.

In the next section, I report my findings from my interview with the three mathematics faculty and my analysis of their interviews. I organized the interview results by the five assumptions of the theories of action. These assumptions were used as a framework to describe standards-based teaching in the first two years of college.

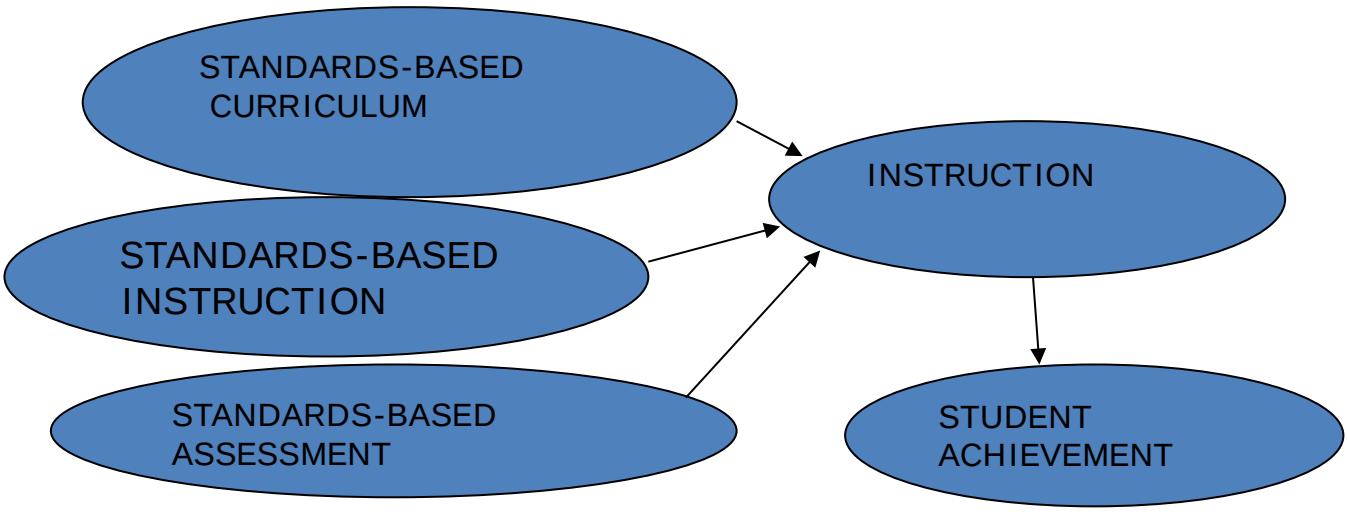
QUALITATIVE ANALYSIS

Three mathematics faculty were interviewed in their offices via telephone for two sessions each lasting over an hour. Each interview was audio recorded, and the audiotapes were used to compile detailed notes. The interviews allowed me to synthesize and analyze their technological usage, their use of multiple instructional strategies, and their use of a variety of classroom activities instead of relying mainly on the lecture format to facilitate student

achievement.

The conceptual framework below conceptualizes theory by showing relationships of variables investigated in a standards-oriented environment and their impact on student achievement.

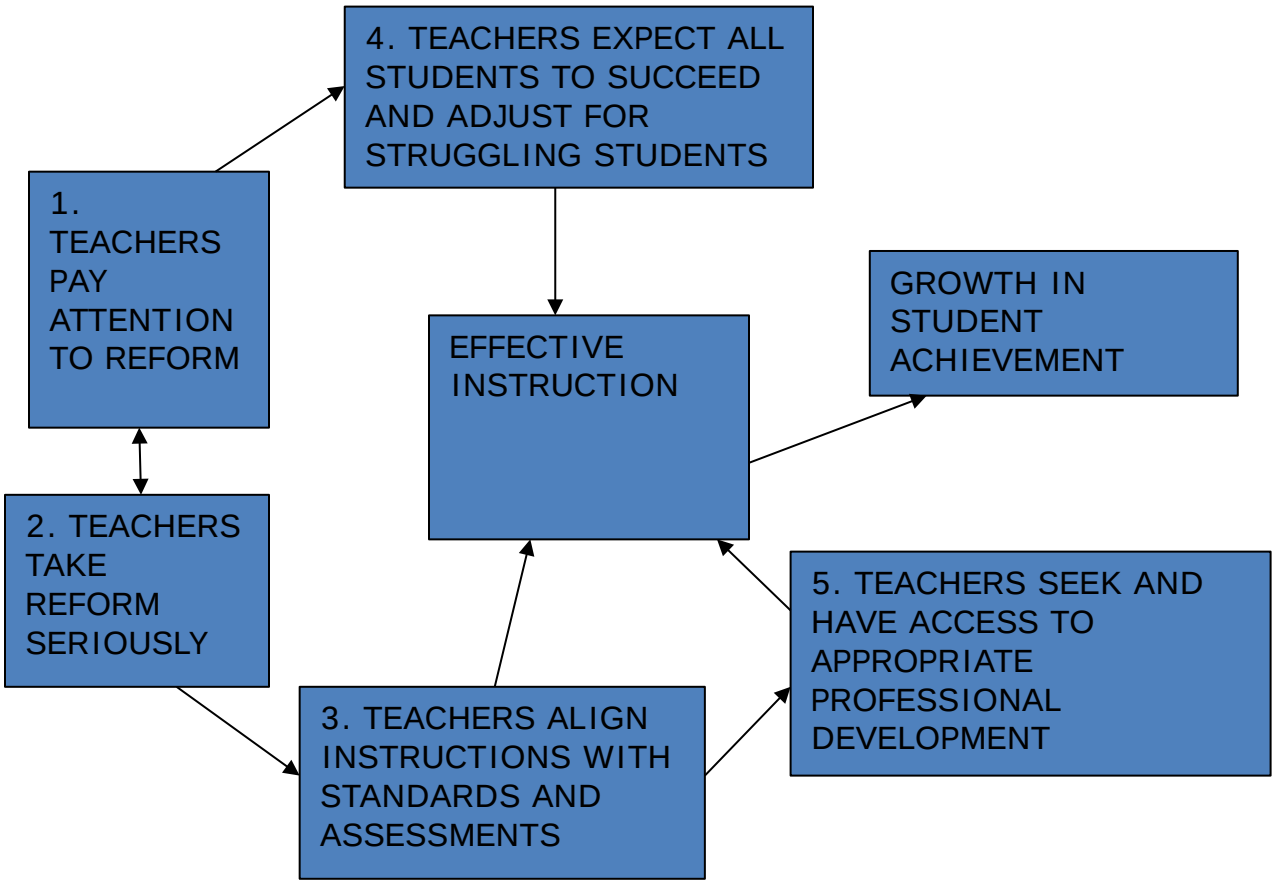
Figure 1 Conceptualizes the influence of standards on learning.



Data were collected as narratives and transformed to standards-oriented characteristics code to helped me identify themes associated with standards-based teaching. This manual process involved coding the responses into a color code that identified teaching with technology, using multiple instructional strategies to facilitate intellectual development, activities that involve active or interactive learning, making connections or experiencing mathematics. I then interpreted these codes into themes associated with standards-based teaching.

Five assumptions known as theories of action were used to interpret and explain how mathematics faculty are aligning their practices with the AMATYC standards. The theory of action is used to describe how mathematics faculty are aligning their instructional practice with standards-based teaching.

Figure 2 conceptualizes the theories of action.



Assumption One*:* Teachers will pay attention to the reform and become familiar with the standards and what they imply for practice (Wilson & Floden, 2001).

The mathematics faculty responses indicate that they have become familiar with the standards through continuing professional development. Along with attending conferences and webinars, the mathematics faculty read articles to stay abreast research in mathematics education.

Carl's comments reveal how he became familiar with the AMATYC standards:

> Well, by going to AMATYC, I know, in fact I've done, um, I've done presentations using Crossroads which are the standards from AMATYC. And uh, I've applied them, um, in the various things, in other words, I've sat down and uh, showed, one of the things I did is

> to show how the online learning system accomplishes these objectives in the Crossroads. So these, all these, all these Crossroad standards are set up, and what's nice about online learning, you can accomplish more of them than if you just used regular traditional instruction, and so I've actually done that, I've gone through and done presentation, I've given it though and given presentations at conferences on how my courses accomplish it with the online learning, and that's why I'm a big believer in online learning, and using online learning because it accommodates so many learning styles, it accommodates the uh, different uh, objectives that you have, and it accommodates the types of, of learning they have to do, you know, from the levels of learning and from Bloom's Taxonomy and so on, so I've, I've been through that whole, whole education drill in looking at it from the standpoint of what does, and when I'm applying it in my course. So whether you know the standards or not, whether you know all the buzzwords or not, it, it's doing it. It's accommodating the students' learning [Carl, Interview].

Assumption Two: Teachers will take the reform seriously, as will their supervisors and other local leaders, who will exhort teachers to meet the demands of the policy, and offer support, as needed (Stecher, Chun, Barron, & Ross, 2000).

Professional growth is the personal responsibility of each faculty member with support from the department, the college, and professional organizations. Professional development activies can be the key to fostering improvement in a mathematics department. Such activities enhance an instructor's mastery of content and knowledge of teaching. By actively participating in faculty development, faculty can be aware of and implement major developments in content, pedagogy, and effective use of technology. Effective teaching is a result of faculty preparation, experience, reflection, and continued professional development (Sparks, 2002).

Alvin believes the best ways mathematics instructors can have access to appropriate professional learning opportunities are via professional organizations and attending conferences.

> Well, I think the best way, ah, especially at the two-year college level is to join the professional organizations like GMATYC and AMATYC. Ah, when I joined AMATYC about ten years ago I was really surprised at the first conference at just how much material there, how much there was to, to learn that actually helped you in the classroom at those conferences. Ah, the MAA conferences are more on research and, and not quite so useful as far as teaching but the AMATYC conference and the GMATYC conference at the Georgia Perimeter College, both of those actually present material that are, you

> know, you can walk out of the, their, those workshops and, and sessions and take that material right to the class and start adapting it and using it. The, it's the best way for a, a math teacher I think to, to improve their teaching skills [Alvin, Interview].

Assumption Three*:* Teachers will adjust their instruction to align with the standards and associated assessments (including preparation for assessment) (Stecher et al., 2000).

Alignment is a key technical matter addressed in the literature. The concept has different constructions. It may specify alignment between standards and assessments, standards and teaching, standards and curriculum, and between teaching and assessments. Any or all of these may be present in specific cases. The evidence is that the closer the alignment between these factors, the better the students achieve (e.g., Clune, 2001; Linn & Herman, 1997; Porter & Smithson, 2001).

Carl incorporates graphing utilities, group learning and learning management systems to facilitate his students' intellectual development. Carl's comments reveal how is adjusting his instruction to align with technological usage as advocated by the AMATYC standards:

> I've always made sure I incorporate, you know, the latest graphic, calculator techniques and the, now, now it's online learning. I'm very much a strong supporter of online learning and I also monitor when new systems come out. There are good systems out there and you just have to know their strengths and limitations and, uh, so, uh, uh I've used them. Now at the university that I teach part-time, we use Math Excel and here at our college I use Hawkes Learning so, but I could use Hawkes, uh, Math Excel here if I wanted to 'cause some of the other instructors use Math Excel but Aleks, um, and some of these other systems, um, they're, they're not as powerful, I think, and so I wouldn't use them and if you wanted to build them it's just a matter of, if you want to try one, you can go out and get the software, usually from the vendors and then try it[Carl, Interview].

Carl's comments reveal how he has adjusts his teaching and uses writing assignments to stimulate critical thinking in the first two years.

> You just have to try these things and I've adjusted through time. I go pick up a technique, uh, you can't do everything, you just take, I take a small piece of it like this critical thinking, it's one of the reasons I wanna go back to the, give my presentation of what I did because it's drastically different from the ideal, you know, uh, and it's not, and it's also applied to mathematics which is different from just critical thinking in general, you

> know. You have to take anything you learned and, and see how and see – you've got, you gotta find out yourself of whether you understood what was supposed to be done and then you try it and then if, and then you have to look at your assessments and see if it's improved your, you know, of improved things. And then, so I continually have done, done that. Okay, uh, well I've, I've got – the main thing I've done this last year is I've added the critical thinking and, uh, I've always used small group learning and I've used the inter, interactive, uh, learning systems of Hawks, so I've been doing that and that's, we, that was a major change in my instruction from what I did 20 years ago. Um, now, I've, uh, group learning has been a long, you know, student-centered learning, they call it group learning, they have called it critical thinking, I mean, all these things have, they changed the, the buzz words but they're all basic on helping the students learn better and, uh, so I, I've adapted my – whenever I've learned a new technique, I've tried it and, um, then I've decided whether I want to keep it or not[Carl, Interview].

Carl goes on to talk about how he has also adjusted his assessments to reevaluate his students' critical thinking skills.

> Uh, I, I modified tests, based on uh, for, for example the critical thinking was one that I uh, I'm, I did. I tried something different based on not having critical thinking and then applying critical thinking. And then I did an assessment, you know, I looked at my, my assessment results, so that was one example. Uh, and uh, then I went back and tried, you know, you try something different, the other thing is, you can reorganize the assessments, when you get bad results in, you do a test and you find out the students didn't do so well on a particular material, then you've gotta find out why. Is it because I, they, they didn't know it, or is it because of the way I presented the assessment? So sometimes I have to modify the assessment. For example, you know, you want the students to know everything, but you only have, they only have so much time during the assessment, so you have to be reasonable, and even if you say, well, I've covered that objective four times, I only need to cover two questions on it, you know, or, or uh, maybe I can use one question with several steps, you know, and I can accomplish the same thing and you know, so, see a lot of times in your assessment procedures, uh, you know what you're, we have what you call your, your learning objectives are, um, and uh, so you, you can accomplish those and you can assess 'em in different ways. So sometimes it's a matter of, of, your assessment was, the way you, the way you assessed it was wrong. Sometimes it's a matter of you just didn't assess it, you know, so you didn't know if, if uh, well, if you, if you fail to include, that's usually rare, because usually your students are over-assessed. And, uh, and the more you can, uh, can tailor that to the student. You can't change how much time they have overall, but you can, you can, uh – I, I've tried things where, in a, in a course where, uh, where we were allowed to just open the course up, say okay here's all the stuff that's due. You can do it any time you want and have it done by the last week, and that's a disaster [Carl, Interview].

Carl goes on to discuss how he uses the learning management system to keep track of student progress and offer interventions if necessary. He discusses adjusting lessons to fit the

needs of his students.

> The most important ways in which you can find out how you're doing and do it. The other thing is just keeping track on the learning system. It makes it easy for you to keep track of understanding what the students are doing because at any given time you can check on the class or an individual student, and sometimes, uh, I'll find out that, uh, the class as a whole isn't doing well on something, and so then I need to give them more time, or I need to make an adjustment or go back over something 'cause you tell by looking – that's one nice thing about the online system is you can adjust things and to accommodate the students so they learn better. And then from term to term you can go back and make changes. And I am continually changing, you know, what I put in a particular lesson, how long or how much time in spend on this, and you're always evaluating [Carl, Interview].

Carl discusses how the online learning system can be used to accommodate the learning style of his students.

> The interactive learning system allows the students to work at their own pace, it accommodates those people that need extra time. And also if I have a student that needs extra time on a test or whatever, if they bring in the, you know, the right forms and everything that says they need that, then I can accommodate them individually, um, with the system. And, uh, 'cause the system allows me to adjust times as the, they need and, and so on [Carl, Interview].

Barry discusses how he has adjusted his instruction to align with student-centered teaching strategies through group work and use of online learning systems.

> That’s been through interact math when I can go online and learn some of the, the assign, learn some of the material for themselves, give them like an assignment where they have to go online and, and do a lot of, do some of the work for themselves and in the group work also. I don’t always explain ever single assignment that they have to do. Some of the assignments they have to go out and, and do a little fishing around, so some of the assignments we do it through assignments and interact math. I make minor adjustments, maybe change the way I write my assignments, um, maybe the way I word a question or if I see that this was, uh, let’s say if I saw that the assignment was a problem I may provide some more supplement material and, and try to make sure that I cover those bases during the next class, and sometime I may try to, I may find new, a new strategy or a new technique or may come up with an idea, then try it in another class [Barry, Interview].

Alvin discusses how he implements changes in curriculum, instructional materials and teaching strategies based on assessment results.

> Well, with the assessment results. What you try to do is if, if you had unit that just didn't seem to function properly then, ah, I take those results and, and one of the things I think I mentioned earlier is I attempt to try to find out or at least guess what kind of thinking caused the students to miss that kind of problem. Is, you know, why did they think this was the correct way to answer it, ah, so that when I redesign that, that section of the course for the next term I, I'll try to, you know, preempt that, that false thinking, ah, by, by finding what significant thing got missed the time before. Ah, ah, some, sometimes I'm pretty successful at that and sometimes the results are about the same. So the next time I figure well, I didn't really figure out, you know, what it was, but I, I've discovered over the years that it, with students if you got a section where they failed for didn't achieve the level you thought. There's usually some very logical thinking going on by the students. It's just not the right thinking. You know they all believe that this is the way the problem should have been worked. They're not just guessing at things, and so I try to find out from my assessment, you know, ah, if I can figure out what type of errors they made, why they made those errors and what type of assumptions and thinking they were doing to lead 'em that way [Alvin, Interview].

Carl discusses how he implements changes in curriculum, instructional materials and teaching strategies based on assessment results.

> Another thing is you'll see is that, on a particular test, you may see a lot of alibis. Okay, I know and you know that because, for example one time the uh, the system went down when, everybody kinda waits 'til the last minute and the system went down just before the weekend and a lotta people came to me and says well, I had a, the system was down and I had to wait 'til the last minute and, and so on, and so I, what I did is, I said, well okay, I'm gonna extend the, uh, the deadline for this, which is nice about online testing. You can say, okay, um, it's, it was due Friday, we'll have it due Monday, now, or due Monday night at midnight, so if you have, you need some more time, now, now if you used all your attempts, you got time to do it, it was just a problem, you didn't do it, if you didn't know what to do, then you've got a learning problem, and then tell me why you were having a problem and we'll see if you can be re-assessed again at a later date. And it's like, it's like I do at a, with a written test. A lotta times you allows students to, to give 'em a retake on a test, and say okay, I'll have a date scheduled for re-testing and if you wanna come in and do that, your grade for this test goes away and then you have to come in and re-take the test on your own again. And so uh, you know, you're continually uh, so, I, I can discuss the results. I, I don't go up and put everybody's grade. I can do that if I wanted to, I could actually display it, but I don't, I don't display the grades. I just tell them that at times, from time to time when I know the class is having a problem, I'll offer additional time or I'll offer a chance to re-do the test and so on, if it was something beyond the student's control. Now if it's something that the student had, I ask them, that's what I have alibi testing, if it's something that they in particular, like I said, well I was in the library and I was working on it, and I have this note from the librarian that said, you know, that the system went down when I was doing this. I said, okay, well that's good, that's a good reason. All right? So next week when I have alibi testing on this test, then you give that to me so that I can go back, in fact that's what I'm gonna be doing tonight.

> I'm gonna be going through all these alibis and looking at all the re-do tests that people did last week. [Carl, Interview].

Assumption Four: Teachers will expect all of their students to succeed—and believe that they are capable of succeeding (Orfield & Kornhaber, 2001). Where students are likely to struggle, teachers will adjust their teaching practice to maximize the students' chances of success (Kannapel, Aagaard, Coe, & Reeves, 2001).

Alvin discusses how he exhibits that he has high expectations for all students.

> Well it, it simply is, ah, I, I don't allow, ah, anything except the best work from anyone, ah, and I don't allow, like, ah, the first day of class I tell all my students when I call on somebody I don't allow, I don't know or refuse to answer, ah, because sometimes we learn more from wrong answers and finding out why it's wrong than if everybody just, you know, memorized all the right answers. So my main thing is I just refuse to accept anything but accept their best effort and if they tried not to, ah, participate then I just keep asking 'em questions doing it. Sometimes I think they give up and figure well if I don't answer his question he, he'll keep at me, but, ah, I just, I, I, ah, enforce my standards by simply not accepting anything less than that [Alvin, Interview]

Carl discusses how he exhibits that he has high expectations for all students.

> Basically I tell them the, uh, the standards. Uh, I tell them the, uh, the standards. Uh, I tell them that, uh, they have to meet the standards, uh, you know, the, the goals and objectives of the course. That they have to – and I expect them to meet those. Also I tell them the goals. Like on the homework they know that they have to complete 80 percent to, to successfully certify a homework before they can go to the test. They have to, they have to complete 80 percent, you know, at the 80-percent level of the homework. And, uh, and then of course their grading systems, uh, they're told, you know, what they wanna do to get A, B, C, so on and, and that's, uh, pretty clear, uh, based on the writing and everything else. And at any given time, uh, the students can check their, uh, uh, can check where they're at on a progress report throughout the course because that every time they do something it's, not only is, is, is what they do recorded, but also the amount of time they spend on it. And, uh, the, and then of course if I want to send them – we've got the, the normal things you can do like send them announcements, uh, send them connect messages and so on. Um, if, if you, uh, and then, and, and, and using – and also simultaneously when you're doing, uh, when you're teaching the calculator, I mean you're, you're explaining to them how their, you know, you show 'em the long way to do it, and then you say you gotta a choice, or you can do it the long way or you can do it the technological way, and, uh, you get the same answer. So, uh, but, uh, you know, **** it's not just putting numbers in. You have to understand the concepts. The computer can do the arithmetic and it saves you time there. But, uh, but you still have to understand the

concepts of what to put into the formulas whether you do 'em by hand or whether you do 'em on the calculator. The biggest thing the students need to, to, to know is that the vocabulary that is associated with anything that's technological. Statistics and, and mathematics have terms that they have to know. sometimes this, the writing assignment is just to, to take something in English and translate it into something, uh, mathematical, like, uh, at least, at most, uh, between, you know, these are quantitative reasoning skills that the student, students a lot of 'em fail to have when they come to college. They, they, and, and then I'm continually, uh, finding that I have to teach, uh, you know, I have to go over those types of things so that they can understand how to, you, you know, technology wants you to input something in a, in a symbol form, but you, unless you know how to do a less than, greater than, uh, not equal, things like that, uh, and how, what's the English for that. You know, so at least, at most, uh, has to be translated into a technological symbol. So that's one of the biggest challenges is to – and also how do I recognize what the problem is? For example, if I ask you how many, I'm looking for a number. If I'm asking what part, I'm looking for a percentage or I'm lookin' for a proportion. If I ask you to tell me, a, uh, a specific value, then, you know, these are – I key them in on these types of things because in real life, um, you're asked questions like that and if you don't know, uh, how, you know, those words have meaning as to what you're looking for, then, uh, you don't know what to do technologically [Carl, Interview].

Barry discusses how he exhibits that he has high expectations for all students.

I let ‘em know that, well, you know, that learning is important. I also let them know when I give them their tests back that they all, they can go visit the computer, the tutoring center that we have. They can also ask me for help and that, I tell ‘em that whatever the grade they get that’s the grade they’re gonna have and so if they want their desired grade they have to work for it [Barry, Interview]

Carl discusses how he is sensitive to the impact of mathematics anxiety on students.

Well, I, I talk about, you know, that, where I think they're gonna have problems, and particularly in the online learning, and um, try to overcome their fears that you don't have to be a uh, a genius to be, to be good at math, but you do have to invest time, so I said, if you don't have the time, you're gonna have problems. You know, so then the anxieties is, is gonna be with you making sure that you can schedule enough time to do this course. And that's, you know, if, when a student comes in and wants to withdraw, one of the things I always do, they have to have a reason for the withdrawal. And they say, well I just can't do the work. I said, no, that's not good enough. You can't do the work because? And what's different now than when you started the course? And so most of the times I'll get them to admit, well they had a change in their job and they don't have the time to ****, or now they, there was a family problem that they had, that takes some of their time. I said, well that's fine. I said, what you've gonna, you know, it's a good reason, but the same thing in the beginning of the course, you can tell 'em, you know, if you don't have the time, if you can't organize your schedule, you're gonna have a problem. That's usually the main, the main things students, uh, uh, and I told 'em also,

> will relieve a lot of uh, stress that you have. If you can't provide the time for anything in your life, it's gonna make str-, it's gonna be stressful, if you don't plan for it. You gotta plan for it [Carl, Interview].

Carl offers strategies to minimize the students' mathematics anxiety and develop confidence in mathematics.

> Okay, uh, well, I mean, part of that is just, is, is talking about it. The other part of it is the system itself, uh, accommodates different learning styles, so they uh, they can come to me at any time, now I, when I have a help day, they can come in, you know, and a lot of students take advantage of that, and if I, if I have a student that's got a lot of, say, they're having anxiety but I don't see 'em, and they don't come for help, then I basically say, you know, you need to come see me and get some help. And then the students that start coming for help, they realize that they can get help, and they realize that the help is gonna, you know, relieve their stress, and a lotta times they'll find, wow, I just, just need a little ole help getting over this new learning. And uh, so uh, the strategies that are used are offering the opportunities to the students, and I'll tell you, we're in a modern world. You, you have to take advantage-, there's opportunities, I can give you the opportunities, but you have to take advantage of 'em, and then I, and um, and once you get them to do that, then they develop the self-confidence. And once I, once I get students coming in for help, they continually will come in for help. And, but a lotta time is getting them to understand, a lot of 'em are just in a course and think that they can just uh, not get help when they need it. Um, you know, when you get stuck on area, you've got to get help, and um, and of course, if you practice, you know, if your math skills are, are such that, you have students that are coming into the college algebra, for example that have had calculus already in high school, and so they've already had good math skills, they just, they are in there coasting, you know, and, and, you see that on the online courses. These are the students that got all their homework done way in advance and they're waiting for you to put the test online. You know, so I mean, you've got all different types of people in a, in a class, and uh, and, and these are the students that actually like online learning. They like it because their time, they, they know that, they wanna spend as little time as they have to because they, they understand a lot of the material. But then the students that – Didn't spend a lot of time, then they're the ones that, that need that, that extra help. They need to be encouraged to come in and get help, and that's not always easy to do. 'cause with today's non-traditional student, they've got about a zillion things goin' on [Carl, Interview].

Assumption Five*:* Teachers will have access to appropriate professional learning opportunities (Dutro, Fisk, Koch, Roop, & Wixson, 2002; Thompson & Zeuli, 1999). What is more, those teachers who are not fully prepared to teach to the ambitious learning standards, if

not others, will take advantage of these learning opportunities, thereby developing the requisite knowledge, skills, and commitment, and their teaching practice will improve accordingly.

Carl discusses the different ways that mathematics instructors can have access to appropriate professional learning opportunities.

> Uh, well, they can go to, uh, they can go to their boss and say I'd like to go to a conference. They can go online, there's all kinds of, of uh, web, webinars that you can go to and, uh, you could, and, uh, I have a sketch of, uh, cites that I provide to my students. For example, if they need help on a graphics calculator, uh, they have Ask Mr. Math, uh, you can do the same thing yourself –um, and, and particularly if you, you want to expand your use of technology. There's so much out there it's hard to, uh, hard to decide what you want. Sometimes you just say no, I'm not, I'm just not gonna go there because, uh, I can't do everything, you know [Carl, Interview].

Barry discusses ways that mathematics instructors can have access to appropriate professional learning opportunities.

> Uh, mostly the, mostly what we do is through AMATYC and GMATYC and we have access to also, um, NADE and GADE and sometime we may send a person to, to one of those conferences. Mostly to national conferences, I've just been attending the conferences. I haven't made any presentations or, or wrote any articles of that nature. I, I basically kind of just participate in the discussions and the workshops at least twice a year and, and met, mostly we just kind of read and read along, read some books. Sometimes they give us, the college has given us some other books that we've read along the way and to kind of help us keep abreast on our students' learning and different things we need to be aware of [Barry, Interview].

Alvin discusses how he stays abreast of new research in mathematics and mathematics education.

> Well, online makes it easier than it used to, ah – but I, I attend, I attend as many conferences as I can. In fact, you know, I'm, I'm getting ready to go to, ah, Austin for the AMATYC conference, ah, next week, and I usually attend, ah, the MAA conference, the AMATYC conference and the, ah, GMATYC conference in, in, in Atlanta, ah, those three I attend every year and, ah, ah, ah, every couple of years if I can find the time and the money I try to take a course just, just for the fun of it, especially now that I'm getting' close to being a senior citizen it's, it's cheap. Ah, the State of Georgia let's, let's me do it free if there's room in the classroom, so. Ah, but I, I try to take courses just to see, you know, what's, what, ah, my students is I teach at the two-level are, are actually gonna look forward to but, ah, I try to get as many conferences and, and do as much online

seminars as I can. Well, I, I attend their conferences and I also try to do a presentation at least once, but generally I make it about twice a year, ah, either at a local or regional conference [Alvin, Interview].

Carl discusses how he stays abreast of new research in mathematics and mathematics education.

Oh, I read things, I go to, I go to the uh, two conferences. I go to the Georgia Perimeter Conference in Atlanta in February, and I attend the national conference in, in uh, in the uh, wherever it's scheduled in the United States, so this year, next year, this next one that's comin' up is gonna be in Jacksonville and then I've also uh, attended the Critical Thinking National Conference, so through conferences and uh, primarily and then primarily and then reading, professional reading and uh, you know, when you pick up literature and you pick up new ideas and new types of uh, vendor software. That's how we got involved with Hawks, uh Mr. **** and I liked it and then we decided, we went to our boss and said we wanna try it and now we're using it. And the same thing with Math Excel. The other instructors like Math Excel, so they're using it in their uh, and they, and they like the grade book, and so that's how you do, you pick up these things at conferences and then you try 'em.Uh, I've, at, at most of the conferences uh, I've given, at several of the conferences I've given presentations in uh, things that I've tried or done, and uh, and I'm planning to give one um, at the uh, in critical thinking at the Critical Thinking National Conference-, I didn't get to, I had my heart surgery and was all set to do that last fall-summer, and then uh, I didn't get to do it, and I'm gonna use that presentation as the trial here in April at, at College forum. I've given it at college and it was well received, and now I wanna do it, uh, to the, because these guys are different. They're not mathematicians, so I wanna give 'em my take and what I, how I use their stuff to enhance my math, the critical thinking, and see what they think about it, though they might say, well you're just a old infantryman slugging around in the dirt, and you really don't know what you're doin', you know[Carl, Interview].

Carl discusses his participation in professional development activities.

You don't, you don't use any of the terms or anything that we did, but you think, you maybe think you're successful but you're not, or you were successful, you just didn't use the terms we use, you know, so, so that's, so that's what you do. You go, you go to these meetings and you give a presentation once in a while and um, and uh, so that's what I did, and also, you, by attending the uh, the things you're active in the, I'm active in GMATYC and, and uh, I'm on some of the committees, like the statistic committee and things like that, so, so I have uh, I have also helped out from time to time in some of these things.[Carl, Interview].

Table 2 Contains the faculty responses to theory of action assumptions.

Table 2 *Summary of Faculty Responses to Theory of Action Assumptions*

ASSUMPTIONS	FACULTY RESPONSES
TEACHERS PAY ATTENTION TO REFORM	BECOME FAMILIAR WITH STANDARDS
TEACHERS TAKE REFORM SERIOUSLY	PROFESSIONAL ORGANIZATIONS & ATTENDING CONFERENCES
TEACHERS ALIGN INSTRUCTIONS WITH STANDARDS AND ASSESSMENTS	TECHNOLOGY USAGE & CRITICAL THINKING
TEACHERS EXPECT ALL STUDENTS TO SUCCEED AND ADJUST FOR STRUGGLING STUDENTS	MASTERY-BASED LEARNING, BEST WORK,
TEACHERS SEEK AND HAVE ACCESS TO APPROPRIATE PROFESSIONAL DEVELOPMENT	CONFERENCES, READ ARTICLES, ADDITIONAL GRADUTATE STUDY

It is of interest to note that ages of Alvin and Carl have a great deal to do with their experience and awareness of standards-based teaching.

Next, I answer the research questions based on what I deduced from the participants interviews.

Research Question #1 What alignment exists between two-year college mathematics instructors knowledge and the instructional standards published by the AMATYC Beyond Crossroads?

Alvin's comments reveal what he feels the alignments are based on instructor knowledge and awareness AMATYC standards:

> Well, I, I think the, ah, the, ah, AMATYC Crossroad has now become, ah, the standard that, ah, most of the, ah, two-year college teachers I know, ah, try to strive for. Ah, I think the coordination, that, that, that's, the campuses I have visited and instructors I have visited at other schools, the, there seems to be, ah, a major push to try to get their departments and their schools to, ah, wholeheartedly accept the concepts of, ah, of the Crossroads. Ah, I, I personally think that, ah, you know, the, the closer you can do things to, ah, student-centered learning and following the Crossroads approach, the, the more your students are gonna learn.[Alvin, Interview].

Barry's comments reveal what he feels the alignments are based on instructor knowledge and awareness of AMATYC standards:

> Okay. Some of the things, well mostly what I've been learning from a lot of the

> conferences I've, I've been, ah, attending is using a lot of real world data, so a lot of that I kind of start to incorporate. I think a lot of our students always want to know where are they gonna ever use this stuff so a lot of times I like to bring in data from the outside or, or basically the Internet if we can find it [Barry, Interview].

Carl's comments reveal what he feels that he aligns to AMATYC standards to accommodate student learning:

> Oh, okay. Well, I, I think that, uh, I've done that and, and uh, and in applying the standards I think what's happening is the vendors are not, uh, sitting out there oblivious to what's goin' on, so when they're hocking their wares they're accommodating, they're saying my system can do this, and a lot of times you've been doing these things. Uh, that's why I say that, you know, that you just don't know you're doin' so it, so what you do is, is uh, you go out and you do an examination, um, of, of Crossroads, which I've done, and then I do examination of a particular course and then say I'm doin' these things, you know, so, and, and, and, and if you're not doing 'em, then that leads you to, um, you know, so, to change. And so that's what I did. One of the presentations I had a couple of years ago was when Crossroads was, uh, was big, when Beyond Crossroads was big, I took all the, one of the things was how am I accommodating student learning. That was a big thing and, and how do you accommodate the different styles of learning, and so, uh, I went through and I, I did an assessment of my courses and they were doin' it, and a lot of times you already are doing it, it's just a matter of you have to be able to verbalize it. You have to be able to say to someone I am doing these things, I've always been doing them, and most good instructors, most good professors, people who teach, are doing them, um, if they're being successful, and once in a while they're not doing, maybe they're not doing an aspect of it that could improve the instruction like the critical thinking, which is, uh, the questioning and some of that that I just tried recently, and then before that, uh, using, taking advantage of online learning. You know, so as soon as I took advantage of online learning then, I mean, the interactive learning I mean, uh, you might wanna call it computer aided instruction, CAI, and as soon as I took advantage of that I added it all, a lot of these things at Crossroads, uh, and then the critical thinking added another dimension to, uh, what I'm doing in terms of, uh, being able to accommodate student learning. So uh, I would say that, uh, I feel my courses are, 'cause I've done the, I've done them, the uh, assessment, I've done the analysis. I think my courses are well aligned. I can only speak for me. I can't speak for another instructor 'cause they would have to do that same analysis themselves, but I would say that the, uh, having got, having been told what Crossroads says and being aware what's in Crossroads, and having been to conferences and then having to go and assess my own performance, uh, I can say that I was greatly affected by the, by that. So if the question I guess is, uh, what alignment exists between 'em I say, I think that if professors are knowledgeable of the Crossroads and they are given some incentive to apply them, uh, then they'll do that assessment, or not only apply them but to assess themselves, then they'll apply them. But it's just like anything else. If you are out there, uh, I've known people who haven't changed the way they teach for 20 years [Carl, Interview].

Research Question #2 What are all the components that characterize the instruction of practices of two-year colleges.

Carl's comments reveal what he feels are the most salient practices in the first two years:

> I would tell them to, if it's mathematics was, uh, required to have a technology to make sure they were familiar with how to use, in particular in their text, how the text tells the students and how you tell the students how they're gonna use the TI84 calculator, you know, that technology. If you were going to like use, uh, the uh, Excel, in the spreadsheet Excel, you know, like you know, you have Office Excel and you're gonna use that, uh, to teach statistics or some other, you know, some type of spreadsheet approach, then uh, you need to be aware of, you know, you need to know in the book, uh, and be aware of what, you know, what you're gonna do. If you're teaching for example in collegiate math right now at the university, I'm going through a relearning process of how I'm gonna teach the simpler method. Uh, in the past I've gone and downloaded a program in every, you know, every student's calculator and let them run the program, but I'm, I'm thinking that, uh, an alternative approach is to just have them set the matrices up and then run the things that are just standard to most, the RR, reduced role matrix and things like that. So if you're, in terms of, uh, instructional practices that's one of the things that. You see, the other thing is, if, if an institution is emphasizing something like critical thinking, uh, what I would do is I would talk to the new instructor and say look if you never tried this, try some things like discovery learning. Uh, try some things like questioning, uh, written assignments on questions. Here's how you would, uh, uh, you know, here's, this is critical thinking and here's what I mean in layman's terms, you know, here's how you can use critical thinking and this is what I do. I ask questions about vocabulary, I ask questions about procedures, I have the students research questions that are answers to things, uh, on these various things. So uh, so that, that would be one of the things, the main thing that probably not right in, in um, in the AMATYC standards that I would, I would say tell them, look at the critical thinking aspects and, uh, and you know, discovery, proper learning, uh, and, and, because that's an area where a new instructor might – you know, a lot of our instructors we got that are coming in putting an adjunct, they taught in high school and they do whatever they've been doing before, you know. Some of 'em are very well versed in those things because they use them in high school, but some of these instructors you have been around for 20 years they're not gonna change no matter what. So um, unless, unless you, uh, provide some way of showing how their life can be easier and our students can learn better [Carl, Interview].

Alvin's comments reveal that student confidence is important on getting students to persist and succeed in the first two years:

> Well, the most important one I think, ah, for, ah, two-year community colleges like, like, like Georgia Military College is that a, ah, a real concern, ah, for, for the students' wellbeing, ah, students will most often come to community colleges, ah, not only have a, ah, a light background in mathematics, but they basically come from environments with

> no experience at, at colleges, you know, they, they may even have, be the first person from their family to have ever thought about attending college or even gone, and so they really have no idea what, you, you know, what's going on, and, and teachers to then, you know, not, not only know their mat, materials, not only be able to teach math, ah, ah, but they need to be able to understand that the, the student may need a little, a little extra, ah, TLC, ah, to, to fit in and to do the work and, ah, the main thing is, is to be able get them past the point where they're, they're sure they're gonna fail. Ah, I've, I've seen that for so many years now; the students show up and, ah, on Day 1 they've already figured well I'm gonna fail this math course, ah, because of prior experiences and so math teachers at that level need to be able to take, you know, a student and say, ah, and, and convince them that they are capable of, ah, learning mathematics. [Alvin, Interview].

Alvin's comments reveals that he feels that mathematics faculty are aligning their teaching to the AMATYC standards in the first two years:

> Well, I, I think the, ah, the, ah, AMATYC Crossroad has now become, ah, the standard that, ah, most of the, ah, two-year college teachers I know, ah, try to strive for. Ah, I think the coordination, that, that, that's, the campuses I have visited and instructors I have visited at other schools, the, there seems to be, ah, a major push to try to get their departments and their schools to, ah, wholeheartedly accept the concepts of, ah, of the Crossroads. Ah, I, I personally think that, ah, you know, the, the closer you can do things to, ah, student-centered learning and following the Crossroads approach, the, the more your students are gonna learn [Alvin, Interview].

Research Question#3 What relationship exists between the alignment of two-year college mathematics faculties instructional practices with Beyond Crossroad, would you say a strong, fair or weak?

Alvin's comments reveal that he feels that there is a strong relationship between faculty instructional practice and AMATYC standards in the first two years:

> Oh I think very strong. Well, I think that, that it, it's strong because the, ah, the math teachers at the two-year level have, have realized when, after they've, ah, read the Crossroads and thought about it that, ah, the principles, ah, expressed in the Crossroads are what's needed in order to be, ah, get our students to be successful, as I think they find out they're doing, when you're, when you're doing your assessments and, and you're evaluating not only the class but the programs, I think, ah, more and more instructors and schools are, are making their assessments with the Crossroads and Beyond Crossroads documents in mind.[Alvin, Interview].

Barry's comments reveal that he feels that there is a fairly strong relationship between

faculty instructional practice and AMATYC standards in the first two years:

> Um, I, I think it's fairly, I think it's fairly strong. I, I think so. I think there's a lot of the practice that we use it ****. I believe the students are improving along the way. Um, we just have to keep, keep, um, plugging away until we figure out a way that would get a lot of the students to learn, especially like the in, the, um, more sort of what, the Internet, the web-based and the, the learning center that we're now, that we're now implementing over here where the students can use, we tie in a lot of the web based and the real world type material. I think a lot of them now will, they, they kind of see where they actually can use it so I bet that keeps the students motivated [Barry, Interview].

Carl's comments reveal that he feels that there is a strong relationship between faculty instructional practice and AMATYC standards in the first two years:

> Beyond Crossroads is very detailed because you've got all those learning styles, accommodate learning styles, you got all those things that are – now, it's great for an analysis of how you're doing, I mean, now more awareness is be given in assessing your own class using Beyond Crossroads standards. You could have some presentation of what's in Crossroads and then like any other tool you could use it to self-assess yourself like I've done in uh, in uh, giving presentations. And, and that's why it's a great thing in AMATYC to say okay, uh, how does this – see, Crossroads is good if you, if you make the assumption that Crossroads has the, uh, has the right standards and is a way that you can go throughout the United States, and then, uh, you say how does what I'm doin' in learning stack up with Crossroads. So I've done that, I show that, uh, by adopting standards that I do all these things. I can accommodate the learners, I can do all this kind of stuff that's in Crossroads. And I think that if you wanted to you could make more of an awareness about standards. but it's a good way to assess yourself as an instructor am I, am I doing critical thinking, am I assessing the learner, am I doing this, am I accommodating the learner, okay? You, there's some nice sets of words that are in Crossroads that allows you to take a look at yourself and say yeah I'm doin' all that because that's what I found is that I'm doin' all that, I just never knew how to verbalize it. So I think that the instructors just –they need to be made aware of what's in Crossroads. We're not, we're not twisting your arm and saying make your course like this, but whenever you're asked about all these type of buzz words that people are having, um, you know, you can go to Crossroads and you can find, uh, a little self-confidence that you're doing all these things you just didn't know it, and uh – a way of, of, of just verbalizing the types of things you can do in a course, and as a checklist you don't have to do all these but can I do this one, my course does this one, or maybe I do this in statistics more and I do this one in algebra more and in calculus I do this one more. I would think that most courses if you did the analysis would be aligned. I go to AMATYC and I go to GMATYC and I've read Beyond Crossroads and I looked at in detail and I've analyzed what I'm doing and compared it with the things that are in Beyond Crossroads. I think they, I think they are accomplishing the Crossroads standards. What they need to do is if they knew what Crossroads were and they spent some time analyzing it, Crossroads are a good set of standards to say okay at your college here's a set of standards that were

> developed nationally, uh, why don't you just have your math instructors see for themselves if they do things that meet these standards. And most of the time they are. They're just gonna go – that's what I did is I listed them and then I put, I put examples off to the right. That's all I did in my presentation, I said okay here are the things that Crossroads says, here's, here's how I do it in a – I did it three ways. Here's what Crossroads says, here's how I did it in a traditional class without online learning, and here's how I did it with online learning, and see where I added all these additional dimensions that I didn't have before. Now, you could, you could do the same thing by adding critical thinking. You say okay I added, uh, or I added group learning. Now, you could do the same thing and – because there's all kinds of ways to teach and everybody says this is but if you wanted to do an assessment of yourself and if you wanted to have a comparative assessment, uh, you could have, uh, people from any college can use the Crossroads as a set of standards for comparison, you know, and um, and that's what I did is I assumed that, you know, Because I've done an analysis and I know it. When I give presentations I did a couple of years ago, the first thing I did is I said well I've been to this conference and I learned these standards and I listed 'em, and I said if you accept those standards then here's what a traditional course did, and when I added online interactive learning this is what it added, what dimensions I added to my course work. So uh, so yeah, it's a framework. Crossroads is a framework from, which you can discuss standards. Crossroads was, was – a lot of work went into developing that but I don't, if you take the number of people who are, are AMATYC and GMATYC oriented - they know what goes into good instruction because most every math instructor has been told by their boss to go to some kind of professional development thing. Now, I can take a lot of things that you, we call critical learning or critical thinking and I can go back in my memory as to when I was told the same things in small group learning, I was told the same things in manipulative learning, and I was told the same things in, you know, as far as what I'm doing to help student learning, and um, you know, so that's, that's all – you know, what is the goal of going to all these things is to help, you know, you be a better instructor, better, and students learn more, you know, so – some people just have always been outstanding instructors and they never knew it. But they did all those things that made the instruction strong and made the students learn [Carl, Interview].

The participants interviews revealed that there exist a strong relationship between instructional practice in the first two years with the AMATYC Standards. Professional development is a key factor in aligning instructions with AMATYC standards. The interviews revealed the participants' technological usage, their use of multiple instructional strategies, and their use of a variety of classroom activities to facilitate student achievement. I added a fourth area titled Professionalism as the clustered data revealed that all participants had comments on their professional learning and its impact on their teaching practices. I will interpret these results

in the next chapter. Table 3 Contains the faculty responses to research questions by participants.

Table 3 *Mathematics Faculty Responses to Research Questions by Participant*

PARTICIPANT	ALVIN	BARRY	CARL
RQ#1 ALIGNMENT	STANDARDS TO STRIVE FOR MAJOR PUSH STUDENT-CENTERED LEARNING	PROFESSIONAL DEVELOPMENT ENHANCES STUDENT THINKING	ACCOMODATING DIFFERENT LEARNING STYLES CRITICAL THINKING CROSSROADS GREATLY AFFECTED TEACHING
RQ#2 PRACTICE	SMALL GROUPWORK STUDENT BACKGROUND & CONFIDENCE	MANIPULATE STUDENT LEARNING WEB-BASED REAL WORLD PROBLEMS KEEPS STUDENTS MOTIVATED	TECHNOLOGY ALTERNATING APPROACHES EMPHASIZING CRITICAL THINKING DICOVERY-BASED LEARNING WRITING ASSINGMENT
RQ#3 RELATIONSHIP BETWEEN ALIGNMENT & PRACTICE	STRONG GETTING STUDENTS TO BE SUCCESSFUL EVALUATING CLASS/PROGRESS	FAIRLY STRONG CONSTANTLY CHANGING TO FIGURE OUT STUDENT LEARNING	STRONG USE CROSSROADS TO SELF-ASSESS MOST GOOD INSTRUCTORS ARE USING STANDARD-BASED TEACHING TO IMPROVE INSTRUCTION

In this next section, I report my findings from the survey data and my analysis of their responses. I discuss how the survey was utilized in relation to my study. I organized the survey results by dimensions of standards-based teaching.

QUANTITATIVE ANALYSIS

The survey instrument consisted of 20 items and addressed all dimensions in a standards-oriented environment. The nine dimensions of standards-based teaching include program scope, student tasks, discovery, teacher's role, manipulative and tools, student-centered interaction,

student assessment, teacher's conceptions of mathematics as a discipline, and student confidence (Ross et al., 2003). The instrument based on these 20 items addressed all nine dimensions with between 1 to 3 items for each dimension. About 35% of the items were negatively worded to guard against response bias. The 20-item web-based survey took teachers about 15 minutes to complete.

The survey identifies four levels of implementation from traditional teaching to full implementation (with two intermediary levels) of standards-based teaching. I selected disproportionally from those mathematics faculty that ranked in the full implementation of standards-based teaching because I was more concerned about teachers overestimating than underestimating the extent to which they were implementing standards-based teaching. Three mathematics faculty scoring in the top quartiles of the standards-based teaching survey were invited to participate in interviews. Each two-three hour interview session was audio-recorded, and the audiotapes were used to transcribe the data and compile detailed notes about the interviews. Codes were used to identify the source of the data (Surveys [S] or Interviews [I]) and mathematics faculty identification (Alvin [A], Barry [B], or Carl [C]).

A categorical analysis was used to describe the knowledge and skills necessary to teach in a standards-oriented environment. Standards-based teaching in the first two years will be organized by the nine dimensions in a standards-based environment. The mathematics faculty were asked to respond to twenty true-false questions on the web-based survey. The twenty items on the survey represent various dimensions of standards-based teaching and each item was used to analyze the mathematics faculty responses on commitment to standards-based teaching in the first two years of college.

Next, I will synthesize the survey responses based on the faculty responses on the nine

dimensions of standards-based teaching. I describe in detail full implementation of standards-based teaching in each dimension contrast with traditional teaching in each dimension.

PROGRAM SCOPE

Full implementation of standards-based teaching has the view that all students are enabled to complete high level mathematics problems. Traditional teaching views only those who have mastered basic operation as those who have the opportunities to learn higher mathematics. Survey items 4, 13, and 16 were associated with program scope.

76% of survey respondents responded true to item #4. I tend to integrate multiple strands of mathematics within a single unit. 62% of survey respondents responded true to item #13. In my class it is just as important for students to learn data management and probability as it is to learn multiplication facts. 87% of survey respondents responded true to item #16. I like my students to master basic mathematical operations before they tackle complex problems.

The participants reported they have high expectations for all students. Alvin, Barry, and Carl all use mastery-based learning management systems to engage their students in student-centered learning. Alvin reported that he accepted nothing but their best effort. Barry reported that if the students wanted a particular grade that they would have to work for it. Carl reported that he let his students know that they have to meet the goals and objectives of the course and he expected them to meet them. All participants required 80% successful completion of homework before moving on to the next section or before they could move on to be tested.

The participant used technology to engage dynamic learners who like to learn by exploring and discovery. The participants reported that the web-based homework provided multiple attempts until success was reached and students could see errors immediately and seek additional tutoring to correct answers.

The survey respondents indicate that most mathematics faculty felt that ensuring all students have access to all forms of mathematics is a necessity of teaching in a standards-oriented curriculum. It is vital that the mathematics education community define effective teaching to include not only content knowledge and skill in managing the classroom environment but also expertise in developing and nurturing student, family, and community relationships. Effective teachers and leaders infuse their instruction with culturally relevant and engaging mathematics tasks that are rigorous, yet accessible (Gutiérrez, 2008).

All students should have equitable access to high-quality, challenging, effective mathematics instructions and support services. The mathematics education community must reach out to all students. Active participation of all students in mathematics and the pursuit of mathematics-intensive careers by many are critical goals of our society (AMATYC, 2005).

STUDENT TASKS

Full implementation of standards-based teaching assigns real life problems with multiple solutions. Scaffolding is exhibited to enable all to complete high level mathematics problems. Traditional teaching encourages students to follow a particular procedure to solve particular problem types. Survey items 1, 2, and 11 were associated with student tasks.

97% of survey respondents responded true to item #1. I like to use math problems that can be solved in many different ways. 73% of survey respondents responded true to item #2. I regularly have my students work through real-life math problems that are of interest to them. 87% of survey respondents responded false to item #11. When students are working on math problems, I put more emphasis on getting the correct answer than on the process followed.

The participant, Alvin, used active and interactive strategies to engage reflective learners who are quiet and likes to work alone. The participant reported using active and interactive

strategies to engage active or social learners who like to interact with others. Alvin reported using group work run by students to lead classroom discussions and writing assignments to promote critical thinking. Barry reported using interactive working groups to promote in class discussion and used real world data when interpreting mathematical models in the class. Carl reported using interactive group learning to stimulate small class discussions, writing assignments to stimulate critical thinking, and used online chat rooms to promote interaction outside the classroom. All participants used a variety of instructional strategies to encourage active student learning and address different learning and teaching styles. The participants reported using various methods to scaffold or support student development.

The survey respondents indicate that only few mathematics faculty agree that student tasks be complex, open-ended problems with multiple solutions. This question was the only area where faculty did not agree with implementing complex solutions for student tasks. The survey respondents indicate that the faculty preferred to use basic problems before they tackled complex problems.

Quantitative literacy should be integrated throughout the mathematics program and the college curricula. Quantitative literacy is the "capacity to identify, understand and engage in mathematics as well as make well-founded mathematical judgments about the role that mathematics plays as individual's current and future life as a constructive, concerned and reflective citizen" (OECD, 2003). Students' insight and skills solving quantitative problems in context should be developed throughout the entire college curricula (AMATYC, 2005).

DISCOVERY

Full implementation of standards-based teaching has a focus on student thinking including open ended questions, wait time, follow up probes to elaborate student ideas and has

student guided discussions. In traditional teaching, the focus is on the transmission of accepted knowledge and teacher-defined procedures. Survey item 14 is associated with discovery.

55% of survey respondents responded false to item #14. I don't necessarily answer students' math question but rather let them puzzle things out for themselves.

The participant used using active and interactive strategies to engage dynamic learners who like to learn by exploring and discovery. The participants used technology as a tool to help students discover and understand key mathematical concepts. Alvin reported using multimedia like the TI-84 graphing utility for computer simulations. Barry reported using interact math to engage his students. Carl reported using computer aided instruction to engage his visual learners and auditory learners.

The survey respondents indicate more than half of the mathematics faculty lets students puzzle things out for themselves rather than answering students' math questions. Teachers can inhibit student learning by giving solutions prior to letting the student using their prior experience to solve discovery-based problems. Discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships and new truths to be learned. Students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments. As a result, students may be more likely to remember concepts and knowledge discovered on their own (in contrast to a transmissionist model) Bruner (1967).

TEACHER'S ROLE

Full implementation of standards-based teaching involves creating a math community. The teacher presents their self as co-learner with students. In traditional teaching, the teacher is

the sole knowledge expert. The survey items 5 and 17 were associated with teacher's role.

76% of survey respondents responded true to item #1. I often learn from my students during class because my students come up with ingenious ways of solving problems that I have never thought of. 93% of survey respondents responded true to item #2. I teach students to explain their mathematical ideas.

All of the participants had a goal of creating math communities where students could exchange and discuss mathematical ideas. Alvin and Carl used chat rooms to facilitate discussion outside the classroom during the class week and during weekends. Alvin reported be available to students six days a week. The participants expected all students to use the language and symbolism of mathematics to communicate effectively with other students and co-learners.

The survey respondents indicate that most mathematics faculty felt that the teacher's role is that of a co-learner rather than sole knowledge expert in a standards-oriented environment. Findings indicate that most faculty often learn from students during class because students come up with ingenious ways of solving problems. The teacher's role is less as a director and more of a co-learner. Standards-based teaching calls for deep changes both in teachers' perceptions of their own role in relation to their students and in their classroom practice. In particular, it suggests a move to a more student-centered pedagogical approach, placing the student in a more active role in the learning, teaching and assessment cycle, thus creating a partnership between student and teacher (Black & William, 1998).

MANIPULATIVES AND TOOLS

Full implementation of standards-based teaching is where students have access to manipulatives and tools to solve problems. In traditional teaching, manipulatives and tools are not available. The survey items 10, 18, and 19 were associated with student tasks.

55% of survey respondents responded false to item #10. I encourage students to use manipulatives to explain their mathematical ideas to other students. 73% of survey respondents responded true to item #18. Using computers to solve math problems distract students from learning basic math skills. 67% of survey respondents responded false to item #19. If students use calculators they won't master the basic math skills they need to know.

The participants reported using technology to enhance student learning. The participants used computers to illustrate pictures, graphs, diagrams, and used color coded instruction to stimulate visual learners who relate to charts and diagrams. Alvin reported using google voice to communicate with students six days a week and reported using an internet drop box so students could submit work outside of class time. Alvin reported using the TI-84 computerized smart view to display elementary functions using multiple representations. Alvin and Carl reported that they are active at presenting at mathematics conferences on using technology to enhance student-centered learning. The participants reported using master-based learning systems in their classes to facilitate learning. All participants used technology extensively in the classroom and encouraged the students to have access to manipulative and tools to solve problems.

The survey respondents indicate that more than half of mathematics faculty encouraged students to use manipulatives and calculators to explain their mathematical ideas. The survey responses indicate that most mathematics faculty disagree that using calculators or computers to solve math problems distracts students from learning basic math skills.

Technology should be integral to the teaching and learning of mathematics. Technology continues to change the face of mathematics and affects the relative importance of various concepts and topics of discipline. Advancements in technology have changed not only how faculty teach, but also what is taught and when it is taught. Using some of the many types of

technologies can deepen students' learning of mathematics and prepare them for the workplace (AMATYC, 2005)

STUDENT-STUDENT INTERACTION

Full implementation of standards-based teaching is where the teacher creates opportunities for students to learn from peers by establishing mixed ability groups requiring students to explain math ideas to each other. In traditional teaching, student-student interaction is limited or may be treated as misbehavior. The survey items 3, 6, and 9 were associated with student-student interactions.

63% of survey respondents responded true to item #3. When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with each other. 100% of survey respondents responded false to item #6. It is not very productive for students to work together during class. 66% of survey respondents responded true to item #9. In my classes, students learn math best when they can work together to discover mathematical ideas.

The participant used using active and interactive strategies to engage social or active learners who like to interact with others. The participants used collaborative working groups to stimulate critical thinking and used learning management systems to keep students active inside and outside the classroom. All participants reported using a variety of approaches to engage students in student-centered learning. Alvin reported using google voice, chat rooms, and connect online to communicate with students or co-learners six days a week. All participants reported using group work and writing assignments to stimulate critical thinking. The participants created opportunities for students to learn from peers and required students to explain their mathematical ideas to one another.

The survey respondents indicate that many mathematics faculty do not have students share their steps when using different strategies. The survey responses indicated that all faculty disagreed that is not very productive for students to work together during class time. The survey responses indicated that most mathematics faculty agreed that students learn math best when they work together to discover mathematical ideas.

Effective mathematics instruction should require students to be active participants. Students learn through investigation. Advances in neuroscience confirm that students' active involvement in learning mathematics is important in the process of building understanding and modifying the structure of the mind (National Research Council, 1999).

STUDENT ASSESSMENT

In full implementation of standards-based teaching, assessments use real life situations and there exist a variety of assessment methods where procedures are shown to students. In traditional teaching, there are end of unit exams of near transfer. The survey items 8 and 12 were associated with student assessment.

70% of survey respondents responded true to item #8. I integrate math assessment into most math activities. 73% of survey respondents responded true to item #12. Creating rubrics for math is a worthwhile assessment strategy.

The participants used a variety of assessment formats. The participants reported using electronic homework, writing assignments, and group work to determine course grades in addition to traditional quizzes and exams. The participants thought creating and using grading rubrics to be a worthwhile assessment strategy. The participants reported using the rubrics as a tool to develop student problems solving skills and help students during the learning process.

The participants reported that the rubrics helped students identify scoring procedures on their problem solving abilities.

The survey respondents indicate that most mathematics faculty integrated math assessment into most math activities. The survey responses indicated that most mathematics faculty believed that creating rubrics for math is a worthwhile assessment strategy.

Assessment of student learning in mathematics should be a fundamental tool for the improvement of instruction and student learning. Assessment should support mathematics learning and instruction. An effective assessment program includes assessment of learning outcomes at the class, course, and program levels of instruction (AMATYC, 2005).

TEACHER'S CONCEPTIONS OF MATHEMATICS AS A DISCIPLINE

In full implementation of standards-based teaching, mathematics can be learned in many different sequences and math truths change over time. In traditional teaching, mathematics is a fixed body of knowledge that has to be learned in an inflexible sequence. Survey item 15 was associated with teacher's conception of mathematics as a discipline.

72% of survey respondents responded false to item #15. A lot of things in math must simply be accepted as true and remembered.

The participants view mathematical and pedagogical knowledge as dynamic and requiring lifelong learning. Alvin reported enrolling in classes so that he could anticipate student experience in different courses. Alvin and Carl reported that they are active at presenting at mathematics conferences on using technology to enhance student-centered learning. Alvin and Carl have completed coursework towards Ph.D.'s but have never completed the dissertation. Barry reported taking additional graduate credit in mathematics to broaden his pedagogical knowledge. All participants reported participating in online webinars, attending conferences,

and engaging in professional development to learn additional pedagogical strategies to accommodate diverse learners in the classroom.

The survey respondents indicate that most mathematics faculty disagreed that a lot of things in math must simply be accepted as true and remembered. The mathematics that students study should be meaningful and foster their appreciation of the discipline. Mathematics should be presented in the context of realistic, understandable, applied problems that help students develop an appreciation of the nature, history, and usefulness of the discipline (AMATYC, 2005)

STUDENT CONFIDENCE

In full implementation of standards-based teaching, rewards are based on conceptual understanding and tasks are selected to ensure student success. In traditional teaching, the sole focus is on student achievement. The survey items 7 and 20 were associated with student confidence.

70% of survey respondents responded true to item #7. Every student in my class should feel the mathematics is something she/he can do. 73% of survey respondents responded true to item #20. You have to study math for a long time before your see how useful it is.

The participants used a variety of active and interactive learning to facilitate learning. The participants reported used student-centered teaching strategies to facilitate learning. The participants reported that they used technology to examine mathematical ideas in depth and reported using multiple approaches or representations to reveal the connections among these ideas.

The survey respondents indicate that almost all mathematic faculty agree that every student in the class should feel that mathematics is something he/she can do. The survey respondents indicate that almost all mathematics faculty agreed that you have to study math for a

long time before you see how useful it is.

The beliefs and attitudes that students bring with them to the classroom play a major role in how they learn mathematics. Attitudes toward mathematics can create either a feeling of confidence or anxiety that may have a positive or negative effect on mathematical behavior (Schoenfeld, 1987). This anxiety is a major concern for many college students, particularly those with weak mathematical backgrounds. Faculty and students should work together to identify mathematics anxiety and manage the learning process. Faculty can assist students in overcoming and managing their anxiety by suggesting that students engage in a variety of strategies to cope with and alleviate mathematics anxiety (Peskoff, 2001).

Mathematics courses and programs in the first two years of college should broaden students' options in educational and career choices. The mathematical content, reasoning skills, and communication skills developed in mathematics courses should open doors for students to pursue future work in a variety of fields (AMATYC, 2005).

SUMMARY

This chapter began by analyzing the interview and the survey data. I described the mathematics faculty included in this study based on the information they provided on surveys and during interviews. I completed this chapter by presenting the findings from the interview data organized by research questions and findings from the surveys organized by dimensions of standards-based teaching. Quotes from the mathematics faculty were included to describe how were implementing standards-based teaching in the first two years.

Table 4 Provides a summary on the dimensions of standards-based teaching.

Table 4 *Summary of Dimensions of Standards-Based Teaching*

DIMENSION	TRADITIONAL TEACHING CONTRASTED WITH FULL IMPLEMENTATION
PROGRAM SCOPE	ALL STUDENTS ARE ABLE TO COMPLETE HIGH LEVEL MATHEMATICS PROBLEMS
STUDENT TASKS	FOCUS ON STUDENT THINKING INCLUDING OPEN ENDED QUESTIONS
DISCOVERY	FOCUS ON STUDENT THINKING INCLUDING OPEN ENDED QUESTIONS
TEACHER'S ROLE	CREATING A MATH COMMUNITY, PRESENTS SELF AS A CO-LEARNER
MANIPULATIVES & TOOLS	ACCESS TO APPROPRIATE TECHNOLOGY TO SOLVE PROBLEMS
STUDENT-STUDENT INTERACTION	TEACHER CREATES OPPORTUNITIES FOR STUDENTS TO LEARN FROM PEERS IN MIXED ABILITY GROUPS
STUDENT ASSESSMENT	VARIETY OF ASSESSMENTS USING REAL LIFE SITUATIONS
TEACHER'S CONCEPTIONS OF MATHEMATICS AS A DISCIPLINE	MATH CAN BE LEARNED IN MANY WAYS AND MATH TRUTHS CHANGE OVER TIME
STUDENT CONFIDENCE	REWARDS ARE BASED ON CONCEPTUAL UNDERSTANDING, TAKS ARE SELECTED TO ENSURE STUDENT SUCCESS

The quantitative analysis was used to reveal the dimensions of standards-based teaching. These dimensions were used to contrast traditional teaching with full implementation of standards-based teaching. The dimensions describe the knowledge, skills, and instructional practice necessary for full implementation of standards-based teaching.

The qualitative analysis allowed me to analyze and synthesize the instructional practices of mathematics faculty in the first two years. The analysis revealed that mathematics faculty are aligning their instructional practice with the AMATYC standards to facilitate their students' academic achievement. The interview responses indicate that there exist a strong relationship between instructional practice and standards-based teaching in the first two years. Mathematics

faculty in the first two years indicated that instructors use the AMATYC standards as a framework to analyze and improve their own teaching practice. In the final chapter, I conclude my study on standards-based teaching in the first two years in college mathematics.

The findings of this research study demonstrate how three mathematics faculties in the first two years of college implemented standards-based teaching in introductory collegiate mathematics. As the participants' responses attest, their use of standards-based teaching has improved their teaching methods as they continually adapt their teaching to the needs of diverse learners. Furthermore, the data suggest that there are implications and suggestions for research and practice. In the final chapter, I interpret the results, I discuss the limitations and implications of the study, and I offer suggestions for future research.

Table 5 Provides a summary of faculty responses to technology usage, instructional strategies, and interactive learning.

Table 5 *Summary of Faculty Responses*

TECHNOLOGY USAGE, INSTRUCTIONAL STRATEGIES, AND ACTIVE/INTERACTIVE LEARNING	ALVIN	BARRY	CARL
Chatrooms	X		
Clickers		X	
Videos			X
Google voice	X		
Drop box	X		
TI-84	X	X	X
excel	X	X	X
Mastery-based learning (web enhanced)	X	X	X
Learning management systems (Connect, Hawkes, Aleks, etc.)	X	X	X
Mini lectures	X		X
Small group learning	X	X	X
Quizzes	X	X	
Projects	X		X
Activities/ Interactive Learning	X	X	X
Exams/Practice Exams		X	
Class discussions		X	X
Homework		X	
Board work			
Writing assignments	X	X	X
Attending conferences	X	X	X
Presenting at conferences	X		X
Articles		X	X
Webinars	X		X
Additional graduate study	X		X

CHAPTER 5

CONCLUSION & RECOMMENDATIONS

In the final chapter, I conclude my study on standards-based teaching in the first two years in college mathematics. I discuss the limitations of the study and implications for research and practice. I then make recommendations for those invested in the mathematics education of students in the first two years of college. Additionally, I offer suggestions for future research and provide results of the study as it pertains to facilitating the academic achievement of diverse learners in the first two years of college.

LIMITATIONS OF STUDY

A limitation of the study was that my interview participants included three mathematics faculties that teach mathematics at colleges in the southeast United States of America. One limitation of the study is that my participants were all educated and trained in the South.

Although qualitative research methodology supports a sample size of three, the use of three participants is a limited number of participants for the investigation. Adding more participants to the sample size might have served valuable in an investigation such as this one to add to the knowledge base concerning standards-based teaching in the first two years of college. Also, the findings from the three interview participants in this study cannot be generalized to all mathematics faculties as purposeful sampling was employed due to the nature of the procedures.

IMPLICATIONS

This study on mathematics faculty using standards-based teaching to facilitate students'

academic achievement has implications for research and practice.

The implications of my study are particularly in pedagogy. I conducted my study because I saw the need for improvement of my teaching and teaching in general in the first two years of college. If given the opportunity to use the AMATYC standards as a framework to analyze teaching practice, I think most mathematics faculty will see improvement in facilitating the academic achievement of diverse learners. Therefore, I think mathematics faculty should be strongly encouraged to critique their on pedagogical methods or andragogical methods using the AMATYC standards. The opportunity to improve your teaching practice comes from continually adapting your classroom techniques to address a multitude of learning styles in the first two years.

This study encourages mathematics educators to rethink the use of traditional teaching methods and use learner-centered teaching strategies to facilitate their students' academic achievement. For my study, I used theories of actions to identify standards-based practices and I used the AMATYC standards as a lens to examine instructional practice in the first two years of college. The implication here is that other mathematics faculty in the first two years can use the AMATYC standards to analyze and improve their teaching practice. My study has implications for changing their instructional practices from teacher-centered to student-centered.

SUGGESTONS FOR FUTURE RESEARCH

After conducting this study, I have noted several directions for future research as it pertains to the mathematics achievement of diverse learners in the first two years. These suggestions will also serve valuable to others outside the discipline of mathematics in enhancing the delivery of the content that they teach. Future research should examine the effects of having standards-based teaching on the academic achievement levels of various groups of students. As

such, researchers should initiate conversations with scholars of standards-based teaching who have demonstrated a history of producing students that exhibit a wider variety of problem solving strategies and an increased use of effective problem solving.

Researchers should examine the curricula and practices in the first two years to investigate the ways in which mathematics faculty are educating students to increase their quantitative literacy and become critical thinkers. Alvin, Barry, and Carl all discussed in their interviews that their understanding of standards-based teaching was greatly enhanced by their participation in professional developments such as attending and presenting at conferences. All of the study participants noted professional growth related to an increased understanding of standards-based teaching in the first two years. All of the study participants stated that they infused writing assignments to simulate critical thinking. Beyond the writing assignments, they individually noted an increase in the desire to provide more real world experiences to increase relevancy for their students. I think the examination of the benefits of standards-based teaching in the first two years needs further investigation.

This study indicated that professional development was able to promote changes in instruction among participants. Additional research is recommended in the areas of changing teacher practices to align more with standards-based instruction using reform curricula. Researchers should explore the link between standards-based teaching in the first two years and student academic achievement. The results of this study show the promise of using the AMATYC standards as a framework to analyze mathematics teaching practice in the first two years of college.

In light of what I have learned as a result of this study, I have provided specific suggestions for the improvement of mathematics teaching in the first two years.

1. Provide mathematics educators with professional development opportunities that enrich their conceptual and procedural understanding of standards-based teaching.
2. Provided mathematics educators with resources that allow for successful implementation of the standards-based teaching.
3. Provide mathematics educators with an opportunity for information exchange among themselves related to teaching practice and effective teaching strategies.

The integration of these components will enrich the teaching experience of mathematics educators in the first two years. Throughout this study all of the participants made reference to the above mentioned aspects of their professional development experience.

SUMMARY

This study involved three mathematics educators with significant variations in the number of years teaching experience each possessed. The data that emerged from each of the study participants led to the findings: 1) that standards-based teaching strengthens instructor delivery by accommodating diverse learning styles by using multiple instruction formats along with varying the class layout with learning-centered group work, 2) there exist a strong relationship between alignment of AMATYC standards and mathematics faculties teaching practice in the first two years, 3) standards-based instruction enriches the learning environment by engaging students and provides diverse learning activities that help students make meaningful connections, and 4) using technology to enhance student-centered learning and by providing more student-directed learning opportunities outside of the classroom.

As a result of conducting this study, I will continue to examine the research data in hopes of providing my students with the most beneficial learning experience. The findings of this research study demonstrate how three mathematics faculties in the first two years of college

implement standards-based teaching in introductory collegiate mathematics. As the participants' responses attest, their use of standards-based teaching has improved their teaching methods as they continually adapt their teaching to the needs of diverse learners.

DISCUSSION & CONCLUSION

Through this research investigation, I have explored the teaching practices of mathematics faculties in the first two years of college who are identified as using standards-based teaching to facilitate their students' academic achievement. It is expected that standards-based instruction will lead to changes in classroom practices in the first two years of college. Changes in instructional practices are then predicted to result in higher levels of student performance. This study describes the standards-based teaching practices in the first two years of college. This study is designed to address our knowledge of mathematics teaching and knowledge of student difficulties in College Algebra, and the influence of those variables on instructional practices.

The systematic investigation of teaching has resulted in many explanations of how people learn. The Mathematical Association of America (MAA) recommends to continually strengthening courses that align with student needs and assess the effects of such efforts. My study describes these themes associated with standards-based teaching in introductory level collegiate mathematics.

Prior research on mathematics teaching has made it very clear that over half of students do not persist or achieve to their potential in College Algebra (Dunbar, 2003). Despite our increased understanding of how students learn, how teachers teach, and improved methods of assessing teachers and students, mathematics educators have yet to offer compelling accounts as to why these trends have persisted (Martin, 2000). It is my hope that this work can be useful in

furthering our efforts to improve and more completely understand the standards-based mathematics teaching practice in introductory collegiate mathematics in the first two years. If we are satisfied that our standard-based practices yield positive answers, we can look fruitfully at how to make adaptations to address the needs of academically diverse learners. If our answers are less than satisfactory, we should address the problems. Such problems inevitably point to cracks in the foundation of the quality of teaching, and we diminish our profession by failing to attend to them (Tomlinson, 2000).

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APPENDIXES
APPENDIX A
RECRUITMENT LETTER

From: Laurn Jordan [ljordan8@student.gsu.edu]

To: Mathematics Faculty

Subject: Dissertation Study Advertisement/Recruitment

Hello,

You are invited to participate in a survey about standards-based teaching in the first two years of college. The survey will take less than five minutes of your time. The purpose of this study is to analyze and describe the teaching practices of college mathematics instructors who have been identified as those who use standards-based practices to facilitate instruction in introductory collegiate mathematics. My name is Laurn Jordan, and I am a doctoral candidate in Mathematics Education at Georgia State University. I am also an Assistant Professor of Mathematics at a two year college. You are invited to participate because you have been identified as an effective college mathematics instructor. Your name and other facts that might point to you will not appear when I present or publish its results. The findings will be summarized and reported in group form. You will not be identified personally. This survey will be used to identify three mathematics faculty who are willing to be interviewed on faculty perspectives of standards-based teaching in the first two years of college. Any help in this effort would be greatly appreciated. Thank you in advance for your participation. If you agree to participate in this research, please click on the link to the survey https://www.surveymonkey.com/s/6SKSB9Z.

Laurn Jordan
Assistant Professor of Mathematics

APPENDIX B
CONSENT FORM

Georgia State University

Department of Middle-Secondary Education and Instructional Technology

Informed Consent Form

Title: An examination of standards-based practices in College Algebra in the first two-years of college

Principal Investigators: Dr. Christine Thomas, MSIT
Mr. Laurn Jordan, MSIT

Purpose

You are being asked to volunteer for a research study called "An examination of standards-based practices in College Algebra in the first two-years of college." The purpose of the research study is to better understand mathematics instructor's perspectives on standards-based teaching in introductory collegiate mathematics.

Procedures

In order to be in the research study, you will participate in three 1-2 hour individual interviews and one group interview. The interviews will take place in the faculty offices. All interviews will be audio taped. The tapes will be used to transcribe the interviews. After the tapes are transcribed, the tapes will be destroyed. Your name will not appear on the written record of interview, and those written will be kept in a password protected computer. If you decide to participate, your participation would consist of the components listed chronologically below:

1. Survey of Mathematics Faculty
2. Completion of informed consent (respect for human subjects).
3. Interview about standards-based teaching (learning environment, instructional strategies, curriculum development, assessment, and professionalism).

Risks

In this study, you will not have any more risks than you would in a normal day of life. There are no foreseeable risks to being interviewed for this study, should you choose to participate.

Benefits

There may be no potential benefit to you other than a satisfaction that you have contributed to a research study intending to include college mathematics faculty perspectives on standards-based teaching and that your insight has benefited the mathematics community at large. The benefit to the mathematics education community is such that other instructors may gain insight from your perspective and mathematics teaching and learning could be positively impacted based on the results of this study.

Voluntary Participation and Withdrawal:

Participation in research is voluntary. You have the right to refuse to be in this study. If you decide to participate in the study and then change your mind, you have the right to remove yourself from the study at any time. You can choose to answer any question and may end the interview at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

Confidentiality:

We will keep your records private to the extent allowed by law. Dr. Christine Thomas and Mr. Laurn Jordan will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (GSU Internal Review Board, the Office of Human Research Protection (OHRP)). We will use a pseudonym rather than your name on study records. The information you provide will be stored on a password protected computer. Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally.

Those with the right to look at your study records include Georgia State University Institutional Review Board, Georgia Perimeter College Institutional Review Board and my research advisor, Dr. Christine Thomas. I will use a pseudonym rather than your name on study records. Your name and other facts that might point to you will not appear when I present this study or publish its results.

Contact Persons

You may call Dr. Christine Thomas at (404)413-8060 if you have questions about this study. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at (404)413-3513 or svogtner1@gsu.edu.

Copy of Consent Form to Subject

We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research and be audio recorded, please sign below.

_____ _____

Participant Signature **Date**

_____ _____

Principal Investigator Researcher Obtaining Consent **Date**

APPENDIX C
SURVEY INSTRUMENT

STANDARDS IMPLEMENTATION SURVEY

Self-Report Survey: Mathematics faculty member's commitment to standards-based teaching.

Identify each response as True of False.

1. I like to use math problems that can be solved in many different ways.
2. I regularly have my students work through real-life math problems that are of interest to them.
3. When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with each other.
4. I tend to integrate multiple strands of mathematics within a single unit.
5. I often learn from my students during class because my students come up with ingenious ways of solving problems that I have never thought of.
6. It is not very productive for students to work together during class.
7. Every student in my class should feel the mathematics is something she/he can do.
8. I integrate math assessment into most math activities.
9. In my classes, students learn math best when they can work together to discover mathematical ideas.
10. I encourage students to use manipulatives to explain their mathematical ideas to other students.
11. When students are working on math problems, I put more emphasis on getting the correct answer than on the process followed.
12. Creating rubrics for math is a worthwhile assessment strategy.
13. In my class it is just as important for students to learn data management and probability as it is to learn multiplication facts.
14. I don't necessarily answer students' math question but rather let them puzzle things out for themselves.
15. A lot of things in math must simply be accepted as true and remembered.
16. I like my students to master basic mathematical operations before they tackle complex problems.
17. I teach students to explain their mathematical ideas.
18. Using computers to solve math problems distract students from learning basic math skills.
19. If students use calculators they won't master the basic math skills they need to know.
20. You have to study math for a long time before your see how useful it is.

APPENDIX D
SAMPLE INTERVIEW QUESTIONS

Can your share with me the placement procedures into introductory collegiate mathematics at your college?

How do you provide leadership for the development of policy to place students in mathematics classrooms?

How do you play an active role in advising students?

How do you link the content of mathematics courses to questions or criteria on placement-tests?

How do you exhibit that you have high expectations for all students?

How are you aware, sensitive to, and willing to accommodate the needs of all students?

How do you provide multiple approaches to instruction to address the learning style of all students?

How do you advise the students on availability of resources to them outside the classroom?

How do you assume responsibility of understanding your students learning styles?

How do you implement strategies to maximize learning for each student?

How do you use multiple assessment measures?

How do you use different modes of instruction to accommodate different learning styles?

How do you use technology to promote interaction?

How do you formulate questions that require students to memorize, comprehend, apply, analyze, and/or synthesize mathematical concepts?

How do you encourage students to explain concepts and solutions as well as write about mathematics?

How do you integrate technology into the teaching of mathematics courses?

How do you use technology to communicate mathematical information or

ideas with your students?

How do you provide feedback to students on mathematics assignments/questions constructively?

How do you provide feedback to students on mathematical assignments?

How do you allow discovery based questions and activities to guide classroom discussion?

In what ways have you adjusted your instruction to align with AMATYC standards?

How do you work with faculty from other disciplines to reexamine the development of mathematics courses?

How do you relate course format that relate to directly to desired student outcomes?

How are you sensitive to the impact of mathematics anxiety on students? How do you employ strategies to minimize the students' mathematics anxiety and develop confidence in mathematics?

How do you consult with outside entities to keep course content relevant?

How do you ensure collaborative problem-solving skills?

Do you use multiple assessments strategies to assess students' mathematical reasoning and conceptual understanding?

How are you involved in ongoing assessment activities?

How do you implement changes in curriculum, instructional materials, and teaching strategies based on assessment results?

Do you integrate group activities regularly?

Do you discuss assessment results with the class?

Do you participate in significant professional development activities on a regular basis?

How do you communicate the mathematical needs for students to faculty in other disciplines?

How are you actively involved in professional organizations?

How do you stay abreast of new research in mathematics and mathematics education?

How have you become familiar with the amatyc standards and what they imply for practice?

In what ways can mathematics instructors have access to appropriate professional learning opportunities?

APPENDIX E

MEMORANDUM TO PARTICIPANTS CONCERNING MEMBER CHECKING

To: Dissertation Study Participant
From: Laurn R. Jordan
Date: May, 2012
Subject: Member Checking
Greetings Mathematics Faculty:

Thank you for participating in my research study. The purpose of this letter is to member check my interpretations of the research participants. Member checking is a process in which the researcher (me) shares his information with the research members (you) to produce valid and accurate research findings.

I have changed your names to ensure anonymity and confidentiality. Furthermore, I have changed the names of institutions mentioned, professors, teachers, companies, and so on. The goal is so that readers will not be able to pinpoint who you are.

Please read the qualitative interpretation of your responses and correct any errors that I have made. Also, if my interpretations of a given situation are incorrect, please correct me on that as well. Please either track your changes or highlight your changes in a particular color so that I can decipher the corrections. Once you have corrected your interpretations, email it back to me as soon as possible. If you find that my errors are too numerous and need further clarification, then please contact me directly via telephone.

The member checking is the last thing that I will need from you. I sincerely thank each and every one of you for your time invested into this study.

APPENDIX F

Self-Report Survey: Teacher's Commitment to Mathematics Education Reform

Item Number	Item	Dimension-number	Responses
1	I like to use math problems that can be solved in many different ways.	D2	97% True
2	I regularly have my students work through real-life math problems that are of interest to them.	D2	73% True
3	When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with each other.	D6	63% True
4	I tend to integrate multiple strands of mathematics within a single unit.	Dl	76% True
5	I often learn from my students during math time because my students come up with ingenious ways of solving problems that I have never thought of.	D4	76% True
6*	It is not very productive for students to work together during math time.	D6	100% False
7	Every child in my room should feel that mathematics is something he/she can do.	D9	90% True
8	I integrate math assessment into most math activities.	D7	70% True
9	In my classes, students learn math best when they can work together to discover mathematical ideas.	D6	66% True
10	I encourage students to use manipulatives to explain their mathematical ideas to other students.	D5	55% False
11*	When students are working on math problems, I put more emphasis on getting the correct answer than on the process followed.	D2	87% False
12	Creating rubrics for math is a worthwhile assessment strategy.	D7	73% True
13	In my class it is just as important for students to learn data management and probability as it is to learn multiplication facts.	Dl	62% True
14	I don't necessarily answer students' math questions but rather let them puzzle things out for themselves.	D3	55% False
15*	A lot of things in math must simply be accepted as true and remembered.	D8	72% False
16*	I like my students to master basic mathematical operations before they tackle complex problems.	Dl	87% True
17	I teach students how to explain their mathematical ideas.	D4	93% True
18*	Using computers to solve math problems distracts students from learning basic math skills.	D5	73% False
19*	If students use calculators they won't master the basic math skills they need to know.	D5	68% False
20*	You have to study math for a long time before you see how useful it is.	D9	97% False

* Denotes negatively worded item.