DISSERTATION

MEASURING TEACHER IMMEDIACY AND COMMUNICATION COMPETENCE ON STUDENT ACHIEVEMENT IN CALCULUS: A SEQUENTIAL EXPLANATORY MIXED METHOD DESIGN

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ABSTRACT

MEASURING TEACHER IMMEDIACY AND COMMUNICATION COMPETENCE ON STUDENT ACHIEVEMENT IN CALCULUS: A SEQUENTIAL EXPLANATORY MIXED METHOD DESIGN

On a national level, data indicate that about 40 percent of students in calculus courses finish with a grade of D or F, drop the course, or withdraw (Reinholz, 2009). This high failure rate has led to research studies investigating the teaching of calculus at the national level (House, 1995). Calculus courses have a history of high failure rates, low exam scores, and multiple course redesigns.

This paper explored the relationship between teacher immediacy and communication competence from the student perspective on student achievement in calculus. Instead of focusing on course content, reform can come from revisions of the delivery method or instructor behaviors to improve student achievement. Previous studies focused on instructor behaviors and the motivation of teachers and efficacy (Gorrell, 1990; Schaller, 1993) from the instructor perspective. These studies lack student perspective.

Calculus for Physical Scientists I at Colorado State University is currently in the process of reform (Klopfenstein, 2008). Past research (House, 1995; Reinholz, 2009; Pilgrim, 2010) has identified the need for reform. Research conducted to help students prepare, perform better, or understand concepts at a higher level, could be beneficial to the fields of Mathematics, Engineering, and Education. Overall, any research conducted to improve failure rates in calculus would be beneficial.

Although, findings from this study did not show a statistically significant relationship between student achievement, teacher immediacy, and communication competence, the qualitative findings did show that students who were interviewed enjoyed learning tough concepts, such as calculus, from instructors who used these skills. By using a sequential explanatory design mixed methods study, student opinions expressed in the interviews and focus groups showed a desire for instructors to employ teacher immediacy and communication competence skills.

Ruling out instructor behavior as a factor in explaining student achievement, including teacher immediacy and communication competence, may help direct future research to focus on competing theories.

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CHAPTER ONE: INTRODUCTION

Calculus for Natural Science and Engineering

For students studying calculus at the university level, statistics show these students are not successfully passing at a significant rate (Reinholz, 2009), which has caused researchers to focus on calculus reform (Windham, 2008). According to the University of Colorado (2009), studies conducted by the Mathematical Association of America (MAA) with support from the National Science Foundation (NSF) reported that in 2009 approximately 40 percent of the students enrolled in calculus for natural science and engineering majors earn the grade of D or lower. Calls for reform at the national level have driven many changes in the way calculus is taught. Tall (1996) stated that calculus should be "a genuine driving force for learning instead of a filter which weeded out poor students" (p. 2). The National Science Foundation (NSF) has also provided grants and awards to researchers and teachers who address calculus reform (Ganter, 2001).

Due to the history of high failure rates in calculus, a national reform movement began from a general atmosphere of dissatisfaction among calculus instructors. This dissatisfaction caused mathematics programs around the nation to reform and change the course by removing the traditional way of teaching computation and calculation drills and working problems over and over until they are understood (Tall, 1992). Estep (2008) stated "calculus was invented by people as a tool to solve scientific and engineering problems" (p. 1) and the students who must learn calculus need to master the basics. Estep (2008) also stated "the best way to teach calculus to an engineering student is to go back to these roots and bring out the concepts in context of mathematical modeling of physical phenomena and solving mathematical models in order to

predict physical phenomena" (p. 1). However, changing the course by either adding or removing drill exercises may not be the only way to create change and/or lower the high failure rate. Research could and should be done to examine if instructor teaching style or instructor behavior could play a significant role fostering student achievement in calculus (Shallar, 1993).

At Colorado State University (CSU), the Calculus for Physical Scientists I course (MATH 160) has a history of high student failure rates, low test scores, and multiple course redesigns. According to the literature published by the Department of Mathematics, the failure rate, as defined as students earning a D or F, students at CSU in MATH 160 average around 40 percent per semester (*math.colostate.edu*, 2011). Reinholz (2009) found "data indicate that about 40 percent of students initially enrolled in MATH 160: Calculus for Physical Scientists I finish the course with a grade of D or F, dropped, or withdrew from the course" (p. 19). The Department of Mathematics made it a mission to reform the way calculus was being taught at CSU. According to Estep (2008),

> Two or three decades ago, university faculty began a gradual de-emphasis of the analytic aspects of Calculus, i.e. the epsilon and delta proofs and the art of estimation. By the time I became a professor, Calculus courses consisted essentially of drill in computing derivatives and integrals exactly, with an occasional toy application to graphing and optimization. Of course, such courses are interesting to neither teach nor take and are not particularly relevant to engineering. So, the pressure to "reform" calculus steadily grew all the while. (p. 1)

Estep sought to radically change the course and to improve the outcomes for students, which was done through changes in objectives, standardizing all MATH 160 classes, and having only one person in charge of the course (syllabus, schedule, and exams). Even though changes have been made, the actual failure rates have not changed (Klopfenstein, personal communication, July, 2011). Another course redesign recently done by the Department of Mathematics involved changing the amount of work assigned to the students. According to Klopfenstein (2008),

> Instructors identify many reasons why students do not succeed in MATH 160, but frequently mention that, students' pre-calculus skills are weak, study strategies that students found successful in high school mathematics are not effective for learning university-level calculus and students have unrealistic expectations about the effort required to succeed in a serious university-level mathematics course. (p. 3)

Again, these findings have driven changes for MATH 160, but still have not radically changed the level of success achieved by students. Current failure rates in the first two calculus courses (MATH 160 and MATH 161) are still considerably too high and Estep (2008) suggested even more content and/or course reform (p. 1). According to Pilgrim (2010),

> MATH 160 is the first semester calculus course required for students majoring in natural sciences or engineering at CSU. MATH 160 is not a reform calculus course, but it is also not a traditional calculus course. The course is a lecture-based course and a traditional calculus textbook is used. However, some reform techniques are integrated into the course. There is a strong emphasis on multiple representations in MATH 160 with both technology and writing being used, but neither group activities nor cooperative learning are employed in MATH 160. (p. 39)

This level of reform on the current MATH 160 course, along with multiple instructors teaching from the same syllabus and using the same exams, provided an excellent opportunity for research on the levels of teacher immediacy and communication competence to be conducted.

Instructor Development and Student Learning

According to the Institute for Learning and Teaching (TILT), a department within CSU responsible for teacher and student training and development programs, "several years have been spent by TILT and the Department of Mathematics focusing on course restructuring for MATH 160 to increase the success of the students" (Palmquist, personal communication, Nov 26). This examination of Calculus for Physical Scientists I focused on instructor delivery rather than course content. Measurement of student achievement was based on exam scores and any improvement that might have been related to the abilities of the instructor. Previous studies have focused on instructor behavior and the motivation of teachers and efficacy (Gorrell, 1990;

Schaller, 1993) from the instructor perspective noticeably lacking were studies from the student perspective. During the exploratory phase of this study, this researcher investigated changes, challenges, and existing research related to student achievement in Calculus for Physical Scientists I.

This study was based on the constructs teacher immediacy and communication competence from the student perspective and examined if a relationship existed between teacher immediacy, communication competence, and academic achievement by students enrolled in MATH 160.

According to Mehrabian (1967), "immediacy has been defined as the degree of perceived physical and/or psychological closeness between people" (p. 325) and can be measured through a teacher's use of "humor, addressing students by their names, providing feedback and gesturing positively while talking to the class" (Schaller, 1993, p. 63).

In addition to teacher immediacy, communication competence is "knowledge about appropriate and effective communication behaviors" (Rubin, 1990, p.96). Communication competence includes a teacher's use of "support for students, empathy, behavioral flexibility, social relaxation, and interaction management" (Schaller, 1993, p. 65). By combining these two constructs, the researcher created a measurable level of teacher immediacy and communication competence, either low or high, of the instructor by the student.

Research Problem

The identified problem for this research is whether there is a correlation, or relationship, between teacher immediacy, communication competence, and student achievement. The research literature has reported several ways to measure teacher immediacy (Mehrabian, 1967;

Gorham, 1988; Richmond, Gorham, & McCroskey, 1987), communication competence (Wiemann, 1977; Rubin, 1990) and student achievement (Shallar, 1993).

Research (Pilgrim, 2010; Reinholz, 2009) completed on student achievement in calculus has shown weak results. The MAA and the NSF found that on a national level 47 percent of students initially enrolled in calculus for natural science and engineering majors finished the academic year with a passing grade, which raised concern among mathematicians and educators (Anderson & Loftsgaarden, 1987). Because of high failure rates nationally and at CSU, there is a need for more empirical research and documentation on this topic.

Other research findings on how to structure the format of calculus courses included the work completed by Windham (2008), Reinholz (2009), and Pilgrim (2010). However limited empirical research on the behavior of calculus instructors with effective teacher immediacy and communication competence from the student perspective provided a need for further research on these two instructor behavior constructs.

Purpose

This study explored the relationship between teacher immediacy and communication competence from the student perspective and student achievement. Accordingly, this study examined if student perception of teacher immediacy and communication competence played a role in student achievement on calculus exams. The investigation studied if associations in the relationship between (Gliner, Morgan, & Leech, 2009) teacher immediacy, communication competence, and student achievement existed. The research done in this study was grounded in empirical study and theoretical literature focusing upon teacher immediacy, communication competence, and student achievement.

This study was completed by building off existing knowledge and the research of Mehrabian (1971), Natriello and Dornbusch (1983), Rubin (1990), Schaller (1993), Reinholz (2009), and Pilgrim (2010). The overall purpose of this study was to show if instructors used teacher immediacy and communication competence behaviors in the classroom helped improve student achievement on exams. Secondary purposes were to provide recommendations for the calculus teaching profession and increase the number of students who successfully complete Calculus for Physical Scientists I.

Research Questions

The following overarching research questions were formulated using the work presented by Morgan, Leech, Gloeckner, and Barrett (2007) and Creswell and Plano-Clark (2010). Research questions were developed to study the relationship between teacher immediacy, teacher communication competence, and student achievement on MATH 160 exam scores. The criterion or dependent variable was student exam scores, whereas the predictors or independent variables were teacher immediacy and teacher communication competence. In addition, questions were added looking at the impact of teacher and student gender on overall teacher immediacy and communication competence.

1. *Is there a correlation between the levels of teacher immediacy and MATH 160 test scores?*
    - 1a. Does a correlation exist between the levels of *verbal teacher immediacy* and MATH 160 test scores?
    - 1b. Does a correlation exist between the levels of *non-verbal teacher immediacy* and MATH 160 test scores?

1c. Does a correlation exist between the levels of overall *teacher immediacy* and MATH 160 test scores?

2. *Is there a correlation between the levels of general teacher communication competence rating and MATH 160 test scores?*

    2a. Does a correlation exist between the levels of *affiliation/support* and MATH 160 test scores?

    2b. Does a correlation exist between the levels of *empathy* and MATH 160 test scores?

    2c. Does a correlation exist between the levels of *behavioral flexibility* and MATH 160 test scores?

    2d. Does a correlation exist between the levels of *social relaxation* and MATH 160 test scores?

    2e. Does a correlation exist between the levels of *interaction management* and MATH 160 test scores?

    2f. Does a correlation exist between the levels of overall *communication competence* and MATH 160 test scores?

3. *Is there an interaction of teacher and student gender on teacher immediacy, and/or communication competence?*

    3a. Is there an interaction of teacher and student gender on overall teacher immediacy?

    3b. Is there an interaction of teacher and student gender on overall communication competence?

4. *How well do the combination of overall teacher immediacy, overall teacher communication competence, teacher gender, and student gender predict test scores of students on MATH 160 exams?*
5. *How did the quantitative and qualitative data inform the purpose of this study?*

Definition of Terms

Teacher Immediacy, according to Mehrabian (1969) is "behaviors [that] enhance closeness and generate positive attitudes" (p. 324) and is characterized by decreased physical and/or psychological distance between individuals who are communicating with one another (Mehrabian, 1971). For this study, "the display of immediacy includes such nonverbal behaviors as eye contact and verbally, through behaviors such as the use of humor, praise and addressing other individuals by name" (Schaller, 1993, p. 39).

Teacher Communication Competence according to Rubin includes "knowledge about appropriate and effective communication behaviors, development of repertoire of skills that encompass both appropriate and effective means of communicating, and motivation to behave in ways that are viewed as both appropriate and effective by interactants" (Rubin, 1990 p. 96) which for this study also includes behavioral flexibility which is "adjusting one's behavior to fit a given situation" (Schaller, 1993, p. 35).

Calculus for Physical Scientists I, MATH 160, is a course taught at CSU to Engineering and Natural Science students. The number of students enrolled in MATH 160 and have failed has been identified by the Provost of CSU as extremely high. Multiple course redesigns, course analysis, and curriculum studies have been performed over the past several years with some

success, but the continued high failure and drop-out rate for this course created a need for more analysis.

Teacher Gender is the sex of the teacher identified by the student on the survey instrument as either male or female. The researcher understands that gender can be interpreted in many ways, but for this study the gender of the teacher is limited to either male or female as reported by the students involved in the research project.

Student Gender is the sex of the student, self-identified by the student on the survey instrument as either male or female. The researcher understands that gender can be interpreted in many ways, but for this study the gender of the student is limited to either male or female as reported by the students involved in the research project.

This research defines *Course* as Calculus for Physical Scientist I (MATH 160) at Colorado State University taught over a 15-week academic semester at Colorado State University during the fall 2011 semester. This traditional class took place on campus in a traditional classroom setting. MATH 160 consisted of 11 sections of MATH 160 taught by 11 different instructors.

This research defines *Section* as the same course, but taught at different times or dates. Calculus for Physical Scientist I (MATH 160) had 11 different sections during the fall 2011 academic semester.

This research defines *Class* as each time a course met, or each specific period in which students met to learn in the classroom. In the fall of 2011, each section met several times per week over the 15-week semester.

Limitations and Assumptions

Past research focusing on the high failure rates in calculus (Tall, 1996; Reinholz, 2009; Pilgrim, 2010) pointed out different ideas for improving student achievement in calculus class, including Calculus for Physical Scientists I. Though this is a continuing issue and a concern nationally, this study takes place within the administration of CSU and the Department of Mathematics. According to TILT (2011) and Klopfenstein (2008), there have been multiple interventions aimed at increasing the success of students taking MATH 160. The departments involved provided access and data required to perform this study with the hope of long-term student learning, retention, and achievement.

This study was not designed for the results to be generalized to all universities; however, the results could have implications for other calculus courses at CSU and even other calculus programs at other universities. It is assumed that all students who responded to the survey, and participated in the interviews and focus groups provided honest and meaningful responses.

The focus of this study is on student perception of teacher immediacy and communication competence of instructors from the student perspective and exam scores in MATH 160. Therefore, this study did not account for different learning styles, mathematics backgrounds, the amount of time each student spent preparing for class, and student attitudes towards learning a complex topic like calculus. However, the sections involved in this study all used the same syllabi, course content, textbooks, objectives, and exams. What did vary was the teaching styles, communication styles, attitudes of the instructors, and the overall classroom environment, or atmosphere.

Delimitations

By choice, this study was delimited to students enrolled in MATH 160 at CSU during the fall 2011 semester. This study focused on students enrolled in the scheduled 11 sections of MATH 160. The many other calculus courses offered at CSU are different in content and applications, and are outside the scope of this research. The researcher for this study took precautions to establish parameters for the study including:

1. This study was delimited to student perception of instructor behavior and student achievement on exams in MATH 160.
2. This study was delimited by data that could be collected from the student via questionnaire, MATH 160 exam scores, and student interviews/focus groups.
3. The scope of this study was delimited to the 11 offered sections MATH 160 at CSU in the fall of 2011 with a total enrollment of 450 students.
4. No on-line or distance students were included due to the nature of the study focusing on teacher behavior in the classroom, thus the study was delimited to traditional classroom settings.

Significance of the Study

The benefits derived of instructors having effective teacher immediacy and communication competence are related to making students more comfortable in the classroom, and the more comfortable students are, the more students tend to learn (Knowles, 1973).

Due to a national trend at universities indicating students studying calculus struggle to pass with a grade of C or higher, studies have been conducted by the MAA with support from the NSF. These studies state about 40 percent of the students enrolled in calculus for natural science and engineering majors earn the grade of D or lower (Ganter, 2001). The high failure rate

among students created reform at that national level and has driven many changes in the way calculus is taught.

At CSU, one of the university's main objective as an organization is to teach students. CSU's mission statement clearly points out the importance of teaching; "Inspired by its land-grant heritage, Colorado State University is committed to excellence, setting the standard for public research universities in teaching, research, service and extension for the benefit of the citizens of Colorado, the United States, and the world" (Colorado State University, 2005, p. 1). Instructor development programs can focus on improving instructor effectiveness through the intervention of human development (Swanson, 2001). Through the development of instructors, the significance of this study was based in human development theory and practice, to improve the teaching, a key component in the mission of CSU, through the development of mathematics instructors.

By focusing on the development of instructors, human development "is a process of developing and/or unleashing human expertise through personnel training and development for the purpose of improving performance" (Swanson, 2001, p. 304). This study provided the basis for improving student achievement, through the measurement and possible improvement of instructor expertise. According to Haycock (1998), good teachers "have profound implications for states and communities striving to get larger numbers of their students to high standards of achievement" (p. 62). Researching the effectiveness of teacher immediacy and communication competence in MATH 160, which has a significantly high failure rate, could be beneficial, even there is the slightest increase in passing rates.

Currently missing from the literature is empirical evidence related to teacher immediacy and communication competence behaviors used by instructors in complex classes, like Calculus for Physical Scientists I, and student achievement. With a current failure rate of 40 percent (Reinholz, 2009) in Calculus for Physical Scientists I at CSU, and a 40 percent failure rate in calculus courses on a national level (Ganter, 2001), the significance of this cannot be overlooked. Currently the calculus failure rate is too high (Estep, 2008), and the failure rate ought to be much lower. Research done to help decrease the number of students receiving a grade of D or lower is significant to the field of mathematics and perhaps the impact on the number of successful scientists, mathematicians and engineers in the future.

Researcher's Perspective

Based on the researcher's experience as a university instructor and as a student studying Organizational Performance and Change (OPC), studying this topic from an instructor development perspective using both quantitative and qualitative methodologies could generate findings that may be generalizable to other calculus courses. Because of the high failure rates in calculus nationally, there is a need to understand what role teacher immediacy and communication competence may play in student achievement.

Teaching at CSU is a large organizational investment. Instructors are "to provide conditions in which individuals can develop their capacity to create what they care about" (Senge, Kleiner, Roberts, Ross, & Smith, 1994, p. 199). The Institute for Learning and Teaching (TILT) "fosters connections among learners and teachers throughout the University, across program and disciplinary boundaries, and in the broader community. Working together, they pursue a mission of enhancing learning, teaching, and student success" (www.tilt.colostate.edu, 2011); and TILT has spent several years working on projects focusing on decreasing the number

of students who receive a grade of D or lower in MATH 160 (Palmquist, personal communication, Nov 26).

As a Graduate Assistant in TILT, the researcher has worked with several projects relating to helping students succeed in MATH 160. It is this experience of working with enhanced learning that has fostered an interest for the researcher to conduct a study researching student achievement in Calculus for Physical Scientists I at CSU.

The quantitative portion of this research was completed in post-positivistic method (Gliner et al., 2009), which researched student achievement and studied possible correlations that influenced outcomes (Creswell, 2008). The researcher followed a scientific procedure, or approach, which quantified findings through data analysis. According to Gliner et al., (2009) "quantitative data are said to be objective, which implies that the behaviors are easily classified or quantified" (p. 8). The researcher looked to use scientific or quantifiable methods along with qualitative methods to research if there was a relationship between the constructs of teacher immediacy, communication competence, and student achievement.

The qualitative portion of this research was completed in sequential explanatory where priority was given to the quantitative portion (Creswell & Plano-Clark, 2010) followed by qualitative interpretation. The qualitative portion researched student achievement and studied possible correlations that influenced outcomes (Creswell, 2008). Through this method, the researcher followed a theoretical perspective to explain findings through data analysis. The researcher looked to use interpretation methods to research whether a relationship existed between the constructs of teacher immediacy, communication competence, and student

achievement. In addition, the researcher explored meaning in the data through qualitative interviews and focus groups.

Teacher immediacy and communication competence are both examples of teaching components that can be studied for the purpose of improving student exam scores. Calculus for Physical Scientists I has a history of high failure and dropout rates. By studying instructor behavior, this study intended to provide a new perspective on teacher immediacy and communication competence as skills used by instructors to improve student achievement.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

Many students find calculus difficult. Past research (House, 1995; Pilgrim, 2010) at a national level has shown nearly a 40 percent failure rate in Calculus for Physical Scientists I. The high failure rate necessitated calculus reform out of the "recognition of the changing focus of college math departments' being predominantly the educators of future research mathematicians to being the educators of the many and varied disciplines that use mathematics including engineering and natural sciences" (Windham, 2008, p. 5). Students pursuing degrees outside mathematics are often required to take calculus as a prerequisite course. Selden, Mason, and Selden (1989) state; "a majority of undergraduate calculus students deemed to possess average skill levels were at a loss to solve problems that were not formula-driven" (p. 47).

Adding to the reform movement, the National Research Council (NRC) challenged college mathematics departments to reconsider calculus teaching methodologies (Windham, 2008). The NRC (1989) stated:

> Not only do all the sciences depend on strong undergraduate mathematics, but also all students who prepare to teach mathematics acquire attitudes about mathematics, style of teaching, and knowledge of content from their undergraduate experience. No reform of mathematics education is possible unless it begins with the revitalization of undergraduate mathematics in both curriculum and teaching style. (p. 39)

Even with the NRC stating that teaching style is part of the issue, most reform done relates to structure of the class. According to House (1995), "the relationship between student attitudes and later mathematics achievement has been explored in a limited number of studies" (p. 111) indicating more research is needed in calculus reform.

Discussion of calculus reform began in the early 1990s: Ferrini-Mundy and Graham (1991) stated, "Substantial discussion is underway in the mathematics education and mathematics communities concerning calculus pedagogy and curriculum" (p. 627). However, according to Ferrini-Mundy and Graham (1991) "calculus reform discussion has been centered on streamlining the traditional syllabus to create lean and lively courses" (p.628). Findings from this research helped change the application process from repetition of calculus problems to a more active learning process. From this process, instructors are often overlooked. Ferrini-Mundy and Graham (1991) stated

> We have little framework for understanding the possible pitfalls of a national curriculum reform at the post-secondary level; it is unclear whether we can learn from the "new math" experience in this regard. The typical college calculus instructor, as least as we know him or her anecdotally, is a relatively independent type whose opinions about the important content of calculus are relatively firm. (p. 632)

And it is these same instructors that are rarely even taken into consideration when dealing with calculus reform.

In addition to the national studies, Colorado State University (CSU) has investigated reform, including Calculus for Physical Scientists I (MATH 160), including multiple course format changes, and research. Extensive reform literature indicates a decline in student achievement in calculus, and is summarized in Table 2.1.

Table 2.1

Calculus Research and Reformation at Institutions of Higher Education

Institution	Researchers	Findings
Northern Illinois University	House, 1995	Lower levels of achievement in mathematics courses restrict entry into careers.
Tennessee Tech University	Selden, Mason, & Selden 1989	Calculus students deemed average are at a loss with problem solving.
National Research Council	NRC, 1989	Reform is only possible by the revitalization of calculus courses and current teaching styles.
Florida State University	Windham, 2008	Calculus reform should be addressed at all universities, but this reform will be met with resistance.
Colorado State University	Reinholz, 2009	40% of students finish with a grade of D or lower in Math 160.
Colorado State University	Pilgrim, 2010	By adding an intervention course, data indicated higher final exam scores and course grades for students in the group in the intervention.

Research (Selden, Mason, & Selden, 1989; Reinholz, 2009; & Pilgrim, 2010) stated that of all students initially enrolled in calculus 40 percent finish with a grade of D or lower, drop, or withdraw from the course. Because of the high failure rate, students who do not earn a grade of C or higher in calculus courses have to re-take the course or change degree programs.

Calculus reform which from an instructor development perspective provides four reasons why this failure rate should be of concern: 1) the mission of CSU and the university's focus on setting a high standard for public higher education in teaching; 2) "if only a small proportion of students are successful in MATH 160, then only a small proportion of students continue on-track in natural sciences and engineering programs" (Pilgrim, 2010, p. 18); 3) this drop in students from going into natural sciences and engineering programs leads toward fewer students receiving bachelor's degrees in these fields, which also contributes to fewer people working in natural sciences and engineering (Pilgrim, 2010); and 4) failing is a waste of student and faculty time and effort that could be better applied to other efforts and really impacts CSU's efforts to increase the number of Science, Technology, Engineering, and Mathematics (STEM) graduates.

Both faculty and administration at CSU have concern for this high failure. This chapter describes past research on student achievement in calculus and rational for needed improvement in the number of students passing calculus courses.

Mission of Colorado State University

School leaders and administrators need to provide strategic focus to their schools, colleges, and universities (Fayad, 2011). One way to achieve this is through a mission statement. According to Radtke (1998), "every organization has a mission, a purpose, a reason for being. Often the mission is why the organization was first created – to meet a need identified years ago" (p.1). Fayad (2011) stated that, "mission statements play a paramount role in the process of

conveying a sense of purpose to an organization and the strategic directions that it may take" (p. 2).

Land grant universities, including CSU, have carefully crafted mission statements that express organizational purpose to foster student, faculty, and support staff support. CSU established core values of how it wants to be perceived by the public who financially support the school. The following statement, excerpted from the Board of Governors of the Colorado State University System (2005) relates to the university's mission statement:

> The Colorado State University System is committed to excellence, setting the standard for public higher education in teaching, research, and service for the benefit of the citizens of Colorado, the United States, and the world. Inspired by its land-grant heritage, Colorado State University is committed to excellence, setting the standard for public research universities in teaching, research, service and extension for the benefit of the citizens of Colorado, the United States, and the world (*www.colostate.edu,* 2005).

The idea of setting the standard of excellence in teaching is not consistent with the 40 percent failure rate in MATH 160.

Development for Instructors

One idea to help increase student achievement is through the development of mathematics instructors. Selden, Selden and Mason (1994) stated, "persistent high dropout and failure rates in traditional courses and mounting evidence that even apparently successful students acquire limited understanding of calculus concepts have convinced many instructors that there must be better curriculum materials and teaching strategies (p. 19). And through instructor development, teaching strategies can be modified or improved. Schoenfeld (1997) stated, "initiatives have tried to present key calculus concepts in more depth with less stress on memorization of algorithms and symbol manipulation" (p. 2). Selden et al. and Schoenfeld both

referred to changing instructor behaviors; behavior modification can be done through an effective instructor development program.

In addition to materials and content reform, few mathematics programs have researched techniques to improve instructor delivery of calculus to undergraduate students. According to Keynes and Olson (2002), "a central issue facing undergraduate mathematics instruction is finding ways to encourage innovation and improvement of both content and instructional methods" (p. 113). In an instructor development intervention, Ahmadi and DeMarois (2002) stated, "mathematics educators have increased the use of active learning strategies in mathematics classrooms" (p. 107). However, not enough research has been completed. Butler (2008) stated, "little research has been conducted to analyze the success of professional development for teachers, while there have been many calls to complete such research" (p. 55). In an attempt to provide findings, Butler (2008) also stated, "results from the research literature and from experiences conducting and maintaining professional development workshops lead the author to believe that much more work needs to be done to offer effective professional development for teachers in mathematics" (p. 57). According to Tall (2008), many of the changes made in calculus courses were based on opinion rather than any clear empirical base.

Because instructors of calculus are teaching a complex class, instructors struggle to help students understand the concepts and content. According to Thompson, Cheepurupalli, Hardin, Lienert, and Selden (2010),

> In order to succeed in calculus, students must make connections among concepts and between concepts and symbolic expressions of them. Unfortunately, many students enter calculus with a long history of experiencing mathematics as rules without reason on marks without meaning. (p. 1)

According to Thompson et al. (2010), students do not attach the proper meaning and values to symbols. When this happens, students are likely to "fail to conceptualize calculus properly and appreciate its importance" (Thompson et al., 2010, p. 1). However, Thompson et al. (2010), believed "calculus instructors can assist students by changing the culture of their classrooms" (p. 4) which can be learned through instructor development.

Frid (1994) suggested calculus reform has primarily focused on curriculum instead of the development of instructors.

> In recent years, educators have recommended a number of curriculum reforms in calculus instruction. Recommended changes include: 1) shifting the focus of calculus teaching to the fundamental ideas of calculus, rather than emphasizing drill in routine skills and techniques, 2) integrating applications into the body of calculus courses by reinforcing the roles of approximations and problem situations with contexts relevant beyond the field of mathematics, 3) producing textbooks to support curriculum changes, and 4) integrating computing technology into calculus curricula. However, research into the teaching and learning of calculus is in an embryonic state. Studies are needed of various instructional emphases and formats and their subsequent effects on learning. (p. 69)

Although educators favor change in instruction of calculus, Frid (1994) stated, that, "a crisis exists in the teaching of undergraduate calculus" (p. 70) and there needs to be a focus on the way instructors teach the course.

The study of instructor development programs for mathematics instructors as a way to improve student achievement is an important influence in calculus education research because it provides a valuable perspective from which to understand mathematics learning (Frid, 1994). Supovitz and Turner (2000) stated, "staff development lies at the heart of nearly every educational effort to improve student achievement" (p. 963). Hawley and Rosenholtz (1984) stated, "virtually every instance in which researchers have examined the factors that account for student performance, teachers prove to have a greater impact on the program. This is true for average students and exceptional students, for normal classrooms and special classrooms" (p. 3).

Appreciating a 40 percent failure rate in MATH 160 is high, this research focused on the dynamics of optimizing student achievement through instructor development and course improvement (Swanson, 2001).

Supovitz and Turner (2000) suggested, creating high quality professional development opportunities for instructors that model inquiry forms of teaching to provide instructors with teacher immediacy and communication competence skills. In a like manner, instructor development models could be used to examine the student perspective of instructor behavior and focus on instructor delivery. Instead of restructuring a course, reform may come from improving instructor behavior, including teacher immediacy and communication competence, to seek improvement on student achievement. Previous studies that examined instructor behavior tended to focus on the motivation of teachers and efficacy (Gorrell, 1990; Schaller, 1993) from the instructor perspective, but lack the perspective of the students.

Measuring student achievement based on teacher immediacy and communication competence could provide an opportunity to explore how these behaviors could be beneficial to CSU instructors and students. Teacher immediacy, measured by using the constructs of instructor use of humor, addressing students by their names, providing feedback and gesturing positively while talking to the class (Mehrabian, 1967), are all skills that can be taught through instructor development. Likewise communication competence, measured with the constructs of instructor use of "support for students, empathy, behavioral flexibility, social relaxation, and interaction management" (Schaller, 1993, p. 65) to work with students, are skills that can also be taught to instructors teaching MATH 160 through the use of instructor development.

Research Constructs

Using student-focused techniques to foster student achievement is not new; "teachers are called to guide students through the information resources rather than distribute content" (Gumport & Chum, 2005, p. 407). Teachers provide student focused help in calculus in order to explain the material in different ways (Groth, 2008) providing students with varied learning styles (Dunn & Dunn, 1978) to adopt and learn the information. To analyze how instructors manage varying teaching behaviors, this study delineates constructs into multiple elements, or behaviors used by teachers: teacher immediacy, communication competence, and student achievement.

Teacher Immediacy

Instructors who use teacher immediacy behaviors enhance closeness and generate positive attitudes (Mehrabian, 1969). These teachers also decrease physical and/or psychological distance between themselves and their students (Mehrabian, 1971). Several studies analyze the use of teacher immediacy behaviors (Andersen, 1979; Gorham, 1988; Plax, Kearney, Richmond, & McCroskey, 1986; Richmond, Gorham, & McCroskey, 1987). Mehrabian (1967) defines teacher immediacy as the degree of perceived physical and/or psychological closeness between people. Christophel (1990) added, "in behavioral terms, immediacy is based on an approach-avoidance theory and is an affect-based construct" (p. 325).

Teacher immediacy plays a significant role in education. According to Rourke, Anderson, Garrison, and Archer (2001):

> The designation of this line of research as teacher immediacy implies an instructor-centered perspective of the teaching-learning relationship where the teacher plays a central and authoritative role in the classroom. According to this perspective, the creation of a warm, open, and trusting environment is regarded primarily as the responsibility of the teacher. In the community of inquiry model, teachers and learners participate in a

> learning transaction that is more readily identified with constructivist rather than instructivist orientations. Therefore, in the community of inquiry model, social presence is regarded as a function of both learners and teachers. (p. 7)

This helps provide an environment that may allow teachers and students to interact with each other without significant teacher behavior and communication barriers to learning the objectives in class. Teacher immediacy behaviors include the use of humor, addressing students by name, providing feedback, and gesturing and smiling while talking to the class (Schaller, 1993). All of these traits have been studied as predictors of instructional effectiveness and were correlated with favorable student attitudes, but not shown to correlate with student success (Christophel, 1990).

Past research (McCroskey, Fayer, Richmond, Sallinen, & Barraclough, 1996; Burroughs, 1990; Plax, Kearney, McCroskey, & Richmond, 1986) focused on the value of non-verbal communication in the classroom. McCroskey et al., (1996) has provided a basis for additional research on immediacy behaviors in the classroom and stated,

> Research has established that nonverbal immediacy has mediational as well as direct effects on student's affective learning. For example, research focused on teachers' influence attempts indicates that the impact of these attempts is mediated by the immediacy relationship between teacher and student. Immediate teachers' influence attempts are more effective and less likely to result in student resistance than are those attempts of less immediate teachers. Clearly, immediate teachers exert more power and influence and have more of a positive impact, both directly and indirectly, on their students' affective learning than do non-immediate teachers. (p. 297)

Humor

Teacher immediacy consists of several aspects, including the use of humor by an instructor. Kher, Molstad, and Donahue (1999) stated, “humor is a valuable teaching tool for establishing a classroom climate conducive to learning” (p. 400).

In a study done by Bryant, Comisky, and Zillmann (1979) findings "indicated that most of the humor employed by college instructors is closely related to the primary educational message and contributes at least moderately toward getting the point across" (p. 117). Bryant et al., (1977) did not show any "significant impact on students' perceptions of their teachers or on instructional effectiveness" (p. 117). However, Kaplan and Pascoe (1977) stated, "the use of humor significantly increases recall for only those items based on humorous examples" (p. 65).

Kaplan and Pascoe (1977) and Bryant et al., (1979) laid the foundation for subsequent studies. Ziv (1988) found that "humorous illustrations and test items should be kept in mind when preparing the inclusion of humor in teaching" (p. 13), and further suggested teachers should choose the kind of humor that fit the type of objectives and teaching that occurred in their classrooms.

In a research study completed by Matthews (2011), "scientist are beginning to have a better grasp on the connection between humor, emotional states, and memory" (p. 14) showing that stress-reducing behaviors, including humor, are being recognized by researchers as strategies to increase student achievement in class (Matthews, 2011). The use of humor in the classroom becomes another behavior used by teachers to reduce the levels of anxiety shown by students learning difficult topics. The explicit use of humor has the benefit of increasing student achievement and engagement in the classroom (Holmes, 2007).

Students' Names

Teachers using immediacy call a student by name, allowing for a decrease in physical and/or psychological distance between the teacher and the student (Mehrabian, 1971). This is not always possible in large section classes, but Rourke et al., (2001) stated that addressing students by name "suggests that these types of behavior also contributing significantly to

students' affective learning" (p. 5). The first researcher to publish research on oral behaviors, Gorham (1988) stated behaviors such as talking about outside the classroom experiences and addressing students by name are behaviors that are supportive of student achievement.

According to Zapf (2008), "when working to establish rapport with students and motivate future student contact with the instructor (principles of good practice), instructors may choose to refer to students by first name on a regular basis" (p. 16) to help students become more comfortable and help achieve goals set in class. This type of immediacy behavior encourages dialogue by opening communication channels with the instructor (Zapf, 2008). The use of building rapport by addressing students by name helps create successful integration of student participation, comfortable communication, and the goal of facilitating meaningful discussion and cooperation between instructor and students (Zapf, 2008). This strategy not only aligns with the immediacy behavior of encouraging students to participate, but affords instructors the opportunity to provide feedback on student achievement (Gorham, 1998), because the student and instructor have created a first name relationship with each other.

The use teacher immediacy behaviors can help remove the hierarchical levels that separate an instructor from a student. A student who is called upon by first name is more likely believe hierarchical levels are less intimidating (Zapf, 2008).

Student Feedback

Providing students with feedback is another aspect of teacher immediacy. According to Oliver, Yeo, and Tucker (2000), "feedback is any response made in relation to students' work such as an assessment" (p. 2). Chamberlain, Dison, and Button (1998) stated,

> Feedback is intended to acknowledge the progress students have made towards achieving the learning outcomes of a unit. Good feedback is also constructive, and points students

> to ways in which they can improve their learning and achievement. Providing a mark or a grade only, even with a brief comment like "good work" or "you need to improve" is rarely helpful. (p. 15)

Providing feedback to students has long been studied. More than fifty years ago, researchers addressed feedback as contingent events that reinforced or weakened responses by students (Mason & Bruning, 1999). Others extended teacher immediacy behaviors to include cognitive learning to show how much a student thought they learned in the class (Rourke et al., 2001). Rourke et al., (2001) suggested teachers who provide feedback more often than before on the likelihood those students would use the theories learned outside the classroom. According to Kulhavy and Stock (1989),

> Effective feedback provides the learner with two types of information: verification and elaboration. Verification is the simple judgment of whether an answer is correct or incorrect, while elaboration is the informational component providing relevant cues to guide the learner toward a correct answer. Most researchers now share the view that successful feedback (feedback that facilitates the greatest gains in learning) must include both verification and elaboration. This combination can highlight response errors, give correct response options, and provide information that both strengthens correct responses and makes them memorable. (p. 280)

Effective feedback allows teachers to open lines of effective communication between themselves and students through the use of teacher immediacy and provides a mechanism to elicit correct responses from students.

Using Gestures

The final aspect of teacher immediacy is gesturing, smiling, and talking to the students in the classroom. Studies (McDowell, McDowell, & Hyerdahl, 1980; Richmond, Gorham, & McCroskey, 1986; Gorham, 1988) showed that non-verbal teacher immediacy associates with cognitive learning at the college level and that smiling at the class, having a relaxed body

position, and expressive gestures emerged as particularly meaningful to students; while increased teacher movement and using hand gestures related clearly with increased learning for students.

Previous studies (Richmond, Gorham, & McCroskey, 1986) supported a relationship between teacher immediacy and student achievement. According to McCroskey et al., (1996),

> The relationships between nonverbal immediacy and affective learning are consistent across cultures. Our results indicate that, in all four cultures, increased teacher immediacy is significantly associated with increased affect toward the content of the class and, in three of the four studies, increased immediacy is associated with increased willingness to enroll in another class in the same subject matter. The simple correlations between overall perceptions of teacher immediacy and affective learning as well as the multiple correlation (regression) were all positive and accounted for 6-24% of the variance in affective learning. (p. 303)

However, these findings were not found in calculus courses. Previous research focused on multiple cultures, ethnic groups, and socioeconomic status in the classroom and not on learning complex topics such as MATH 160.

Teacher Communication Competence

Prior research on communication competence demonstrated that "teachers who communicate competently are able to facilitate student learning" (Schaller, 1993, p. 35) while still providing a comfortable classroom. Rubin (1990) pointed out that teachers who use communication competence have a "repertoire of skills that encompass both appropriate and effective means of communicating" (p. 96). Shallar (1993) added a situational element. Hurt (1984) stated "all of the subject matter in the world will not make a teacher competent unless that information can be accurately and appropriately moved to students" (p. 152).

Because instructors spend a great deal of time communicating, communication competence is a necessity (Schaller, 1993). Instructor communication disseminates the majority

of the information to students. McCroskey and Richmond (2006) stated, that in the classroom, effective communication competence equals communication effectiveness (p.27). For calculus, effective communication between the instructor and student "can provide a basis for understanding reality" (Fiske, 1982, p.129).

Passing information to others is a primary purpose for communication (Light, 1988), and people who are effective communicators more likely engage more effectively with others (Wright, 2010). Students struggling in class likely opt to engage with instructors who have the ability to effectively communicate.

The measurement of effective communication is difficult. Instructors communicate by the basic description of their profession. Many instructors may believe they are effective at communication. According to Schirmer, Mauksch, Lang, Marvel, Zoppi, Epstein, Brock, and Pryzbylski (2005),

> Assessing communication competence is complex. Skills that require performance are difficult to assess through disembodied means (such as written tests) but require in-vivo demonstration. Further, competence is not defined solely by the presence or absence of specific behaviors but rather by the presence and timing of effective verbal and nonverbal behaviors within the context of individual interactions with patients or families. Effective communication includes the ability to adapt, to be responsive, and to manage self-awareness during the process of talking and listening. (p. 184)

It is the understanding the complexity of communication competence that may allow an instructor to effectively communicate with students.

Like teacher immediacy, communication competence consists of several behaviors exhibited by teachers including affiliation/support of students, empathy, behavioral flexibility, social relaxation, and interaction management.

Affiliation/Support

Teachers show students how to behave in the classroom. Studies, including Moos (1978) showed that "Students expressed greater satisfaction in classrooms characterized by high student involvement and affiliation, by innovative teaching methods, and by clarity of rules regarding classroom behavior" (p. 63). Linking back to communication competence, teacher support for high student affiliation has provided information about student achievement based on how they are supported by their teachers. Trickett and Moos (1974) developed the Classroom Environment Scale (CES) to link student satisfaction to the social environment to provide guidance to teachers for showing how to support student achievement.

DeYoung (1977) stated "several researchers have investigated and/or suggested ways of making social science classes interesting and exciting as well as intellectually challenging" (p. 252). DeYoung (1977) also stated "the best way to capture undergraduate student participation is to humanize classroom instruction" (p. 252) utilizing student evaluations of teacher behaviors. Although DeYoung (1977) stated,

> the study suggested that the social climate methodology can be a useful tool in helping an instructor understand the organizational dynamics of his or her class from the students' viewpoint. Furthermore, the social climate change logic suggests at least one way of improving instruction in the social sciences. (p. 256)

Collecting data for his study was difficult and that the measurement of affiliation and support were not easily attained. Affiliation and support from a social perspective add a perspective of the instructor becoming more of a facilitator in the classroom, rather than teacher. DeYoung (1977) also stated,

> While college instructors may have little control over various institutional variables which dictate when and to whom they must teach, they still may have the ability to improve the social climate of their classroom, which may be a very rewarding option indeed for both the student and the teacher. (p. 256)

This control of social climate creates a sense of teacher involvement with students, creating a support system for students in the classroom.

Research on teacher support for affiliation commences with Walberg's (1969) studies showing the learning environment in science and physics related to student interest in physics. Classroom environment, students notwithstanding, becomes more valuable to add teacher behavior to the research to verify a relationship between communication competence and student achievement.

Empathy

Eisenberg and Strayer (1987) defined empathy as "an affective response more appropriate to someone else's situation than to one's own with concern, compassion, and tenderness experienced as a result of witnessing another person's suffering" (p. 3). Teachers who use empathy in their teaching believe they can understand the situation or situations of the students in their classroom (Eisenberg & Strayer, 1987).

A real need for "concrete human relations training programs" (Redman, 1977, p. 205) developed in the 1960s when the first inclusion of teacher empathy appears in modern research. Although Redman (1977) focused on minority students, his finding revealed,

> that the obtained *t* (paired sample) values of 4.35 and 5.64 on pre-post-mean differences were significant at the .001 and .000 levels, respectively. Hence one may say with surety that a positive change in empathetic reaction to minority persons appears to have occurred in a significant segment of the program participants and the magnitude of that change appears meaningful. (p. 209)

Redman's (1977) findings provided a starting point for the effectiveness of instructors using empathy as a teaching tool in the classroom. Redman (1977) stated, "the findings reported

herein suggest training may well have a greater and more lasting impact" (p. 209) on students in the classroom.

According to McAllister and Irive (2002), "empathy involves cognitive, affective, and behavioral components that teachers believed were manifested in their practice" (p. 433), which allowed teachers to understand the perspective of the student. By understanding that students struggle in different classes like MATH 160, not just knowing that they are struggling, but understanding what makes students struggle, may help instructors become more effective in teaching a complex topic.

Behavioral Flexibility

Behavioral flexibility is the ability of a teacher to "cope with wide ranges of environmental circumstances" (Thomas, 1977, p. 488). Behavioral flexibility allows a teacher to rely on more than a single behavior to deal with multiple students, circumstances, and situations. The ability to change one's own behavior to fit a situation, particularly for a teacher, requires complex quantification and measurement, but when related to communication competence, flexibility is necessary and requires thinking to generate student interest (Thomas, 1977).

Brophy (1988) stated, "the emphasis is on process-outcome research linking teacher behavior to student-achievement gain, the key to achievement gain is the time they spend being actively instructed by their teachers" (p.235). Students who benefit from teachers who actively engage in behavioral flexibility more likely have a stronger relationship between themselves and their teacher.

Many instructors have only one teaching style, which could possibly have a negative impact on a student whose learning style is different from the teacher's style. By providing

instructors with training on multiple learning styles, students may mesh more aptly with the instructor's style (Brophy, 1988).

Social Relaxation

The literature defined social relaxation as the ability of a teacher to stay calm in extreme circumstances. Wrightstone (1933) first studied the effects of the social classroom as early as 1933, stating that the "measurement of democracy in children's behavior related to the social setting in the classroom should be analyzed" (p. 34). In a study that followed the 1933 study measuring the social climate of the classroom, Wrightstone (1951) stated,

> careful observers with knowledge of the dynamics of a group action can assess in a crude way the social climate of a classroom. In one classroom they may discern a warm and friendly climate, in another a temperate and cooperative climate and in another a cool and unfriendly climate. If the personal and social development and growth of children is an important objective of education, it is essential to measure and study more carefully and systematically the effects of social climate on the behavior of pupils in a classroom. (p. 341)

Wrightstone (1951) believed that "it is generally recognized that social climate is an important factor in learning" (p. 341). His studies in social climate and student achievement in the 1950s set the foundation for future research. Marshall (1990) stated "teachers are trained under the assumption that students come to school to work" (p. 96) and that work is drudgery and working hard is the only way to be successful. In this study Marshall (1990) also stated, "that this stereotype should not exist and that teachers and instructors need to explore a more socially relaxed environment" (p. 96).

Setting the tone in the classroom by using a carefully planned social atmosphere was also studied at the Army's War College (Beckett, 1985; Krueger, Harig, & Price, 1995) where social relaxation takes on the demeanor of being in control and not panicking under pressure. The War

College studies focused on stresses felt by the family members of soldiers who deploy on combat missions, and with the stresses of military nurse work. In the classroom, the teacher's understanding of the role of the instructor in regard to social relaxation sets the tone and climate of the class by minimizing stress.

Interaction Management

Interaction management is the use of teacher-to-student and student-to-student interaction to enrich the learning in the classroom. Driver (2001) stated, "vicarious interaction significantly affects student class satisfaction. In some way, perhaps group interaction is vicarious when it comes to overall class interaction even in the absence of significant learner–instructor interaction" (p. 37). Interaction management has similarities with social interaction, as teachers may use classroom discussion to help set the atmosphere in the classroom and control the behaviors of their students while under pressure.

Wilson, Woods, and Gaff (1974) stated that "effective education requires close working relationships between faculty and undergraduate students" (p. 74) and that "faculty beliefs or attitudes which support a view of education as an interactive process and faculty behaviors which appear to invite discussion both within and beyond the classroom" (p. 81) associated with student achievement. Their findings went beyond interaction within the classroom, and discussed the benefits of instructor and student interaction outside the classroom too. Wilson et al., (1974) stated,

> Whether implicitly or explicitly, many recent indictments of higher education have been made from a philosophical vantage point which posits the importance of close faculty-student interaction not only as a means by which the transmission of knowledge and student intellectual growth is best facilitated, but as an educational goal in and of itself. (p. 74)

Wilson et al., (1974) showed a correlation between instructor-student interaction and discussion beyond the classroom as a necessity for student success at the college and university level. Interaction management in the classroom, before or after class, or during office hours helps create a relationship based on course objectives allowing clearer communication competence between instructors and students.

As a complex and difficult class, MATH 160 has proven a very stressful class for students (Klopfenstein, 2011) where success through instructor and student interaction may help alleviate the levels of stress produced by learning a complex and difficult topic. Teachers' use of interaction management to control the atmosphere of the class may allow students to feel more comfortable and willing to interact with the instructor, in the classroom, outside the classroom, or during office hours.

Student Achievement

Student achievement is an outcome of student learning. Student learning, according to Bloom (1956), is learning that has been "conceptualized as a process involving the acquisition or modification of cognitive, affective, and/or behavioral outcomes" (p. 57). Christophel (1990) added, "specifically, cognitive learning emphasizes comprehension and retention of knowledge" (p. 323). With a difficult concept like calculus, active learning techniques bring about an increase in student achievement. Kaput, Schoenfeld, and Dubinsky (1991) stated,

> Involving students in doing mathematics instead of lecturing at them; stressing conceptual understanding, rather than only computation; developing meaningful problem-solving abilities, not just "plug-and-chug"; exploring patterns and relationships, instead of just memorizing formulas; becoming engaged in open-ended, discovery-type problems, rather than doing routine, closed-form exercises; and approaching mathematics as alive exploratory subject, not merely as a description of past work. (p. 156)

Past research (Douglas, 1986; Ganter, 2001; Reinholz, 2009; & Pilgrim, 2010) showed that creating an environment that is student centered and facilitates active learning is important when teaching calculus. Pilgrim (2010) stated, "it was believed by mathematics instructors that students should have the opportunity to explore calculus concepts in various forms and that an active learning environment is necessary for calculus instruction and learning" (p. 22).

Standardized exams measure student achievement. Using standardized exams allowed for an entire student sample to complete the same objective measurement process.

Gender and Learning

Research (Wei1, Lu1, Zhao, Chen, Dong, & Zhou, 2012) indicated that gender differences in math has long been examined. Weil et al., (2012) stated that "results showed that gender differences in arithmetic were significant and favored girls" (p. 329) and that the more complex the mathematic, including calculus, females tended to score higher on exams (Weil et al., 2012). In contrast, Linn and Hyde (1989) stated,

> Males have greater access to science and technical fields and greater earning power than females. Many argue that cognitive and psychosocial gender differences explain these career differences. In contrast, evidence from meta-analysis and process analysis indicate that (a) gender differences on cognitive and psychosocial tasks are small and declining, (b) gender differences are not general but specific to cultural and situational contexts, (c) gender differences in cognitive processes often reflect gender differences in course enrollment and training, and (d) gender differences in height, physical strength, career access, and earning power are much larger and more stable than gender differences on cognitive and psychosocial tasks. (p. 17)

Linn and Hyde (1989) believed that the gender differences in exam scores are related to cultural differences in the students and not gender differences. Glazer (2005) stated that, "some differences are well established. Girls do better on tests of content learned in class and score much higher on reading and writing tests than boys" (p. 208). Glazer (2005) followed that

statement with, “boys score higher on standardized tests with math and science problems not directly tied to their school curriculum” (p. 208).

Although claims have been made to identify which gender, male or female, perform better in complex courses, the fact remains that there is much disagreement amongst researchers. According to Ehrenberg, Goldhaber, and Brewer (1994),

> Females are underrepresented in many scientific and engineering fields at the collegiate level, both as students and faculty. A major reason for this is that by the time females reach the ends of their high school careers, they perform, on average, poorer than males in many science and mathematics classes and on standardized tests (p 1).

Ehrenberg et al., (1994) provided more disagreement among scholars while adding little or no validity to the argument of which gender performs better in mathematics.

Ehrenberg et al., (1994) stated, “data suggest that for the most part these teacher characteristics do not affect how much students learned” (p. 13) when dealing with the gender of the teacher. Harding (1996) stated, “what is clear to educationalists is that interactions between gender and science result in the alienation of women and girls from math and science, especially from physical sciences” (p. 3) creating a need for more female instructors in mathematics.

What research neglected to agree upon is a clear understanding of gender and learning in complex courses like MATH 160. Dynamics created in the classroom between male students and male instructors, female student and female instructors, and the opposite, male students and female instructors and female students and male instructors provide a need for further research on student performance based on gender.

Summary

As stated previously, the national trend at universities for undergraduate students studying calculus is difficult. Both the MAA and NSF state about 40 percent of the students enrolled in calculus for natural science and engineering majors earn the grade of D or lower (Ganter, 2001). This high rate of failure has created a national call for calculus reform that has driven changes in calculus pedagogy. Tall (1996) stated, universities should "make calculus a genuine driving force for learning instead of a filter which weeded out poor students" (p. 2). In addition, the NSF provides grants and awards to researchers and teachers who address calculus reform (Pilgrim, 2010).

By studying instructor behavior in the classroom, this study looked at one aspect of calculus reform. This study included the behaviors of teacher immediacy and communication competence. Teacher immediacy behaviors, as defined by Mehrabian (1971), draw people "toward persons they like, evaluate highly, and prefer" (p. 1) where communication competence opens lines of communication between instructor and student where students feel more comfortable in the class. Results from Kearny, Plax, and Wendt-Wasco (1985) indicated "that teacher nonverbal immediacy was a significant predictor of affective learning" (p. 74) and results from Rubin and Feezel (1986) stated that communication competence "as measured by components of credibility and communicator style, is positively associated with perceived teaching effectiveness" (p. 13).

According to Bloom (1968), students who spend more time focusing on a concept have a deeper understanding and tend to perform with more proficiency. Bloom (1968) also stated that students' must put in much more time on school tasks to achieve this level of proficiency.

Otherwise known as mastery learning, Bloom's concepts for learning have shown effective for students. However, MATH 160 is held to a rigid time-line and students often do not have more than the fifteen weeks allotted for the course. Bloom's ideas, however, might be validated and supported, by the number of students attending the Institute for Learning and Teaching's tutoring program (www.tilt.colostate.edu, 2011).

Another criticism of Bloom's concepts includes the time needed to professionally develop instructors to teach mastery learning. Instructor development, as a subset of human development has been identified "as the discipline that takes care of people (including competency, motivation, helping people achieve success and making work meaningful)" (Rouna, Lynham, & Chermack, 2003, p. 277) and analyzing if the Department of Mathematics has the time available to provide an effective instructor development program. This study examined the behaviors of instructors in the classroom who teach MATH 160, i.e., if these instructors used teacher immediacy and communication competence to provide an opportunity for student achievement.

However, instructor behavior, such as teacher immediacy and communication competence is difficult to quantify improvement. Educational institutions do not currently measure teacher immediacy and communication competence behaviors to extract the amount required to increase student achievement in MATH 160.

Conclusion

The researcher has designed this study to identify the relationship between teacher immediacy and communication competence of instructors from the student perspective in MATH 160 and student achievement. Understanding the importance of ideas to increase student

achievement without spending additional funding could be extremely critical. By comprehending the meaning of teacher immediacy and communication competence from the literature, instructors currently do not know the importance of understanding how these constructs may help student achievement. The current lack of empirical research on instructor development could help validate a need for this study. Even if a slight increase in the percentage of students who pass MATH 160 occurs, the return on investment of instructors showing more teacher immediacy and improved communication competence is valued.

As stated in *Positive Organizational Scholarship* (2003), "The manifestation and consequences of hope, gratitude, wisdom, forgiveness, compassion, resilience, and other similar virtues are beginning to receive substantial attention in the scientific literature" (Cameron, Dutton, & Quinn, p. 49). Finding any increase in student achievement in MATH 160 due to teacher immediacy and communication competence, however minor, could prove beneficial to universities, instructors, and therefore warrant further study.

CHAPTER THREE: METHODS

Research Design and Rationale

This section discusses the proposed methodology used to address the research questions in regards to teacher immediacy, communication competence, and student achievement as follows: description of the design, description of the participants, rationale for data collection procedures based on methodology choice, discussion of instrumentation, including scale of measurement, and the presentation of research questions and corresponding analysis.

The overall purpose of this study explored if a relationship existed between teacher immediacy, communication competence, and student achievement. A secondary purpose is to provide recommendations for instructors and mathematics departments to help increase the number of students who successfully complete Calculus for Physical Scientists I. Accordingly, this study examined if teacher immediacy and communication competence from the student perspective played a role in student achievement on calculus exams. The investigation intended to use both quantitative and qualitative research paradigms (Creswell, 2009). The study was grounded in empirical research and theoretical in literature by examining teacher immediacy, communication competence and student achievement and providing a test of theory to verify if this correlation existed.

Type of Research/Methodology

The reason for conducting mixed method research using both quantitative and qualitative analysis was to understand the degree of correlation of achievement on exams, because of teacher immediacy and communication competence, and to find meaning in this relationship. The implementation of a sequential explanatory study was where the researcher used a quantitative method prior to the qualitative method. The first part of this study involved a survey, which provided numeric data, which according to Creswell (2009) was classified in the quantitative paradigm. This was an associational approach because this study used two or more continuous variables from the same group of participants and did not determine the cause of differences in the dependent variable (Gliner, Morgan, & Leech, 2009). In addition, the second part of this research included interviews and focus groups conducted toward the end of the fall 2011 semester. These interviews and focus groups were completed via interviews set up with students who performed either extremely well on the course exams, or who scored extremely poor on the course exams.

For the quantitative portion, the sample was not randomly selected; this was considered non-experimental research using a survey to collect data that used a quantitative instrument on a Likert scale, which was designed to produce measurable statistics or results. The use of quantitative analysis was helpful in identifying whether the level of teacher immediacy and communication competence played key roles in influencing student achievement.

Respondents selected a value assigned between 1 and 5 for how they perceived teacher immediacy and communication competence of their instructor in MATH 160 and the measurement of student scores on standardized exams given in class. The exams given in all 11 sections of MATH 160 were the same.

The correlational analysis identified the rationale for why this phenomenon existed or did not exist (Creswell, 2009). To examine this phenomenon, qualitative interviews and focus groups were used. In addition, an examination whether a prediction could have been made between the constructs of teacher immediacy and communication competence on student achievement with a sample.

The type of data collected in the qualitative portion were based on subjective values, where respondents explained how they perceived teacher immediacy and communication competence of course instructors in MATH 160 and the measurement of student scores on standardized exams given throughout the course.

Rationale for Sequential Explanatory Mixed Method Design

The rationale for the proposed sequential explanatory mixed method design was to use quantitative analysis to explore an association, or relationship, between the constructs where the researcher should have "considered an approach to research where the independent variable was usually continuous" (Gliner et al., 2009, p. 50) as shown in teacher immediacy and communication competence in the classroom. Quantitative research according to Keller and Casadevall-Keller (2009) is "used to find statistical relationships between variables" (p. 49).

The instruments chosen for this study had questions that were correlated with standardized MATH 160 exams. The assumptions of the research survey were that the instrument used and developed provided accurate and reliable data. In addition, the answers provided by the respondents were assumed to be honest and reflect true feelings and beliefs about MATH 160 instructors.

The qualitative portion of the sequential explanatory mixed method design research was conducted through small focus groups and interviews that collected data to help find meaning in the data collected during the quantitative analysis. By using a mixed methods approach, both empirical and interpretive data were collected and analyzed. According to Creswell (1994), "the procedure for a qualitative study includes advancing the assumptions of qualitative designs, indicating the specific type design, reflecting on the researcher's role, discussing the data collection, developing data recoding procedures, identifying data analysis procedures, specifying verification steps, and delineating the narrative outcomes of the study" (pp. 143-144). By using both quantitative and qualitative designs, the researcher anticipated both statistical significance and interpretive meanings.

Scope

The scope of this study included teacher immediacy and communication competence related to student achievement. By focusing on one academic unit at CSU, this study limited the instructors and students to similar classroom schedules, course content, and objectives. Also limiting the scope were the constructs of the study. By limiting the scope to this specific population and to these constructs, the research focus was more narrowly defined creating greater internal validity. The research in this study was associational and there was only one group being studied (Gliner et al., 2009).

Participants

The survey participants included all students who were taking MATH 160 at CSU in the fall of 2011. The theoretical or target population, which included "all of the participants of a theoretical interest to the researcher" (Gliner et al., 2009, p. 117), included all students enrolled

in Calculus for Physical Scientists I (or STEM calculus courses) at all universities. The interview participants included the same sample but were limited to students who had done extremely well on the course exams and others who had done poorly on the course exams. Due to time and monetary restraints, it was not feasible to survey all students taking Calculus for Physical Scientists I at all universities, so sampling was used "as the process of selecting part of a larger group of participants with the intent of generalizing from the sample (the smaller group) to the population (the larger group)" (Gliner et al., 2009, p. 115).

The accessible population, or group of participants to which the researcher had access (Gliner et al., 2009) for this study consisted of students who were enrolled in MATH 160 at CSU in the fall 2011 semester. There were 11 sections of MATH 160 offered in the fall of 2011, with a total of 450 enrolled students. All 11 sections were used in the sample.

Sampling Selection

The sample used for quantitative portion of this study was based on the location of the respondents and the significance of how much research and time has been spent working on calculus failure rates in the past. Known as an accessible and convenience sample, this was the group of participants to which the researcher has access (Gliner et al., 2009).

For this study, the selected sample was a smaller group of participants selected from the larger accessible population of students enrolled in MATH 160. This study included 268 students who completed the online survey and eight students who were interviewed. These students were all in the accessible population because they all had been asked to participate in the study.

Due to the sampling technique, the population external validity of this study was low. Because the sample was taken from the 11 sections of MATH 160 scheduled at CSU in the fall of 2011, the researcher did not use a random or other probability sampling design (Gliner et al., 2009), but studied the entire population of MATH 160 students available for the fall of 2011. These results are generalizable to the fall 2011 students at CSU but may not be generalizable to other semesters or universities. Also related to external validity, the ecological external validity was medium to high because the survey was given in the students' natural setting as assigned work done on RamCT, where the students involved were already submitting classwork (Gliner et al., 2009).

The sample used for qualitative portion of this study was designed by the researcher to interview ten students enrolled in MATH 160 during the fall semester, 2011. The researcher contacted ten MATH 160 students for interviews and focus groups. Of the ten contacted, eights students completed interviews with the researcher in person on November 26th, 2011. Students were purposely chosen based on convenience, the lead instructor's recommendation, and academic status in the course.

The intent was to interview students at various grade levels in the class, including students who had scored high on the three course exams, include the course mid-term (with a score of 80 percent or more), and students who scored poorly on those same exams (with a score of 69 percent or less). Of the eight students interviewed, three students scored above 80 percent on the exams, two scored in the 70 percent range on the exams, and two scored below passing with scores below the 69 percent range. Each interviewee and member of the focus groups was asked the same eight questions. Students interviewed were contacted prior to the interview times were set up for the participants for interviews and focus groups. Three students set up a time to

participate via email in advance; the remaining five students volunteered during open studying hours in the TILT building the day of interviews and focus groups.

Physical Setting

The setting for the quantitative research was the classrooms at CSU where MATH 160 is taught. In the fall of 2011, the students in all MATH 160 sections for that semester were given the survey to complete either in class or on-line on the class RamCT web site. Class-time was allotted to allow students to complete the surveys and return the surveys back to the researcher. An option to complete another class assignment was given in lieu of taking the survey, as was the option to opt-out of completing the survey. The survey was limited to undergraduate students actively attending classes on campus. No on-line or distance students were included due to the nature of the study focusing on teacher behavior in the classroom.

For the qualitative portion, the focus groups and interviews were conducted on campus in the Great Hall of the Institute for Learning and Teaching building. This is where mathematics instructors hold office hours and where the calculus tutoring is normally conducted. Students are familiar and comfortable with the setting. The focus groups and interviews took place toward during the eleventh week of classes in the fall of 2011, allowing for the students to have an idea of their grades and course standing. This also allowed students to have more familiarity with their instructors.

Research Questions

The following overarching research questions were formulated from the work of Morgan, Leech, Gloeckner, and Barrett (2007) and were developed to study the relationship between teacher immediacy, communication competence, teacher gender, student gender, and student

achievement on MATH 160 exams. The criteria or dependent variable was student scores on MATH 160 exams, whereas the predictors or independent variables were teacher immediacy, communication competence, teacher gender, and student gender.

For the first two research questions, the data were normal/scale and a Pearson correlation is being used for statistical analysis or Spearman rho if the data were skewed, per Gliner et al., (2009).

1. *Is there a correlation between the levels of teacher immediacy and MATH 160 test scores?*
    - 1a. Does a correlation exist between the levels of *verbal teacher immediacy* and MATH 160 test scores?
    - 1b. Does a correlation exist between the levels of *non-verbal teacher immediacy* and MATH 160 test scores?
    - 1c. Does a correlation exist between the levels of overall *teacher immediacy* and MATH 160 test scores?
2. *Is there a correlation between the levels of general teacher communication competence rating and MATH 160 test scores?*
    - 2a. Does a correlation exist between the levels of *affiliation/support* and MATH 160 test scores?
    - 2b. Does a correlation exist between the levels of *empathy* and MATH 160 test scores?
    - 2c. Does a correlation exist between the levels of *behavioral flexibility* and MATH 160 test scores?

2d. Does a correlation exist between the levels of *social relaxation* and MATH 160 test scores?

2e. Does a correlation exist between the levels of *interaction management* and MATH 160 test scores?

2f. Does a correlation exist between the levels of overall *communication competence* and MATH 160 test scores?

The appropriate analysis for the third research questions and sub-questions was a one-way ANOVA, because these were difference questions, per Gliner et al., (2009).

3. *Is there an interaction of teacher and student gender on teacher immediacy, and/or communication competence?*

4a. Is there an interaction of teacher and student gender on overall teacher immediacy?

4b. Is there an interaction of teacher and student gender on overall communication competence?

The appropriate analysis for the fourth research question was Multiple Regression, because this was a complex association question where two or more variables were considered together, per Gliner et al., (2009).

4. *How well do the combination of overall teacher immediacy, overall teacher communication competence, teacher gender, and student gender predict test scores of students on MATH 160 exams?*

The appropriate analysis for the fifth research question was sequential explanatory, because this was a mixed quantitative and qualitative question, per Creswell and Plano-Clark (2010).

5. *How did the quantitative and qualitative data inform the purpose of this study?*

Procedures

Upon approval of Colorado State University Institutional Review Board (CSU IRB), data collection for the **quantitative phase** began with a survey given to all registered students in MATH 160 at CSU in the fall semester of 2011. The survey (Appendix A), originally developed by Weimann (1977) and Richmond, Gorham, and McCroskey (1987) was given to the instructors and loaded onto the class RamCT web site. The specific steps to collect data were as follows:

1. Contacted Dr. Ken Klopfenstein, MATH 160 course coordinator at CSU, and MATH 160 section instructors for the fall of 2011 in the summer of 2011.
2. Obtained Institutional Review Board (IRB) approval to conduct study at CSU, communicated with students, and collected standardized exam scores in the fall of 2011.
3. Provided section instructors with survey that was posted on course section RamCT web site, set up alternate assignments for students who did not want to participate in the research, and provided options to allow student to opt-out.
4. Administered survey to the class sections of MATH 160 in the fall of 2011, during week eight to gather data from students who did not drop the class due to poor performance on the first exam. Students had the option to drop the course and enroll in CSU MATH180 before re-enrolling in MATH 160.
5. Collected data from RamCT and instructors, coded data, ran data through statistical software (SPSS 20.0), and analyzed survey responses and exam scores.

6. Followed-up with students, collected any missing data, and verified that data collection was completed in the fall of 2011.
7. Followed-up with Dr. Ken Klopfenstein and the MATH 160 instructors about completion of data collection in the fall of 2011.

Steps were taken to maximize the return of completed surveys including a discussion about how the survey could be given as an assignment to the students in course, with an opt-out option. Also the students were informed that the data being collected would not impact or affect grading in the course. Because of the sensitive nature of students rating teacher immediacy and the communication competence of their instructors, it was important to have department approval and support to mitigate any student fear of retribution for honestly answering the survey.

Upon approval of Colorado State University Institutional Review Board (CSU IRB), the data collection for the **qualitative phase** began with interviews and focus groups given to students in MATH 160 at CSU in the fall semester of 2011 that had done extremely well or very poor on the course exams. The interviews were conducted during week 11 of 15 during the fall 2011 semester. The specific steps to collect the data were as follows:

1. Contacted Dr. Ken Klopfenstein, MATH 160 course coordinator at CSU, and MATH 160 section instructors for the fall of 2011 in the summer of 2011.
2. Obtained Institutional Review Board (IRB) approval to conduct study at CSU, communicated with students, and collected standardized exam scores in the fall of 2011.
3. Provided section instructors with marketing materials and options to allow students to opt-out.

4. Administered the interviews and focus groups on November 26th with students enrolled in MATH 160 during the fall of 2011. The interviews and focus groups were conducted the eleventh week of the fall semester, to gather data from students after most course exams were completed.
5. Collected data from, coded data, and analyzed interview responses and exam scores.
6. Followed-up with students, collected any missing data, and verified that data collection was completed in the fall of 2011.
7. Followed-up with Dr. Ken Klopfenstein and the MATH 160 instructors about completion of data collection in the fall of 2011.

The qualitative portion of the research was conducted during the eleventh week of the fall 2011 semester and carried out in multiple interviews, and two small focus groups. In attendance during interviews was undergraduate student who took notes along with the researcher.

Taking place on November 26th, 2011 in the Great Hall of the Institute for Learning and Teaching building at CSU, the interviews were conducted throughout the day with individual students. Ten MATH 160 students were contacted and times were originally set up for meetings. Eight students were interviewed or participated in the focus groups. Four students showed up on their own for individual interviews, and the remaining four showed up two at a time and were interviewed together in relatively small focus groups. The researcher conducted four separate interviews and two separate focus groups.

Of the eight students to be interviewed, five were female and three were male. Although gender was not the focus of the interviews, the responses of the students related to their own

gender and the gender of their instructors provided additional, and interesting findings as reported in Chapter 4.

Conditions of anonymity were impossible due to the collection of exams scores. The researcher did know and correlate the student surveys and interview transcripts with exam scores. All attempts were made to separate the survey data from the exam scores and student identification to allow for maximum confidentiality.

The ten MATH 160 students were contacted for interviews during the eleventh week of classes in the fall of 2011. Students were chosen based on the instructor's recommendation and academic status in the class. The intent was to interview students at various grade levels in the class, included were students who had score high on the two exams and the one mid-term exam (with a score of 80 percent or more), and students who score poorly on those same exams (with a score of 69 percent or less). Three students scored high on the exams, three scored low, and two student scored average (with scores in the 70 percent range). Each interviewee was asked the same questions (Appendix B).

Data Collection and Analysis

The questions used on the inherent quantitative survey (Appendix A) were all scale responses measuring from 1 to 5, or otherwise ranged from low (1) to high (5) for each construct. Participants selected the answer that best fits their perspective of teacher behavior in the classroom. Because of the use of multiple variables in this study, "empirical investigations involve questions that call for descriptive techniques that simultaneously summarize data on more than on variable" (Huck & Cormier, 1996, p. 51) which required this study to use statistical

analysis. The data were examining to verify if an association existed between the two variables and were measured for correlation.

The survey was broken down in three broad categories. The first section related to the demographics of the students and instructors. The second section related to communication competence. The third section related to teacher immediacy. The intent or design of the survey was to predict or show how one or more variables enabled one to predict another variable (Gliner et al., 2009).

For the qualitative portion, the data were collected during the fall 2011 semester. The researcher intended to interview ten students enrolled in MATH 160 and their responses were analyzed for common themes (Creswell, 2009). The interviews took place on the CSU campus during the eleventh week of class, after three of the course exams were completed, including the mid-term exam.

Data Analysis Method

The data analyses were based on the type of questions examined in this study, inferential statistics lead to inferences about the association or relationship between variables in the population (Morgan et al., 2007) in which this study was examining a correlation between teacher immediacy, communication competence, and student achievement on calculus exams in MATH 160. In addition, this was a post-positivist approach where the relationship between that of the researcher of what was knowable and what was probably true (Creswell, 2008). Taking this scientific approach to research, post-positivists studied the possible causes that influence outcomes.

Because both variables were normal data (Gliner et al., 2009) Pearson correlation (or Spearman's rho for skewed data), independent *t* tests, one-way ANOVA, Factorial ANOVA, and multiple regression tests were run to find significance in the relationship between attribute variables of teacher immediacy, communication competence and the dependent variable student achievement. Gliner et al. (2009) stated that "the strength of the relation between two continuous variables could be indicated with a Pearson product-moment correlation coefficient" (p. 330) but by adding the additional step of a "multiple regression equation so that the researcher could attempt to predict" (p. 330) student achievement.

Methods Used to Represent and Systematically Summarize Data

The quantitative data were entered into SPSS (20.0) software and analyzed for findings. According to Huck et al. (1996),

> The key concept of correlation required that we look at the data on our two variables *simultaneously.* In doing this, we are trying to see (1) whether there is a relationship between the two sets" (p. 52) which would be scores for teacher immediacy, communication competence and for student achievement and "(2) how strong or weak that relationship is" (p. 52).

The data from this survey was posted on a scatter diagram which had horizontal axis and a vertical axis labeled to correspond with teacher immediacy, communication competence and student achievement.

Tables show the raw data collected from the original surveys. According to Huck et al., (1996) "interpretation of scatter diagrams involves an element of subjectivity, numerical summaries of bivariate relationships appear in research reports far more frequently" (p. 56), but for dissertation purposes, both were used to represent the data collected for this study.

Coding, or the process of assigning numbers to the levels or values of each variable (Gliner et al., 2009) were based on the original Likert scale. High numbers (4 and 5) were used

for “agree” answers. Low numbers (1 and 2) were used for “disagree” answers. Systematically, some answers used reverse coding because the survey used has both positively and negatively worded items. Data shown in the appendix were representative of the sample selected. For the qualitative portion, the data from the interviewed students enrolled in MATH 160 and their responses were analyzed for common themes (Creswell, 2009) and coded from the notes taken by the researcher and one undergraduate student who also took notes. This was done by mapping out the relationship of the textual data to the research questions and by making clear pathways between the research questions and coding (Zickmund, 2010) using grounded theory. To control for bias, the researcher used a second person to help code, otherwise known as triangulation.

By using the same questions in the interviews and focus groups, consistency was created across the text and a structured coding approach was used. The idea was to record ideas and topics that came up more than once (Zickmund, 2010) that were important to the research questions. Each code also had a defined definition with clear examples. This was done to capture major themes (Creswell & Plano-Clark, 2010).

Instrumentation

Validity and Reliability

This dissertation focused on using both quantitative and qualitative analysis and a “triangulation of data sources to aid internal validity” (Ohmer, 1997, p. 64), whereas both a survey and interviews were used to gather data. The validity and reliability for the quantitative survey are listed below.

Survey Part I (Demographics)

Part one of the survey used in this research was designed to gather demographic data on the participants taking MATH 160 and the teachers teaching the sections and used mostly for descriptive purposes. Also included were questions related to class rank, and other math classes taken, including any other classes that the participants have taken with the same instructor providing the researcher with information about existing relationships between the students and their current MATH 160 instructors. Section instructors provided the link to the survey on RamCT. The student consent forms were signed by willing participants at this time. No data were collected from students that did not sign consent forms. This was done during the eight week of the fall 2011 semester. The consent forms were collected by the section instructors prior to the students participating and given to the researcher.

Survey Part II (Teacher Communicative Competence)

Part two of the survey used in this research was developed originally by Weimann (1977) and has been used and published multiple times. According to Weimann (1977) the instrument developed has provided "in a post hoc analysis of the revised instrument, its reliability was estimated at .96 using Cronbach's Alpha" (Weimann) and estimated at .79 using Cronbach's Alpha for this research project. Validity was taken into consideration through factor analysis bringing an original 57 Likert type items down to 36. Used in revised to 32 questions form, "reliability has ranged from .84" (Street, Mulac, & Weimann, 1988) to .95 (Schaller, 1993). Cronbach Alpha's for individual constructs used in this study on the communication competence survey are listed in Table 3.1.

Table 3.1

Reliability Statistics for Communication Competence

Constructs Measured	Cronbach's Alpha Communication Competence Scale	
	For Past Research (Weimann)	For this study
Interaction Management	.96	.76
Empathy	.86	.72
Affiliation/Support	.90	.63
Social Relaxation	.93	.62
Behavioral Flexibility	.95	.79

Section instructors provided the link to the survey on RamCT. Consent forms were also signed by willing participants at this time. No data were collected from students that did not sign consent forms. This was done during the eight week of the fall 2011 semester. The consent forms were collected by the section instructors prior to the students participating and given to the researcher.

Survey Part III (Teacher Immediacy)

Part three of the survey used in this research was developed originally by Richmond, Gorham, & McCroskey and also has been used in multiple studies. During instrument development, "reports of reliability for the verbal dimension have ranged from .88" (Christophel, 1990) to .94 (Gorham, 1988). Reliability for the survey used in this research is listed in table 3.2. The non-verbal dimension of the scale have "ranged from .80" (Richmond, Gorham, & McCroskey, 1987) to .89 (Gorham & Zakahi, 1990) [and] an "alpha coefficient of .88" (Schaller, 1993) achieved in a 1993 dissertation study that focused on teacher efficacy, teacher immediacy, and communication competence.

Table 3.2

Reliability Statistics for Teacher Immediacy

Constructs Measured	Cronbach's Alpha Teacher Immediacy Scale	
	For Past Research (Shallar)	For this study
Verbal Immediacy	.93	.92
Non-Verbal Immediacy	.89	.87

Section instructors provided the link to the survey on RamCT. Consent forms were also signed by willing participants at this time. No data were collected from students that did not sign consent forms. Of the 435 students who were enrolled in MATH 160 during the fall 2011 semester, 320 students participated in the survey. Of those 320 students who participated, 268 signed the consent forms providing permission to use the data collected. Only the data from the 268 participating student was used in the research study. This was done during the eight week of the fall 2011 semester, during the week of September 19th, 2011. The consent forms were collected by the section instructors prior to the students participating and given to the researcher.

Limitations, Delimitations, and Biases that Affect the Validity/Reliability

The focus of this study was on the students' perceptions of the immediacy and communication competence of their teachers and the associated exam scores in MATH 160. Therefore, this study did not account for the different learning styles, mathematics backgrounds, or the amount of time each student spent preparing for class and student attitudes towards learning a complex topic like calculus. However, the classes involved in this study all used the same syllabi, class structure, content, textbooks, and objectives creating the ability to measure the differences in teaching.

An assumption that was made during this study was that all students who responded to the survey were honest and provided meaningful responses. All necessary requirements were set in place to allow for participant reliability and validity.

Summary

The methodology of this study was designed to help identify if there was a relationship between teacher immediacy, communication competence and student achievement in MATH 160 at CSU. The overall design of this study was a sequential explanatory mixed method design. This research used both qualitative and quantitative data to investigate these if there was a statistical significance for the hypotheses of this study that stated, teachers who use immediacy and communication competence that provided an atmosphere where students achieved success in MATH 160 as shown in standardized exam scores.

The use of "qualitative data were drawn from interviews and focus group sessions" (Plano-Clark, & Creswell, 2008, p. 554) to investigate teacher behavior for use in gaining an understanding of student perceptions. The quantitative phase of the project consisted of an online survey of a representative sample (Creswell et al., 2010) of 268 students at CSU.

CHAPTER FOUR: RESULTS

Introduction

This study explored the relationship between teacher immediacy and communication competence from student perspective and student achievement in Calculus for Physical Scientist I (MATH 160) at Colorado State University (CSU). This chapter presents the results of the five research questions posed in chapter three. The findings of the research questions are both quantitative and qualitative in nature. This chapter presents the organized around each research question; therefore all quantitative results are followed by qualitative results.

Quantitative Results

To answer the quantitative research questions, the researcher used statistical package SPSS Statistics *20.0*. The researcher has listed each research question below with results under each research question heading. All interpretation of the findings were analyzed and written up using Morgan, Leech, Gloeckner, and Barrett, (2007).

Research Question One

The first research question asked whether or not a correlation would exist between student perceived teacher immediacy and scores on the three MATH 160 exams during the fall 2011 semester, including the mid-term exam. To answer this question, this researcher addressed two sub-questions. Each sub-question is a correlation question involving data that are normal/scale. For statistical analysis, a Pearson correlation was used for non-skewed data and Spearman's rho for skewed data, as recommended by Gliner, Morgan, and Leech, (2009).

Sub-questions:

1a. Does a correlation exist between the levels of *verbal teacher immediacy* and MATH 160 exam scores?

Of the 268 students that completed the survey, 238 completed the verbal teacher immediacy portion of the survey during the fall 2011 semester. A correlation analysis between verbal immediacy and MATH 160 exam scores was conducted. The mean verbal immediacy score was 3.62 and the mean exam score was 71.82. The Pearson Correlation coefficient was .10; (p = 0.116). Thus no statistically significant correlation between these two variables existed, however there is a small effect size according to Cohen (1988) and Morgan et al., (2007).

1b. Does a correlation exist between the levels of *non-verbal teacher immediacy* and MATH 160 exam scores?

Of the 268 students that completed the survey, 237 completed the non-verbal immediacy portion of the survey during the fall 2011 semester. A correlation analysis between non-verbal immediacy and MATH 160 exam scores was conducted. The mean verbal immediacy score was 3.89 and the mean exam score was 71.82. The Pearson Correlation coefficient was -.02; (p = 0.780). Thus no statistically significant correlation existed between the two variables, however there is a small effect size according to Cohen (1988) and Morgan et al., (2007).

1c. Does a correlation exist between the levels of overall *teacher immediacy* and MATH 160 exam scores?

Of the 268 students that completed the survey, 267 completed the overall teacher immediacy portion of the survey during the fall 2011 semester. A

correlation analysis between overall teacher immediacy and MATH 160 exam scores was conducted. The mean verbal immediacy score was 3.67 and the mean exam score was 71.82. The Pearson Correlation coefficient was .10; (p = 0.107). Thus no statistically significant correlation existed between the two variables but there was a small effect size.

The Pearson's *r* values, coefficients of determination, significances, and effect sizes for each construct can be found in Table 4.1.

Table 4.1

Summary of Correlations for Teacher Immediacy

	MATH 160 Exam Scores (Fall 2011 for $N = 268$)
Verbal	
Pearson's *r*:	$r = 0.10$
Coefficient of Determination:	$r^2 = 0.01$
Significance:	$p = 0.116$
Effect Size:	Smaller than typical
Non-verbal	
Pearson's *r*:	$r = -0.02$
Coefficient of Determination:	$r^2 = 0.0004$
Significance:	$p = 0.780$
Effect Size:	Much smaller than typical
Overall Teacher Immediacy	
Pearson's *r*:	$r = 0.1$
Coefficient of Determination:	$r^2 = 0.01$
Significance:	$p = 0.107$
Effect Size:	Smaller than typical

Research Question Two

The second research question asked whether or not a correlation would exist between student perceived teacher communication competence and scores on the three MATH 160 exams during the fall 2011 semester, including the mid-term exam. Five sub-questions addressed this question. For the sub-questions, the data were normal/scale and a Pearson correlation was used for statistical analysis, as recommended by Gliner et al., (2009). For questions where the data were skewed, a Spearman's rho was used for statistical analysis, as recommended by Gliner et al., (2009).

Sub-questions:

2a. Does a correlation exist between the levels of *affiliation/support* and MATH 160 exam scores?

Of the 268 students that completed the survey, 238 completed the communication competence portion of the survey during the fall 2011 semester. A correlation analysis between affiliation/support and MATH 160 exam scores was conducted. The mean affiliation/support score was 4.10 and the mean exam score was 71.82. Affiliation/Support was skewed (skewness = -1.112), which according to Morgan, et al., (2007) is larger than -1.0, violated the assumption of normality. Because the data were skewed, a Spearman rho statistic was calculated, $r_s(236) = .06$, $p = .323$. No statistically significant correlation existed between the two variables and the effect size was small (Cohen, 1998).

2b. Does a correlation exist between the levels of *empathy* and MATH 160 exam scores?

Of the 268 students that completed the survey, 237 completed the communication competence portion of the survey during the fall 2011 semester. A correlation analysis between empathy score and MATH 160 exam scores was conducted. The mean empathy score was 3.76 and the mean exam score was 71.82. The Pearson Correlation coefficient was .05; ($p = 0.462$). Thus no statistically significant correlation existed between the two variables, however there is a small effect size according to Cohen (1988) and Morgan et al., (2007).

2c. Does a correlation exist between the levels of *behavioral flexibility* and MATH 160 exam scores?

Of the 268 students that completed the survey, 238 completed the communication competence portion of the survey during the fall 2011 semester. A correlation analysis between behavioral flexibility score and MATH 160 exam scores was conducted. The mean behavioral flexibility score was 3.93 and the mean exam score was 71.82. Behavioral flexibility was skewed (skewness = -1.001), which according to Morgan, et al., (2007) is larger than -1.0, which violated the assumption of normality. Because the data were skewed, a Spearman rho statistic was calculated, $r_s(236) = .15$, $p = .023$. For behavioral flexibility, there exists a statistically significant correlation between the two variables. Using Cohen's (1988) guideline, the correlation is .15, meaning the effect size was smaller than typical.

2d. Does a correlation exist between the levels of *social relaxation* and MATH 160 exam scores?

Of the 268 students that completed the survey, 237 completed the communication competence portion of the survey during the fall 2011 semester. A correlation analysis between social relaxation score and MATH 160 exam scores was conducted. The mean social relaxation score was 4.16 and the mean exam score was 71.82. The Pearson Correlation coefficient was .13; ($p = 0.039$). For social relaxation, a statistically significant correlation existed between the two variables. Because of the significance, the researcher considered the effect size and by using Cohen's (1988) guideline, the correlation was .13, meaning the effect size was smaller than typical.

2e. Does a correlation exist between the levels of *interaction management* and MATH 160 exam scores?

Of the 268 students that completed the survey, 235 completed the interaction management portion of the survey during the fall 2011 semester. A correlation analysis between interaction management score and MATH 160 exam scores was conducted. The mean interaction management score was 4.33 and the mean exam score was 71.82. Interaction Management was skewed (skewness = -1.226), according to Morgan et al., (2007) is larger than -1.0, which violated the assumption of normality. Because the data were skewed, a Spearman rho statistic was calculated, r_s (233) = .07, p = .306. Thus there was no statistically significant correlation between the two variables. According to Cohen's (1988) guideline, the effect size was much smaller than typical.

2f. Does a correlation exist between the levels of overall *communication competence summated* and MATH 160 exam scores?

Of the 268 students that completed the survey, 237 completed the overall teacher immediacy portion of the survey during the fall 2011 semester. A correlation analysis between overall teacher immediacy and MATH 160 exam scores was conducted. The mean communication competence score was 3.90 and the mean exam score was 71.82. The Pearson Correlation coefficient was .09; (p = 0.164). Thus no statistically significant correlation existed between the two variables. According to Cohen's (1988) guideline, the effect size was much smaller than typical.

Of the five constructs that make up communication competence, the strongest positive correlation, with typically small effect sizes was between behavioral flexibility and exam scores, r_s (236) = .15, p = .023 and between social relaxation and exam scores, r (235) = .13, p = .039. This means that students who identified teachers who exhibited high behavioral flexibility and high social relaxation in class were more likely to achieve high exam scores. These are only two of the five constructs that make up communication competence, and there was no statistical significance on the other three constructs.

The Pearson's r and Spearman rho r_s values, coefficients of determination, significances, and effect sizes for each construct can be found in Table 4.2.

Table 4.2

Summary of Correlations for Communication Competence

	MATH 160 Exam Scores (Fall 2011 for $N = 268$)
Affiliation/Support	
Spearman rho r_s:	$r_s = 0.06$
Coefficient of Determination:	$r^2 = 0.004$
Significance:	$p = 0.323$
Effect Size:	Much smaller than typical
Empathy	
Pearson's r:	$r = 0.05$
Coefficient of Determination:	$r^2 = 0.002$
Significance:	$p = 0.462$
Effect Size:	Much smaller than typical
Behavioral Flexibility	
Spearman rho r_s:	$r_s = 0.15$
Coefficient of Determination:	$r^2 = 0.022$
Significance:	$p = 0.023$
Effect Size:	Smaller than typical
Social Relaxation	
Pearson's r:	$r = 0.13$
Coefficient of Determination:	$r^2 = 0.017$
Significance:	$p = 0.039$
Effect Size:	Smaller than typical
Interaction Management	
Spearman rho r_s:	$r_s = 0.07$
Coefficient of Determination:	$r^2 = 0.004$
Significance:	$p = 0.306$
Effect Size:	Much smaller than typical
Overall Communication Competence	
Pearson's r:	$r = 0.09$
Coefficient of Determination:	$r^2 = 0.0081$
Significance:	$p = 0.164$
Effect Size:	Much smaller than typical

Research Question Three

Is there an interaction of teacher and student gender on overall teacher immediacy, or overall communication competence? For this, there were two different sub questions asked. The appropriate analysis for the third research question is Factorial ANOVA, because this is complex interaction question, as recommended by Gliner et al., (2009).

3a Is there an interaction of teacher and student gender on overall teacher immediacy?

Of the 268 students that completed the survey, 237 completed the overall teacher immediacy portion of the survey during the fall 2011 semester. An interaction analysis (Factorial ANOVA) between student and teacher gender on overall teacher immediacy was conducted. Table 4.3 shows that there was no significant interaction between student gender and teacher gender on overall teacher immediacy ($p = 0.615$). There was, however, a significant main effect of teacher gender on verbal teacher immediacy, $F\ (1, 264) = 23.121$, $p < .001$ indicating a main effect, meaning students rated female teachers as having a high verbal immediacy scores. But according to Cohen (1988), the Eta^2 was about .08, indicating the effect size was smaller than typical

3b. Is there an interaction of teacher and student gender on overall communication competence?

Of the 268 students that completed the survey, 237 completed the overall communication competence portion of the survey during the fall 2011 semester. An interaction analysis (Factorial ANOVA) between student and teacher gender

on overall communication competence was conducted. Table 4.3 shows that there was no significant interaction between student gender and teacher gender on overall communication competence ($p = 0.530$), however there is a small effect size according to Cohen (1988).

Table 4.3

Analysis of Variance for Gender on Teacher Immediacy and Communication Competence

Constructs	Main Effect Student Gender			Main Effect Teacher Gender			Interaction		
	F	*p*	Eta^2	*F*	*p*	Eta^2	*F*	*p*	Eta^2
Exam Scores	0.198	0.656	0.001	0.253	0.615	0.001	0.900	0.344	0.004
Teacher Immediacy (Summative)	1.487	0.244	0.006	1.261	0.262	0.005	0.253	0.615	0.001
Verbal	0.269	0.604	0.001	23.121	**<.001**	0.081	0.021	0.886	<.001
Non-Verbal	4.045	0.0045	0.015	0.345	0.558	0.001	0.076	0.784	<.001
Communication Competence (Summative)	2.840	0.093	0.011	0.757	0.385	0.003	0.396	0.530	0.002
S. Interaction	0.745	0.389	0.003	0.007	0.931	<.001	0.640	0.424	0.002
Empathy	1.445	0.230	0.005	<.001	0.985	<.001	<.001	0.985	<.001
Affiliation	1.876	0.172	0.007	0.125	0.724	<.001	0.755	0.386	0.003
S. Relaxation	0.045	0.832	<.001	0.378	0.539	0.001	0.751	0.387	0.003
B. Flexibility	1.008	0.316	0.004	0.017	0.895	<.001	<.001	0.985	<.001

Note. N = 237

Research Question Four

How well do the combination of teacher immediacy, teacher communication competence, teacher gender, and student gender predict test scores of students on MATH 160 exams? A Multiple Regression was used to analyze this data, because this is a complex association question

where two or more predictor variables were considered together with one dependent variable, as recommended by Gliner et al., (2009).

The researcher conducted simultaneous multiple regression to investigate the best predictors of success on the MATH 160 exam scores. Table 4.4a displays the means, standard deviations, and intercorrelations. Any combination of variables to predict exam scores from teacher gender, student gender, communication competence, and/or teacher immediacy showed no statistical significance, F (4, 226) = 1.47, p = .179. Table 4.4b presents the *beta* coefficients. The adjusted R^2 value was .044, indicating that the model explained four percent (4%) of the variance in the exam scores. Cohen (1988) would suggest, this is a smaller than typical effect size.

Table 4.4a

Summary of Means, Standard Deviations, and Intercorrelations for Calculus Exam Scores

Variable	M	SD	SG	IG	CC	TI-V	TI-NV
Predictor Variable	71.93	16.88	-.045*	.074*	.087*	.097*	-.020*
1. Student Gender	1.25	.433	- -	.06	-.76	.21	.06
2. Instructor Gender	1.60	.491		- -	-.03	-.35	-.16
3. Com Competence	4.34	.730			- -	.13	.00
4. Teacher Immediacy Verbal	3.64	.963				- -	.30
5.							
6. Teacher Immediacy Non-Verbal	3.89	.875					- -

*Note. N= 234. *p > .05*

Table 4.4b

Predictors of Calculus Exam Scores

Variable	*B*	*SEB*	β	t	Sig.
Student Gender	-1.90	2.57	-.049	-.740	.460
Instructor Gender	3.75	2.40	.11	1.566	.119
Comm. Competence	-.21	1.88	-.01	-.109	.913
Teacher Immediacy Verbal	2.17	1.30	.12	1.684	.094
Teacher Immediacy Non-Verbal	-.97	1.24	-.05	.728	.467
Constant	52.69	10.65			

Note. N= 234. R^2 = .044; F (4, 226) = 1.47, p = .179

Research Question Five

How did the quantitative and qualitative data inform the purpose of this study? For this question, a sequential explanatory design was used to analyze both the quantitative and qualitative data gathered.

Qualitative research analysis was used in addition to the quantitative research in this study. Considered a pragmatic approach, "pragmatism is certainly not new to the social sciences" (Plano-Clark & Creswell, 2008, p. 57) and was used in this study "as a justification for combining qualitative and quantitative methods" (Plano-Clark & Creswell, 2008, p. 57) to help find meaning in the data collected from the on-line survey administered in MATH 160 during the fall 2011 semester.

Past research (Shallar, 1993; Weimann, 1977; Gorham, 1988) stated that the teacher immediacy and communication competence behaviors of instructors show evidence of students performing better. This idea was supported by the qualitative data collected in this research, "teacher behavior does impact our learning" (Samantha, personal communication, November 26, 2011). However, the sequential explanatory design of this study gave "priority to the quantitative data, and the two methods used were integrated during the interpretation phase of the study" (Plano-Clark & Creswell, 2008, p. 178) and the findings from the quantitative portion provided no statistical evidence that teacher immediacy and communication competence behaviors provided any improvement in exam scores in Calculus for Physical Scientists I at CSU in the fall of 2011.

The benefit of using a sequential explanatory design was useful because the results from the quantitative portion of the study were unexpected (Creswell & Plano-Clark, 2010). Even though the students involved in the qualitative portion stated that they believe their exam scores

were better based on the behaviors of their instructors, the findings suggest that this is not the case and using both quantitative and qualitative data together helped the researcher examine the surprising results in more detail (Creswell & Plano-Clark, 2010). Further explanation of the qualitative findings is explored in detail in the qualitative research section of this chapter.

Qualitative Results

Student Responses

The qualitative portion of the research was conducted during the eleventh week of the fall 2011 semester and carried out in multiple interviews, and two small focus groups. In attendance at these interviews was an undergraduate student who took notes along with the researcher. According to Plano-Clark and Creswell (2008),

> A pragmatic approach not only supports the kinds of research methods that we advocate but also provides a basis for reorienting the field of social science research methodology in the directions that we favor. (pp. 61-62)

Ten MATH 160 students were contacted and scheduled times were originally set up for meetings. Eight of the original ten invited were interviewed. Four students showed up on their own for individual interviews, and the remaining four showed up two at a time and were interviewed together in focus groups. The researcher conducted four separate interviews and two separate focus groups.

Of the eight students interviewed, five were female (identified with fake names here as Heidi, Rachel, Natalie, Samantha, and Hilary) and three were male (identified with fake names here as Brian, Brad, and Greg). Although gender was not the primary focus of the interviews; the responses of the students related to their own gender and the gender of their instructors provided additional findings.

To verify trustworthiness, the researcher utilized the use of a student note taker to also write down interviewee answers. This provided two sets of notes for each interview and focus group and helped improve validity (Creswell, 2008). The researcher then met with the student note taker after each interview and focus group to find common themes and compare interpretations of answers provided. The researcher has listed each research question below with findings related each research question.

The responses to the interview and focus group questions varied. The researcher read and analyzed sixty-four responses multiple times to find common themes. Common themes from the student responses were also echoed during the focus group discussions. Student responses varied relating to the behaviors of the instructors, however common themes for each question are reported below.

Question one asked if the instructor used verbal immediacy behaviors in class (called student by name, addressed student individually). All eight students commented that their instructors used these behaviors, including calling each student by their name, answering questions, and following up with each student during class. Samantha (2011) stated,

> My teacher is very nice to the students in class, he makes it easy to sit through and come to class. Because I enjoy the class, it is easier to listen to the teacher. I also believe that I come to class more often because the teacher talks to me. (personal communication, November 26)

Other female students echoed this opinion, including Heidi and Rachel; all the students interviewed expressed that they enjoy class and attend more often because the instructor behavior.

During the first focus group meeting, Hilary (2011) expressed "my teacher has great interpersonal skills, but for some reason she cannot teach" (personal communication, November

26). A theme for question one that emerged from these interviews and focus groups was the feelings being expressed about instructor gender. Of the students who the researcher met with, the female students expressed enjoying male instructor behavior more than female instructor behavior, thus the need for the analysis absent in the quantitative portion of this study.

Although no significance was shown in the quantitative data that teacher gender had any interaction on exam scores, comments from female students Heidi (2011) included "she is difficult" and "she is harsh" for female instructors compared to "he makes class fun" and "he makes me enjoy learning this difficult topic" (personal communication, November 26) for male instructors.

These comments were not highlighted until coded and compared for themes, then compared against the quantitative portion of this study. The emotions of the male and female students were difficult to separate until the analysis of these questions where the differences between male and female instructors were recognized.

Question two asked if the teacher used non-verbal immediacy behaviors; including eye contact, open posture, smiling, and the use of hand gestures. Only six of the students answered affirmatively, the other two students responded negatively. The common theme for question two related to instructor ability to capture the student attention based on drawing their attention to the teacher through kinesics and gestures. Six of the students agree that feel better in class and "enjoy being in class because the teacher acts excited for the topic and is all animated" (Brad, personal communication, November 26, 2011). Of the two students who stated that their teachers did not use non-verbal immediate behaviors; Samantha (2011) stated,

> My teacher is nice, and talks to the students, but does not command any attention in front of the room. She is very meek and does not bring any attention to herself. She does

> address each student by their name, but only if we ask for her assistance. Otherwise she just talks to the board as she writes. This is frustrating. (personal communication, November 26)

The second student, Greg (2011), stated that it was "ok the teacher did not use non-verbal immediacy behaviors because I do not need the teacher to use these gestures" (personal communication, November 26).

Question three asked if the instructor used good communication skills in class. All eight students agreed that their instructors used good communication skills. This opinion appeared to be unanimous, with one student commenting on how energetic the instructor was in the classroom. Another common theme expressed by the interviewees included that the instructors were good communicators, and very personable.

Question four asked if students feel their performance in class was impacted by the behavior of the instructor in class. According to all eight students interviewed, they strongly believed that their scores were impacted by the behavior of the instructor because they were more excited to come to class, which helped with their understanding of the topic. Greg (2011) stated that "the more animated the teacher behaves, the more the interesting the class topic becomes" (personal communication, November 26). But disagreed with each other on if this is beneficial to the learning taking place in the classroom because as Rachel (2011) said "a fun class doesn't really help me understand the topic more, it just makes me more interested in listening" (personal communication, November 26).

This same question asked in the second focus group did not produce any more insight. One student in that focus group stated, "yes, teacher behavior does impact our learning" (Samantha, personal communication, November 26, 2011), but did not elaborated on how. Rachel (2011) expressed that the instructor "cannot put information in layman terms, so I cannot

find the main point of the exercises, but my [female] teacher seems to be a great teacher, but I don't understand her" (personal communication, November 26). Question four's answers also followed the same theme at question three, where the female students were more harshly answering questions when the instructor was a female.

Question five asked if students could have done better/worse based on your instructor's behaviors. Seven of the students stated that they believed they did better in class based on the instructor's behavior. A few students stated that this was based on the instructor exhibiting good communication and positive teacher immediacy. These few students felt more motivated to attend class, to try harder in class, and work towards impressing the instructor. However, Heidi (2011) stated,

> I am doing worse in class based on the skills of my teacher; this class and this teacher are not a good learning zone. I am only learning because of the tutoring program. I attend the tutoring program because I do not understand my teacher. My teacher uses great communication skills and is very friendly, but I do not understand the concepts. And the teacher talks as if I understand the concepts. (personal communication, November 26)

Heidi (2011) expressed that the behavior of the instructor had a negative impact on understanding calculus. Heidi did not provide the researcher with the gender of the instructor, so the theme from questions three and four could not be identified in question five.

The other seven students, both from individual interviews and the two focus groups stated that good communication skills help with achieving good exam scores. Brain (2011) stated, "if he [the instructor] was tough, negative, or hard to understand, I would have a difficult time learning calculus" (personal communication, November 26). Natalie (2011) said, "because the class is not boring, I feel like I pay more attention and do better because I am listening" (personal communication, November 26). Finally, the last student in the final focus group stated that "I feel more personally connected to the teacher because of good one-on-one conversations"

(Hilary, personal communication, November 26, 2011) because the instructor exhibits great communication skills.

Question six asked how students think their instructor behavior could be improved so students could do better in class. Four of the students independently interviewed stated that they could not think of any way to improve instructor behavior in the classroom. However, the other four from the focus groups stated the instructors should run class like a tutoring program, which is more one-on-one and run at a slower pace than class. The two students from the first focus group, Brad, (2011) stated that they love the way the tutors speak the "same language as us, and know where we are struggling" (personal communication, November 26). The tutoring program that was discussed in the focus groups is the Institute for Learning and Teaching tutoring program that takes place in the same Great Hall that these interviews and focus groups were conducted with mathematics undergraduate students employed as calculus tutors. The students in the focus groups also stated that this tutoring program plays a strong role their understanding of Math 160 concepts. Samantha (2011), from the last focus group stated "more in common with the tutoring program tutors than with their MATH 160 instructor" (personal communication, November 26).

Questions seven and eight were similar questions that asked from positive and negative perspectives. Question seven asked if there was anything about the instructor's behaviors that made class better; where question eight if instructor behavior made class worse. Heidi (2011), from her interview stated that instructor behavior "made class worse" (personal communication, November 26), while the other seven from the interviews and focus groups stated that class was better due to instructor behavior. Brad and Greg (2011), first focus group agreed that instructors have a "major impact" (personal communication, November 26) on how the students learn and

believe that instructors who use positive actions in class produce positive outcomes. When probed on what that meant, both students agreed that they like when instructors are passionate, nice, and helpful in class. The researcher then asked if these attributes have any impact on their understanding of calculus to which Greg (2011) stated, "I just like the class, that doesn't mean I understand the topic" (personal communication, November 26).

What Students Liked About Instructors

Students unanimously stated that the more they liked their instructor and the more the instructor used immediacy and communication competence skills, the more they want to attend class. Brian (2011) stated,

> I really enjoy the humor and relaxed atmosphere that my teacher creates in class, this relaxed atmosphere makes class fun and the teacher easier to listen to. This makes me want to come to class and learn. I don't know if I learn more, but I do show up more often and attend more classes because of it. (personal communication, November 26)

Another theme that emerged from the interviews and focus groups was that related to content knowledge. Students stated that they are more comfortable learning from an instructor that has a lot of content and calculus knowledge. Heidi (2011) stated, "my teacher is knowledgeable, but she doesn't really know how to teach" (personal communication, November 26). When probed on that comment, Heidi (2011) said, "the teacher knows her stuff, but cannot address students, nor does she know how to teach" (personal communication, November 26).

Students also agreed with the success they find using tutors. It might have been the fact that the interviews were being conducted in the same location at the CSU tutoring program, but there were a few students who said that the one-on-one qualities of tutoring were very helpful with understanding the topic. They also stated that this really is not possible in a classroom setting. Examples of qualities that students listed that they enjoyed about their instructors were,

content knowledge, personable, knowing the name of each student, following up with students concerns, being animated, one-on-one interaction, not intimidating, and clear concise answers. All of these words and behaviors came up in several of the interview with several of the students.

What Students Did Not Like About Instructors

All eight students stated that they liked when their instructors acknowledged students and did not like when the instructor just stared at the board when working on complex calculus problems. Rachel (2011) stated,

> I do worse in class based on my teacher not being able to put information into layman's terms that I understand. I have a hard time understanding the point to the instructor's lecture when I do not understand the terms being used. And when the teacher uses these terms as he flies trough problems, I get lost. (personal communication, November 26)

Rachel continued to discuss feelings of being lost in class when the instructor focuses on the white board and not on the puzzled looks on the students' faces.

Heidi (2011), as stated earlier, rated the MATH 160 instructor high on knowledge as a skill beneficial to instructors, but did not like the instructors teaching ability. Along with teaching ability, which was never defined by the students being interviewed, there were five students, both male and female that stated their dislike for instructors who do not use layman's terminology when talking to the class. Heidi (2011) said "she cannot put information out in layman's terms, so it is hard to see her point" (personal communication, November 26).

There were a few examples of what students did not like about their instructors, or the calculus course including, instructors with negative attitudes toward students, intimidating instructors, class size too large, instructors who use fear or harsh threats, or are boring. These

terms were written down because of common themes that were used by the students, during the interviews and focus groups.

Samantha and Hilary (2011), from the last focus group both stated that they do not like the fact that calculus is required for their degree programs. This resentment might also play a role in the achievement level of the students on Math 160 exams, but this was not taken into consideration for this study.

What Students Perceived as Helpful Towards Grades

Students again stated that they found attending class regularly, going to the instructor's office hours, attending the tutoring program offered by The Institute for Learning and Teaching as being the most helpful for getting good grades in Math 160. Greg (2011) said, "the one-on-one teaching and the time the tutors spend with each student was very helpful" (Greg, personal communication, November 26) towards getting what was described as decent grades in Math 160.

Greg (2011) also stated that instructors who are "straight forward and organized" (Greg, personal communication, November 26) are better than instructors who are not. Greg (2011) then went on to say "this organization and direct teaching, has a positive impact on my learning" (Greg, personal communication, November 26). This was only stated by one female student from an individual interview and was not a common theme throughout the interviews.

Summary

Overall, the qualitative data related to the behavior of instructors in the classroom showed some common themes and patterns to the researcher. According to Creswell and Plano-Clark (2010), using a sequential explanatory mixed methods design with both quantitative and qualitative data will add meaning to the findings. The quantitative portion used an on-line survey, where the qualitative used interviews and focus groups to find meaning in the data and help further interpret the quantitative findings of this research. The next chapter presents the researcher's perspective of the quantitative and qualitative research.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This study explored the relationship between teacher immediacy and communication competence from the students perspective and student achievement in MATH 160 using a sequential explanatory mixed method design. Accordingly, this study examined the role of teacher immediacy and communication competence played on student achievement on calculus exams. The investigation studied the existence of a relationship between variables (Gliner, Morgan, & Leech, 2009, p. 21) using both quantitative and qualitative measures in a pragmatic approach to further the process of inquiry (Creswell & Plano-Clark, 2010). The researcher grounded this study in the literature on teacher immediacy, communication competence, and student achievement in calculus. This chapter discusses the results of the research questions presented in chapter four and posed in chapter three.

Research Question One

Research question one investigated whether a correlation existed between the scores on MATH 160 exams and the levels of self-perceived teacher immediacy. For this study, teacher immediacy was broken into two distinct constructs, verbal immediacy ($p = 0.116$) and non-verbal immediacy ($p = .780$) where neither construct showed any statistical significance. In addition to testing the two constructs individually, the researcher tested overall teacher immediacy and found no statistical significance.

The results did not surprise the researcher. Calculus is a high demand class (Klopfenstein, 2011) that requires rote memorization and repetitive calculations (Estep, 2010). The findings from this study contradicted Bell and Pearson's (2007) findings about student

enjoyment of learning producing student achievement. In a class like calculus, it is not always what the student wants or enjoys that is conducive to students scoring higher on exams. Students who rated instructors low on the teacher immediacy scale earned similar scores on the MATH 160 exams as students who rated their instructors high on the same scale.

The statements that students made during the interviews and focus groups identified what was enjoyed. Overall, the interviewed students enjoyed the behavior of their instructors in the classroom, believing that the behavior of their instructors did have a positive impact on their MATH 160 exam scores. The majority of the interviewed students stated that they enjoyed attending classes when the instructor used effective teacher immediacy. Only one student disagreed with the rest of the students interviewed.

The qualitative findings from this study support Shallar (1993) and Bell and Pearson's (2007) earlier research, but neither of those studies focused on calculus courses. Student opinions about performing better on exams were not statistically correlated leading this researcher to believe student perception of instructor behavior does not always predict actual performance.

Research Question Two

Research question two investigated if a correlation existed between the scores MATH 160 exams and the levels of instructor communication competence. Communication competence was broken down into five sub-constructs to find statistical significance between each sub-construct and MATH 160 exam scores.

The first construct was affiliation/support. No statistically significant correlation existed between the two variables. The second construct was empathy. No statistically significant

correlation existed between the two variables. The third construct was behavioral flexibility and there existed a statistically significant correlation between the two variables. Because of the significance, the researcher considered the effect size and by using Cohen's (1988) guideline, the correlation is .15, meaning the effect size is smaller than typical. The forth construct was social relaxation; which was shown to have a statistically significant correlation between the two variables. Because of the significance, the researcher considered the effect size and by using Cohen's (1988) guideline, the correlation was .13, meaning the effect size is smaller than typical. The fifth construct was interaction management showing no statistically significant correlation between the two variables. Finally, the researcher tested the overall construct of communication competence and again found no statistical significance.

Again, this is not surprising in a high demand course (Klopfenstein, 2011) such as MATH 160. The students who rated instructors low in communication competence earned similar scores as students who rated their instructors high.

The students who were interviewed agreed that class was more enjoyable when the instructor used humor, eye contact, addressed students by their names, and used hand gestures in class. However, students who participated in the interviews and focus groups expressed frustration because these effective communication competence behaviors did not help them understand the complex topic of calculus. Students interviewed stated that they were more apt to attend class because they enjoyed the behaviors of the instructor, but the student interviewed reiterated that these behaviors did not help make the topic easier to understand. The common theme of enjoying the communication competence behavior of an instructor was strong among all eight students interviewed. However, the students who participated seemed to align with each

other on how much these behaviors help with student performance on the exams, which was very little.

Research Question Three

Research question three consisted of two sub-questions involving researching whether an interaction existed between teacher or student gender and exam scores in regard to teacher immediacy, or communication competence.

The data from the first sub-question showed no significant interaction on student gender and teacher immediacy ($p = .615$). Reported as not statistically significant, the students interviewed individually and in the focus groups stated their own gender should not matter when dealing with complex mathematics courses. According to the data, student or teacher gender had little effect on exam scores related to teacher immediacy.

The second sub-question involved researching if an interaction existed between the gender of students or instructors on exam scores in regard to communication competence. The data again showed no significant effect on communication competence ($p = .530$).

What had shown in the quantitative data was a significant main effect of teacher gender on verbal teacher immediacy ($p < .001$). Although statistically significant, according to Cohen (1988) the effect size was small. The students interviewed individually and in the focus groups stated that the gender of their instructor did not matter. According to the data, this had very little effect on exam scores.

Research Question Four

Research question four involved researching if a combination of teacher immediacy, teacher communication competence, instructor gender, and student gender can predict exam scores in MATH 160. The researcher conducted simultaneous multiple regression to investigate the best predictors of student achievement on the MATH 160 exam scores. No combination of variables predicted exam scores. Data showed that the predictor variables only explained four percent (4%) of the variance in the exam scores with smaller than typical effect size.

Overall, data related to the behavior of instructors in the classroom showed little, to no statistical significance ($p = .179$) between the independent variables and the dependent variable. Calculus is a complex class (Estep, 2010), with difficult concepts and problems that involves a tremendous amount of practice, learning, and understanding (Klopfenstein, 2011). As stated in Chapter 2, past research at a national level demonstrated that the failure rates in Calculus for Physical Scientists I approach 40 percent (Ganter, 2001).

Whether students liked or disliked the teacher immediacy and communication competence behaviors of instructors did not show an increase in MATH 160 exam scores. Students strongly stated that they enjoyed when the instructor exhibited these behaviors, and that they more likely attended class. However, students were still not convinced that these instructor behaviors equated to an increase in student achievement on MATH 160 exams.

Research Question Five

Research question five involved examining how the quantitative and qualitative data informed the purpose of this study. Considered a pragmatic approach - "pragmatism is certainly not new to the social sciences" (Plano-Clark & Creswell, 2008, p. 57) - a sequential explanatory design was used "as a justification for combining qualitative and quantitative methods" (Plano-Clark & Creswell, 2008, p. 57) to help explain the surprising results of the quantitative data.

Because research (Weimann, 1977; Shallar, 1993; Gorham, 1988) indicated that the teacher immediacy and communication competence behaviors of instructors showed evidence of students performing better. Shallar's (1993) ideas were supported by the qualitative data collected in this research. Samantha (2011), who participated in the final focus group stated, "teacher behavior does impact our learning" (personal communication, November 26). However, because of the sequential explanatory design of this study, priority was given to the quantitative data, and the two methods used were integrated during the interpretation phase of the study (Plano-Clark & Creswell, 2008) and the findings from the quantitative portion provided no statistical evidence that teacher immediacy and communication competence from the student perspective provided any improvement in exam scores in Calculus for Physical Scientists I at CSU in the fall of 2011. Verbal teacher immediacy did show statistical significance, however, a significant main effect of teacher gender on exam scores in regard to verbal teacher immediacy had a smaller than typical effect size, according to Cohen (1988).

This research benefited from the use of a sequential explanatory design because the results from the quantitative portion of the study were unexpected (Plano-Clark & Creswell, 2008). Students who participated in the qualitative portion stated that they believed that they performed better on exams because of the teacher immediacy and communication competence

behaviors of instructors. The findings from this research suggest that this is not the case and using both quantitative and qualitative data together helped the researcher examine the surprising results in more detail (Plano-Clark & Creswell, 2008).

Implications for Instructor Development

In terms of the benefits derived from providing instructor development for MATH 160 instructors to use teacher immediacy and communication competence, research showed the more instructors use these skills, the more students enjoy the course (Shallar, 1993; Zapf, 2008). Shallar (1993) suggested that student enjoyment correlates with improved grades. Although this was not the case in this study, students interviewed stated that instructors who use teacher immediacy and communication competence created a more enjoyable atmosphere in the classroom. Greg (2011) stated "the more animated the teacher behaves, the more the interesting the class topic becomes" (personal communication, November 26).

There is no empirical research that states class enjoyment is beneficial to learning taking place in complex calculus courses. According to one student who participated in the qualitative portion of this research, Rachel (2011) stated, "a fun class doesn't really help me understand the topic more, it just makes me more interested in listening" (personal communication, November 26). One aspect that was clear from the qualitative portion of this research was that the students interviewed supported Shallar's (1993) findings by expressing how much they felt like they were learning more based on the teacher immediacy and communication competence behaviors of the instructors of MATH 160.

According to Poock (2001), "the nature of graduate education is rapidly changing, and greater emphasis is being placed on professional development. The importance and benefit of

integrating professional development in graduate education is endorsed by professional organizations and supported by empirical research" (p.3). Instructor development could allow calculus instructors to welcome teacher immediacy and communication behaviors into the classroom, thus allowing students to enjoy the class. According to one student interviewed, "if we are more concerned about failing the class, than learning the topic at hand, learning does not take place" (Greg, personal communication, November 26, 2011).

Shallar (1993) contended that instructors' who take time to treat students as individuals help students enjoy class. Although the students in this sample did not perform better on the MATH 160 exam, Selden, Mason, and Selden (1989) suggested students who enjoy class have a better opportunity to perform better on exams. Shallar (1993) also stated that this will help provide a much more stable and open learning environment that will allow for greater success in the classroom. Based on the statements from the students involved with the qualitative portion of this study, the benefits derived from providing development for calculus instructors on how to use teacher immediacy and communication competence in the classroom could provide a more positive learning environment in the classroom. According to students interviewed, a positive atmosphere allows the students to want to come to class and a want to learn.

Cautions and Limitations

The focus of this study was on teacher immediacy and communication competence behaviors of instructors from the student perspective associated with exam scores. Therefore, this study did not account for the different learning styles, mathematics backgrounds, or the amount of time each student spent preparing for class and student attitudes towards learning complex topic. However, this study did have a large sample size and the sections involved in

this study all used the same syllabi, class content, textbooks, and objectives creating the ability to measure the differences in teaching.

Due to the lack of significance shown in the quantitative portion of this study, drawing conclusions about student performance due to the teacher immediacy and communication competence behaviors of instructors was not supported. This research showed no significance on the exam scores when related to several constructs that make up teacher immediacy and communication competence. These limited results still do not provide any less reason for instructors to use these behaviors in their classrooms. Shallar (1993) stated that by using these behaviors, students could perform at a higher level, however Shallar's (1993) research was completed in entry-level non-mathematics classes. Findings from this research found that in calculus classes in higher education improved student achievement was not the case.

Suggestions for Future Research

The findings in this study should not be considered a final verdict. Past research, including Shallar (1993) and work by Zapf (2008), demonstrated links between student achievement and instructor behavior, but further research needs to be conducted on this relationship. Future research should include an additional step between instructor behavior, student enjoyment of class, and student attendance. This step should include classroom monitoring of attendance. Students who enjoy classes based on the behaviors of the instructor could be more likely to attend class more often. It could be possible that students who have better attendance in class could achieve higher scores on exams. Attendance and student achievement were positively related as shown by Roby (2004) using standardized exams.

Another area that was not explored in this research relates to instructor behavior and learning in the on-line environment. Future research could include an examination of teacher immediacy, communication competence, and exam scores in on-line calculus classes. In addition, future students should specifically be chosen by random sample. This study focused on all students enrolled in MATH 160. By randomly selecting students from multiple classes, or even multiple universities, more reliability could be brought into the study.

Conclusion

MATH 160 at CSU is currently in the process of reform. Past research (House, 1995; Reinholz, 2009; Pilgrim, 2010) identified that reform is needed, as does the high number of students failing each semester. Any research done to help students understand concepts at a higher level could be beneficial to the fields of Mathematics, Natural Sciences, Engineering, and Education. In addition, any research to improve the failure rate of MATH 160 from an instructor development perspective may also be beneficial to the Department of Mathematics and CSU. Although the findings from this study did not discover the magic bullet, or secret to helping students achievement on exams in MATH 160, the benefits from understanding that students enjoy learning tough concepts, such as calculus, from instructors who use effective immediacy and communication skills should not be underestimated. Student opinions discovered in the interviews and focus groups expressed a desire for students to want instructors to employ effective teacher immediacy and communication competence skills.

However, by ruling out instructor behavior as one factor in student achievement, future research can now focus on other ideas, theories, and variables. The researcher of this project disagrees with Shallar's (1993) findings that teacher immediacy and communication competence

improves student performance in class. However, by studying instructor behavior in complex calculus classes, this study found that no statistical evidence was discovered that teacher immediacy and communication competence played a role in the effectiveness of learning taking place in class as shown in exam scores.

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APPENDIX A

Part I: Demographics, Part II: Teacher Communication Competence (Wiemann, 1977), Part III: Immediacy Behavior Scale (Gorham, 1988, Richmond, Gorham, & McCroskey, 1987)

Part I

Instructions: Please respond to the items below. Responses to these items will not be used to identify you; they will be used only for purposes of categorizing the data.

1) Participants Sex:
   ____ Male
   ____ Female

2) Are you an international student?
   ____ Yes
   ____ No

3) Class Rank:
   ____ First year student
   ____ Sophomore
   ____ Junior
   ____ Senior
   ____ Other (please Specify) _____

4) Have you taken another class (or classes) with this same instructor?
   ____ Yes
   ____ No

5) Teacher's Sex (Check one)
   ____ Male
   ____ Female

6) Total Number of University Level Math Classes Taken Prior to This Class: _____

7) Major: _____

8) In what class is the survey being completed? _____ Section? _____

Part II

Instructions: Complete the following questionnaire with the teacher of this class in mind. For each item, fill in the number (1-5) on this form which indicates the behavior of the teacher in this class. Always keep the teacher in mind as you answer.

Scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree; 5 = Strongly Agree

SD	D	U	A	SA
1	2	3	4	5

1. This teacher finds in easy to get along with others
2. This teacher can adapt to changing situations
3. This teacher treats people as individuals
4. This teacher interrupts others too much
5. This teacher is "rewarding" to talk to
6. This teacher can deal with others effectively
7. This teacher is a good listener
8. This teacher's personal relations are cold and distant
9. This teacher is easy to talk to
10. This teacher won't argue with someone just to prove he/she is right
11. This teacher's conversation behavior is not "smooth"
12. This teacher ignores other people's feelings
13. This teacher generally knows how other feel
14. This teacher lets others know he/she understands them
15. This teacher understands other people
16. This teacher is relaxed and comfortable when speaking
17. This teacher listens to what people say to him/her
18. This teacher likes to be close and personal with people
19. This teacher generally knows what type of behavior is appropriate in any given situation
20. This teacher usually does not make unusual demands on his/her students
21. This teacher is an effective conversationalist
22. This teacher is supportive of students
23. This teacher can easily put himself/herself in a student's shoes
24. This teacher pays attention to the conversation
25. This teacher is interested in what student s have to say
26. This teacher doesn't follow the conversation very well
27. This teacher is a likeable person
28. This teacher is flexible
29. Students can go to this teacher with their problems
30. This teacher generally says the right thing at the right time
31. This teacher likes to use his/her voice and body expressively
32. This teacher is sensitive to students' needs of the moment

Part III

Instructions: Below are a series of descriptions of things some teacher have been observed doing or saying in some classes. Please respond to the questions in terms of the class you are in now. For each item, fill in the number (1-5) on this form the behavior of the teacher in this class.

PLEASE NOT THE CHANGE IN SCALE ITEMS

Scale: 1 = Never; 2 = Rarely; 3 = Occasionally; 4 =Often; 5 = Very Often

N	R	O	OF	VO
1	2	3	4	5

33. Uses person examples or talks about experiences he/she has had outside of class
34. Asks questions or encourages students to talk
35. Gets into discussion based on something a student brings up even when this doesn't seem to be part of his/her lecture plan
36. Uses humor in class
37. Addresses students by name
38. Addresses me by name
39. Gets into conversations with me before, after or outside class
40. Has initiated conversations with me before, after or outside class
41. Refers to class as "my" class or what "I" am doing
42. Refers to class as "our" class or what "we" are doing
43. Provides feedback on my individual work through comments on papers, oral discussion, etc.
44. Calls on students to answer questions even if they have not indicated that they want to talk
45. Asks how students feel about an assignment, due date, or discussion topic
46. Invites student to telephone or meet with him/her outside of class if they have questions or want to discuss something
47. Asks questions that have specific, correct answers
48. Asks questions that solicit viewpoints or opinions
49. Praises students' work, actions or comments
50. Criticized or points out faults in students' work, actions or comments
51. Will have discussion about things unrelated to the class with individual students or with the class as a whole
52. Is addressed by his/her first name by the students
53. Sits behind the desk while teaching
54. Gestures while talking to the class
55. Uses monotone/dull voice when talking to the class
56. Looks at the class while talking
57. Smiles at the class while talking
58. Has a very tense body position while talking to the class
59. Touches students in the class

60. Moves around the classroom while teaching
61. Sits on a desk or in a chair while teaching
62. Looks at board or notes while talking to the class
63. Stands behind podium while teaching
64. Has very relaxed body position while talking to the class
65. Smiles at individual students in the class
66. Uses a variety of vocal expressions when talking to the class

This completes the survey. Thank you very much for your assistance.

APPENDIX B

Constructs/Questions

Survey Part II (Teacher Communicative Competence)

Interaction Management

- 1- This teacher finds in easy to get along with others
- 4- This teacher interrupts others too much
- 5- This teacher is "rewarding" to talk to
- 6- This teacher can deal with others effectively
- 9- This teacher is easy to talk to
- 11- This teacher's conversation is not "smooth"
- 20- This teacher usually does not make unusual demands on his/her students
- 21- This teacher is an effective conversationalist
- 24- This teacher pay attention to the conversation
- 25- This teacher is interested in what the students have to say
- 26- This teacher doesn't follow the conversation very well
- 30- This teacher generally says the right thing at the right time

Empathy

- 10- This teacher won't argue with someone just to prove he/she is right
- 12- This teacher ignores other people's feelings
- 13- This teacher generally knows how other feel
- 14- This teacher lets others know he/she understands them
- 15- This teacher understands other people
- 23- This teacher can easily put himself/herself in a student's shoes

Affiliation/Support

- 7- This teacher is a good listener
- 8- This teacher's personal relations are cold and distant
- 17- This teacher listens to what people say to him/her
- 22- This teacher is supportive of students
- 27- This teacher is a likeable person
- 29- Students can go to this teacher with their problems

Social Relaxation

- 16- This teacher is relaxed and comfortable when speaking
- 18- This teacher likes to be close and personal with people
- 31- This teacher likes to use his/her voice and body expressively

Behavioral/Flexibility

- 2- This teacher can adapt to changing situations
- 3- This teacher treats people as individuals
- 19- This teacher generally knows what type of behavior is appropriate in any given situation
- 28- This teacher is flexible
- 32- This teacher is sensitive to students' needs of the moment

Survey Part III (Teacher Immediacy)

Verbal

- 33- Uses person examples or talks about experiences he/she has had outside of class
- 34- Asks questions or encourages students to talk
- 35- Gets into discussion based on something a student brings up even when this doesn't seem to be part of his/her lecture plan
- 36- Uses humor in class
- 37- Addresses students by name
- 38- Addresses me by name
- 39- Gets into conversations with me before, after or outside class
- 40- Has initiated conversations with me before, after or outside class
- 41- Refers to class as "my" class or what "I" am doing
- 42- Refers to class as "our" class or what "we" are doing
- 43- Provides feedback on my individual work through comments on papers, oral discussion, etc.
- 44- Calls on students to answer questions even if they have not indicated that they want to talk
- 45- Asks how students feel about an assignment, due date, or discussion topic
- 46- Invites student to telephone or meet with him/her outside of class if they have questions or want to discuss something
- 47- Asks questions that have specific, correct answers
- 48- Asks questions that solicit viewpoints or opinions
- 49- Praises students' work, actions or comments
- 50- Criticized or points out faults in students' work, actions or comments
- 51- Will have discussion about things unrelated to the class with individual students or with the class as a whole
- 52- Is addressed by his/her first name by the students

Non-Verbal

- 53- Sits behind the desk while teaching

- 54- Gestures while talking to the class
- 55- Uses monotone/dull voice when talking to the class
- 56- Looks at the class while talking
- 57- Smiles at the class while talking
- 58- Has a very tense body position while talking to the class
- 59- Touches students in the class
- 60- Moves around the classroom while teaching
- 61- Sits on a desk or in a chair while teaching
- 62- Looks at board or notes while talking to the class
- 63- Stands behind podium while teaching
- 64- Has very relaxed body position while talking to the class
- 65- Smiles at individual students in the class
- 66- Uses a variety of vocal expressions when talking to the class

APPENDIX C

Colorado State University
Knowledge to Go Places

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011 Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	October 13, 2011
TO:	Gloeckner, Gene, 1588 School of Education
	Barclay, Allen, 1588 School of Education, Oltjenbruns, Kevin, 1588 School of Education
FROM:	Barker, Janell, , CSU IRB 1
PROTOCOL TITLE:	Measuring Teacher Immediacy and Communication Competence Toward Students and Achievement in Calculus phase II (qualitative)
FUNDING SOURCE:	NONE
PROTOCOL NUMBER:	11-2898H
APPROVAL PERIOD:	Approval Date: October 13, 2011 Expiration Date: October 03, 2012

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Measuring Teacher Immediacy and Communication Competence Toward Students and Achievement in Calculus phase II (qualitative) . The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Janell Barker

Barker, Janell

Includes:

Approval is for 10 participants using the approved consent form to obtain consent. If any changes need to be made, including recruiting more participants, please submit an Amendment prior to implementation or additional recruitment.

APPENDIX D

Colorado State University
Knowledge to Go Places

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011 Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	September 13, 2011	
TO:	Gloeckner, Gene, 1588 School of Education	
	Barclay, Allen, 1588 School of Education, Lehmann, Jean, 1588 School of Education	
FROM:	Barker, Janell, , CSU IRB 1	
PROTOCOL TITLE:	Measuring Teacher Immediacy and Communication Competence Toward Students and Achievement in Calculus	
FUNDING SOURCE:	NONE	
PROTOCOL NUMBER:	11-2864H	
APPROVAL PERIOD:	Approval Date: September 13, 2011	Expiration Date: August 01, 2012

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Measuring Teacher Immediacy and Communication Competence Toward Students and Achievement in Calculus. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Janell Barker

Barker, Janell

Includes:

Approval is for 470 math 160 students using the approved consent form to obtain consent. Parental permission for participants who may be minors has been waived through 116(d). Any changes to the protocol or forms must be submitted to the IRB as an Amendment prior to implementation.

Curriculum Vita

Name: Allen C. Barclay

Title: Instructor of Management

Address: School of Business
Northern State University
1200 S. Jay St.
Aberdeen, SD 57401
Tel: 605-626-7718

Education

Doctorate – Ph.D., Colorado State University, Education and Human Resource Studies with a focus on Organizational Performance and Change, (Anticipated Graduation: Summer 2012)
Dissertation topic: *Measuring teacher immediacy and communication competence on students achievement in calculus: a sequential explanatory mixed method design*

Masters of Education, University of Minnesota, Human Resource Development. (May 2003)
Focus on training and development with a supporting program of Adult Education
Master Thesis topic: *Training and development in a retail environment*

Bachelor of Science, University of Minnesota, Human Resource Development. (May 2000)
Focus on training and development, organization development with a minor in Business and Industry Education

Publications

Barclay, A., & Coons, L. (2011). Managing for Strategic Leadership. *AHRD International Research Conference*, 2011 Conference Proceedings.

Barclay, A., & Barclay H. (2011). Recession Compassion: 7 steps on how to treat employees to get the best performance during these global economic times, *Journal of Management Policy and Practice, 12*(1).

Barclay, H., & Barclay, A. (2010). Managing up: fight or flight, the power of winning at upward cultural management challenges, *South Dakota International Business Conference*, 2010 Conference Proceedings.

Timpson, W., Schafer, S., Barclay, A. (Eds.) (2010). *Case Studies for Integrating Teaching Diversity with a Context of Sustainability*. Madison, WI: Atwood Publishing.

Barclay, A. (2010). The "Required" Attitude, *Case Studies for Integrating Teaching Diversity with a Context of Sustainability*. Madison, WI: Atwood Publishing.

Barclay, A. (2010). The Disrespectful Student, *Case Studies for Integrating Teaching Diversity with a Context of Sustainability*. Madison, WI: Atwood Publishing.

Barclay, A. (2010). Online Collaboration, *Case Studies for Integrating Teaching Diversity with a Context of Sustainability*. Madison, WI: Atwood Publishing.

Barclay, A. (2010). Managing for strategic leadership: Requiring both management and leadership skills*. AHRD International Research Conference*, 2010 Conference Proceedings.

Barclay, A. (2010). Economic organization culture. *Journal of Management Research, 2*(1) 1-5.

Barclay, A. (2009). Employee change agents: the foundation for effective organizational change. *Journal of International Business Research*, *2*(4) 6-12.

Barclay, A., & Barclay, H. (2009). Recession Compassion: 7 Steps on how to treat employees to get the best performance during these global economic times*. South Dakota International Business Conference*, 2009 Conference Proceedings.

Publication Contributions

Gliner, J.A., Morgan, G.A., & Leech, N.A. (2009). *Research in Applied Settings: An integrated approach to design and analysis.* New York, NY: Routledge: Taylor & Francis. Contributed to the chapter discussions, questions, and summaries as a student project.

Presentations

Colbert, D., & Barclay, A. (2011). Adult Learning Principles, Paper presented at the *Colorado State University Professional Development Institute*, Fort Collins, CO.

Barclay, H. & Barclay, A., (2010). Managing Up: fight or flight, the power of winning at upward cultural management challenges, Paper presented at the *17th Annual South Dakota International Business Conference*, Rapid City, SD**.**

Barclay, A. (2010). Learning styles for undergraduate students. *The Institute for Learning and Teaching,* Academic and Study Skills Workshops. Colorado State University, Fort Collins, CO.

Green, E., Landers, H., & Barclay, A. (2010). Academic Success: reviewing the case studies, *Office of International Programs,* International Student Orientation, Colorado State University, Fort Collins, CO.

Barclay, A. (2010). Learning programs for sociology students guest speaker. *Sociology 105, Colorado State University,* TILT Learning Programs and Workshops. Colorado State University, Fort Collins, CO.

Barclay, A. (2010). Learning programs for adult and veteran students. *Office of Adult and Veteran Students,* Critical Thinking Programs and Workshops. Colorado State University, Fort Collins, CO.

Barclay, A., & Ibrahim, B. (2009). Statistical analysis of college of natural sciences tutorial hall. *Poster Presentation to the Deans of the College of Natural Sciences*, Colorado State University, Fort Collins, CO.

Barclay, A. (2009). Recession Compassion: 7 Steps on how to treat employees to get the best performance during these global economic times. Paper presented at the *16th Annual South Dakota International Business Conference*, Rapid City, SD.

Barclay, A., & Book, C. (2008). Team building for better tutoring. Presentation to the *College of Natural Science's Mathematics and Science Tutorial Hall*, Colorado State University, Fort Collins, CO.

Barclay, A., & Barclay, H. (2008). Managing with compassion. Paper presented at the *Central Association of College and University Business Officers* (CACUBO), Fort Lauderdale, FL.

Barclay, A., Barney, E., & Kolasa, S. (2003). Delivering great service in an academic setting. Paper presented at the *Big Ten Center for Human Resource Development Conference*, Minneapolis, MN.

Grants and Scholarships

Bohemian Foundation (Pending): Involved in proposal for Events Grant ($5,000).

National Science Foundation (Pending): Involved in proposal for Grant Opportunities for Academic Liaison with Industry ($125,000).

Association of Students in Education and Human Development: Scholarship for Students in Human Development ($1000).

Teaching/Training Experience

Faculty Member, Northern State University, August 2011 – Present

Faculty Member in the School of Business teaching *Organizational Management, Business Leadership, and Retail Management*. Teach lecture based courses to a diverse population of students

Graduate Teaching Assistant, Colorado State University, January 2011 – August 2011

Graduate Teaching Assistant in the College of Education assisting in the teaching of *Quantitative Research Methods*, EDRM 700 (Graduate Course) and *Proposal Development – Seminar*, EDRM 792B (Graduate Course)

Community Faculty Member, Metropolitan State University, August 2005 – August 2011

Community Faculty Member in the College of Management, courses taught: *Management Strategy and Policy* (Graduate Course) and *Organizational Behavior* and *Management Principles and Practices* (Undergraduate Courses). Taught lecture based and on-line courses to a diverse population of students

Adjunct Faculty Member, Dunwoody College of Technology, March 2007 – August 2011

Faculty Member in the Business College, courses taught: *Financial Accounting, Supervisory Management,* and *Operations Management* in the Bachelor of Applied Business program

Adjunct Professor, Colorado Technical University, April 2010 – June 2011

Faculty Member in the Management Department, courses taught: *Financial Accounting* and *Managerial Accounting*

Assistant Director of Learning Programs, Colorado State University, May 2010 – August 2011

Supervised twenty student tutors in the Institute for Learning and Teaching (TILT), Designed and developed programs to help improve student retention in the university, Managed payroll (Oracle Database) and budgeted projections for three programs, Organization recruiting, hiring, and staffing tutorial program, Wrote semester reports, ran statistics, and reported findings to the Vice Provost and Director of TILT

Coordinator of Undergraduate Retention, Colorado State University, August 2008 – May 2010

Supervise forty student tutors in the College of Natural Sciences, Design and develop programs to help improve student retention in the college, Manage payroll (Oracle Database) and budget projections for three programs, Organization recruiting, hiring, and staffing for three collegiate programs, Write semester reports, run statistics, and report finding to the Dean, Graduate Instructor for NCSI 394, *Supervised Student Teaching*

Community Education Facilitator, St Michael, MN, January 2006 – February 2008

Taught community education based classes on job interview skills through the St. Michael/Albertville Community Education Center including interpersonal skills, communication skills, active listening, and coaching for better interview techniques

Consultant, Allen Barclay Consulting, January 2005 – June 2008

Specialize in providing customer service programs which include developing and delivering sessions for diverse populations, Created and taught several classes for Minneapolis financial organizations including team building, strategic planning, and interpersonal skills, Mentor and coach individuals on interviewing skills, resume writing, and interpersonal communication skills

Training Coordinator, University of Minnesota, February 2001 – January 2005

Trained over fifty different classes including soft skills and technical payroll software (PeopleSoft/ORACLE) and financial software to University of Minnesota faculty, staff, and students, Designed and developed training for management and supervisory skills, communication skills, listening skills, time management, and delivering great customer service, Created classroom and e-learning technical training courses, Developed materials, timelines, agendas, and objectives used in training courses, Consulted to various departments on problem solving and productivity techniques while maintaining high retention and morale

Facilitator, University of Minnesota, February 2001 – January 2005

Facilitated over 800 hours of classroom training sessions to employees at the University of Minnesota over a five year period, Specialized in leading focus groups as the moderator, including experience as a facilitator, recorder, and supervisor

Relevant Leadership Experience

Senior Accountant, University of Minnesota, January 2005 – June 2008

Serve as budget officer to multiple departments on adhering to policies and procedures, Created spreadsheets consisting of all departmental financial information

Operations Director, Furniture & Things Inc., September 1999 - January 2001

Created sales training and data management manuals, Trained sales skills to newly hired sales associates

Assistant Manager, Pier 1 Imports, September 1997 – September 1999

Trained all personnel on the day to day activities of the organization

Yeoman Second Class, US Coast Guard, San Diego, September 1989 – September 1996

Worked with the financial and Human Resource systems used by the US Coast Guard

Academic Service

Association of Students in Education and Human Development, University of Minnesota

Served as a member of a Student Association, that volunteered in Minneapolis that helped bring University of Minnesota outreach to the community.

Avondale Elementary School, Topeka, Kansas

Volunteered weekly as a mentor to third grade students where I supported the teacher as a role model for underprivileged children.

Professional Affiliations

Academy of Human Resource Development (AHRD): November 2009 – August 2011

Midwest Academy of Management (MAM): January 2009 – Present

Board of Directors, University of Minnesota Federal Credit Union

Past member of the Board of Directors for the University of Minnesota Federal Credit Union helping to create a strategic plan and vision for the organization

Board of Directors, University of Minnesota Financial Systems Users Network

Past member of the Board of Directors for the University of Minnesota Financial Systems Users Network

Volunteer Service

Loveland High School Crimson Regiment, Loveland, Colorado

Volunteered with the Loveland High School Marching Band

Animal House, Pet Rescue, Fort Collins, Colorado
Volunteered to take care and foster dogs waiting to be adopted

College of Natural Sciences, Colorado State University, Fort Collins, Colorado
Volunteered to help with Ram Welcome for incoming freshman, 2008, 2009, and 2010

Volunteered with College of Natural Sciences Undergraduate Graduation, June 2009

St Michael Community Center, St. Michael, Minnesota, September 2006 – June 2008
Volunteered as an Assistant Coach for youth gymnastics

St Michael Community Center, St. Michael, Minnesota, May 2003 – July 2006
Volunteered as an Assistant Coach for youth soccer

Volunteered as an Assistant Coach for youth gymnastics

Honors

University of Minnesota Dean's List, 1998, 1999, and 2000

US Coast Guard Achievement Medal

Presidential Letter of Commendation, US Coast Guard

US Coast Guardsman of the Quarter, 1992

References

Mike Palmquist, Ph.D. Associate Vice Provost and Director, the Institute of Learning and Teaching, Colorado State University. 801 Oval Drive, Fort Collins, CO 80523, (970) 491-3132

mp@colostate.edu

Jack McGrew, Ph.D. Assistant Dean, College of Natural Sciences, Colorado State University. 117 Statistics Building Fort Collins, CO 80523, (970) 491-1300

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Ken Hess, Ph.D. Associate Professor, Management Coordinator, Metropolitan State University. 1501 Hennepin Ave Minneapolis, MN 55403, (612) 659-7265

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Debora.colbert@colostate.edu