DIFFERENCES IN STUDENTS' PERCEIVED CLASSROOM EXPERIENCES BY

INSTRUCTOR GENDER, STUDENT GENDER, AND PERSISTENCE IN STEM COURSES

By

CAROL FOWLKES

Bachelor of Science in Mathematics
MidAmerica Nazarene University
Olathe, KS
1989

Master of Science in Education
MidAmerica Nazarene University
Olathe, KS
1994

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IN STEM COURSES

Dissertation Approved:

Dr. John Foubert

Dissertation Adviser

Dr. Kerri Kearney

Dr. Stephen Wanger

Dr. Yoonjung Cho

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Abstract:
Science, technology, engineering, and mathematics (STEM) fields are growing and have lucrative job opportunities for college graduates. However, the number of students in STEM majors and the number of those who persist in those majors is declining; there is also a growing gender gap in STEM graduates. This study investigated three perceived classroom experiences in STEM courses and the nature of differences in these experiences by student gender, instructor gender, and by those who persisted or did not persist in STEM majors. A factorial MANOVA was the statistical method by which the differences were explored. The statistical analysis revealed non-significant mean differences in three-way interaction, all two-way interactions, and all main effects. There were not gendered differences in students' perceptions of the opportunities for hands-on learning, the instructor cares about students' success, and the instructor encourages students' contributions. Further research is proposed to continue examination of this topic with a larger data set that is consistent with the literature regarding the population of STEM students and the number of STEM persisters, and the male-gendered nature of STEM fields.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

This dissertation examined the nature of differences in science, technology, engineering, and mathematics (STEM) classrooms across instructor gender, student gender, and those who persist/do not persist in STEM majors at the post secondary level. This study was based on a survey of students in a gateway-level (1000 or 2000) STEM course conducted in fall 2012 with subsequent data collected in the spring of 2013. Students were asked to rate their classroom experiences and interactions with the professor on a Likert scale. This introduction chapter explains the background and context of the study, the purpose of the study, the professional significance, and an overview of the methodology. The chapter concludes with the limitations of the study and definitions of terms used in the study.

Background of the Study

In May of 2013, the United States Federal Government issued a 5-year strategic plan for STEM efforts (Holdren, 2013). Among the initiatives put forth by President Barrack Obama was an initiative to make STEM a priority in the education efforts of the Department of Education. President Obama's goal for higher education was to have one million additional students graduate in STEM fields over the next ten years (Holdren, 2013). This is a lofty goal by the president; universities face many challenges in

achieving it. The National Academies Press reports that of the fifty percent of high school

graduates who earn a college degree, only 33% receive their degrees in science or

engineering (Augustine, 2007). Furthermore, colleges are having difficulty in helping

students persist in STEM majors. Atkinson (2012) states that if the United States could

simply reduce the number of non-persisters in STEM majors by fifty percent, it could solve

the STEM field worker problem. Gender inequalities arise in STEM careers and in STEM

graduates, adding to the problem of too few STEM graduates overall to meet the growing

need. Women are vastly underrepresented in STEM jobs at a rate of 76% to 24% even

though women make up 47% of the workforce at large (Beede et al., 2011).   At the

university level, male students graduate with STEM degrees at a much higher rate than

female students (Hoffmann & Oreopoulos, 2009).

Problem Statement

Science, technology, engineering, and mathematics (STEM) fields are growing and

have lucrative job opportunities for college graduates (Carrell, Page, & West, 2010; Holdren,

2013). However, the number of students in STEM majors and the number of those who

persist in those majors is declining; there is also a growing gender gap in STEM graduates

(Atkinson, 2012; Augustine, 2007; Hoffmann & Oreopoulos, 2009; Miyake et al., 2010).

Perhaps educators in STEM courses do not understand the types of classroom experiences

that students in STEM courses need to persist in the courses and ultimately the STEM

degree. Furthermore, educators may not understand how classroom experiences are

perceived differently depending on the gender of the student and the instructor. The purpose

of this study was to explore the differences in students' reported classroom experiences in

STEM courses across instructor gender, student gender, and those who persist/do not persist in STEM majors.

<div align="center">**Professional Significance**</div>

This study contributes to the current body of knowledge surrounding college students persisting in STEM majors, and to gender differences that affect how students perceive their STEM instructor and classroom experiences. This study identified differences or lack thereof between men and women and informs the process of developing further studies to explore those differences. Although many studies have been conducted in STEM courses comparing men and women, most have explored the differences in student gender and underrepresented minorities (Bettinger & Long, 2005; Carrell et al., 2010; Strenta, Elliott, Adair, Matier, & Scott, 1994). There are a few studies that explore instructor gender and the differences that arise in the classroom setting (Bachen, McLoughlin, & Garcia, 1999; Basow, 2000; Feldman, 1993). This study explored these differences at the multivariate level including those who persist/do not persist in STEM courses giving a broader perspective on the role of gender in student/instructor interaction.

Although there are lucrative job opportunities for STEM graduates and President Obama has called for initiatives to increase the number of STEM workers by one million over the next decade, the number of STEM graduates is still declining. Understanding the types of classroom experiences that students need to persist in STEM courses is important for STEM professors. Furthermore, STEM educators may not understand the role that student gender and instructor gender plays in these classroom experiences. This study leads to a greater understanding of these three classroom experiences, opportunities for hands-on learning, the instructor caring about the student's success, the instructor encouraging

contributions, and the role that gender plays in these experiences. STEM professors, male and female alike, armed with this understanding may explore different teaching techniques and focus more efforts on the emotional side of teaching to help their students persist.

Overview of Methodology

In order to explore the nature of reported differences in three perceived classroom experiences across student and instructor gender groups, and those who persist/do not persist in STEM courses, a quantitative study was conducted. The epistemological stance from which the researcher explored those differences is objectivism which "holds that meaning exists apart from the operation of any consciousness" (Crotty, 2003, p. 8). The study focused on whether the perceived classroom experiences of students were different due to their gender, the instructor's gender, and their persistence/non-persistence in STEM courses. Because three reported classroom differences were explored across three categorical variables a factorial MANOVA was conducted. A full description of the methodology appears in Chapter Three.

Limitations

This study was limited by the boundaries imposed from the data itself that were collected from one large research university. However, assuming the population of this university is representative of other large research universities in the STEM context, some generalizability is possible. Although the study refers to STEM fields and STEM majors, the data collected for this study had limited participants in the discipline of mathematics (n=2), therefore, there are unequal n's for each of the STEM disciplines.

Another limitation of this study was the chosen set of dependent variables which were opportunities for hands-on learning, the instructor cares about student's success, and the instructor encourages students' contributions. Although, there are many classroom

experiences that might be explored in the STEM classroom, this study focused on a common classroom practice of hands-on learning and two not-so-common experiences that focus on the emotional side of the STEM classroom.

The participants were student volunteers, chosen from gateway courses for which their professor indicated the researchers were welcome to come to their class for data collection. All professors of gateway courses that had more than 30 students enrolled were emailed and asked for their participation in the study. For this reason, this study is limited to large class sizes and the results of this study may not be generalizable to smaller class sizes in STEM courses.

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Definitions

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Hands-on Learning

Hands-on learning was defined as the active and kinesthetic type of learning that occurs with the use of manipulatives in cooperative learning groups.

Persisters

For the purposes of this study, persisters was defined as those who had declared a STEM major in the fall of 2012 as reported from the Institutional Research and Information Management (IRIM) data at the university studied and remained a STEM major in the spring of 2013 at the time of the second round of data collection. If a student switched majors but were still in the STEM field they were considered a persister.

Non-persisters

Non-persisters were defined as those who had declared a STEM major in the fall of 2012 as reported from the IRIM data and were no longer a STEM major in the spring of 2013.

Gender

Although the researcher recognizes that gender is typically used with reference to social and cultural differences rather than biological ones, for the purposes of this study gender will be defined as the biological differences between male and female.

STEM Major

STEM majors are defined as students' declaring a major in the field of study recognized by the National Science Foundation (NSF) as a STEM degree field: Chemistry, Computer and information science and engineering, engineering, geosciences, life sciences, materials research, mathematical sciences, physics and astronomy, psychology, social sciences, STEM education and learning research (National Science Foundation, n.d.).

STEM Course

A course determined to have prefix compatible with NSF STEM guidelines for a STEM degree field as mentioned in STEM major definition.

Conclusion

The chapters of this proposal that follow include a comprehensive review of the literature and the methodology. In Chapter Two the relevant literature is reviewed, highlighting the growing need for STEM majors in the United States, as well as the steady decline in STEM majors and a growing gender gap. The literature on the three classroom experiences that will be explored in this study is also reviewed, showing conflicting perspectives and gaps in the literature that relate to student gender and instructor gender across these three perceived classroom experiences.

Chapter Three will explore the methodology that was used to conduct this study, including the epistemological position, the data collection process, and a detailed description

of the data analysis. Chapters 4 will report the findings with discussion of the findings in

Chapter 5.

CHAPTER II

LITERATURE REVIEW

Science, Technology, Engineering, and Mathematics (STEM) literature is vast, ranging from careers, school initiatives, recruitment, and gender to name a few. This chapter begins with a broad view of the need for STEM majors and the growing opportunities and lucrative job openings that are on the rise in the United States of America to keep our country competitive in the global marketplace. The focus then turns to the declining numbers of STEM majors in our colleges and universities due to lack of interest in choosing a STEM major and persistence. Furthermore, the declining numbers problem is multiplied when exploring the inequities that exist in the number of male and female STEM graduates. The gender gap is explored and relevant studies that have tried to account for the gender discrepancies are examined. Gender differences, biological and socially constructed, are examined and how these differences affect the university experience as a whole. Classroom experiences at the collegiate level are explored examining studies that have been conducted on the role of student gender, instructor gender, and their interactions in the classroom. Narrowing the topic even further, three perceived classroom experiences in STEM courses are explored. This study focused on these three classroom experiences and how these experiences were perceived differently by student gender, the gender of the student's professor, and if the student has persisted

or not persisted in a STEM major. The threads of student gender, instructor gender, and persistence will run through each classroom experience as the relevant literature is examined. The three chosen classroom experiences in STEM courses that were explored were the opportunities that the instructor gives for hands-on learning, the perception that the instructor cares about the students' success, and, lastly, the perception that the instructor encourages their contributions.

Search Process

The search process discovering relevant literature for this study involved many techniques. The appropriate descriptors of topics were searched on various databases through the Oklahoma State University library website. The most common database for sources was ERIC, an educational database; however, EBSCO, PROQUEST, and Google Scholar were other databases that were searched. Once articles were listed, abstracts reviewed and determined to be useful, the next step was to examine the literature reviews in the chosen journal articles and discover the author's sources to further track the main authors and experts in the chosen topic. The relevant literature was then categorized, analyzed, and synthesized to give a broad understanding of the current conversation that exists in higher education about STEM majors, STEM courses, and STEM classroom experiences.

Need for More STEM Majors

STEM fields are growing and have lucrative job opportunities, but educators are worried the supply is not equal to the demand in these fields. Educators are concerned that colleges are not producing enough STEM majors to meet the growing demand for this job market. In the five year strategic plan for STEM initiatives, the United States

government reports that over the next decade there will be one million fewer STEM

graduates than there are STEM openings in the industry (Holdren, 2013). At the college

level, students are choosing majors at times that are critical; decisions about choosing a

STEM major or persisting in a STEM major can have enormous effects on the nation's

future labor markets (Carrell, Page, & West, 2010). The United States has been a global

leader, but today that leadership is threatened because of the lack of American students

pursuing careers in STEM fields. According to the Department of Education's website

(ed.gov, n.d.), increasing the number of students pursuing careers in STEM fields is a

priority that President Obama has set. Currently, however, reports show that only 16

percent of American high school graduates are interested in a STEM career. The Obama

administration has stressed national strategies, networks, and incentives to encourage

students to pursue collegiate degrees in STEM fields. President Obama's goal for higher

education is to graduate one million more students with degrees in STEM fields over the

next ten years (Holdren, 2013). With this lofty goal by our president, universities must

step up to the plate and do everything possible to achieve this goal and increase our

STEM graduates in the United States.

<p align="center">**Declining Number of STEM Graduates**</p>

The growing need for STEM graduates is apparent; however, universities face

challenges in increasing the number of STEM majors to meet the goal of one million

more STEM graduates over the next decade. The National Academies Press says that

only fifty percent of those who begin college earn their degree. Of the fifty percent who

do earn their college degree, only 33% receive them in science or engineering

(Augustine, 2007). A report by Atkinson (2012), states that the number of engineering

degrees at the undergraduate level has not grown in fifteen years. Furthermore, the high

school pipeline has no apparent leaks because this pipeline produces enough high school

students interested in STEM careers to meet the needed number of STEM Bachelor of

Science degrees. Colleges, however, are doing a poor job of helping those interested in

STEM careers make it all the way to the STEM degree (Atkinson, 2012). The problem

seems to lie in persistence of those first year students declaring STEM majors; quality of

the students who declare STEM majors is not the issue (Seymour & Hewitt, 1997). In

Seymour & Hewitt's study of Science, math, and engineering (SME) major switchers and

non-switchers, they found neither inadequate high school preparation nor conceptual

difficulties were significant factors in switching decisions. They hypothesized that the

quality of high school mathematics preparation should not have created serious

difficulties that would lead them to switching their major from science, mathematics, or

engineering; their study confirmed this hypothesis. This study did find, however, that for

switchers and non-switchers alike, 40% reported some problems related to high school

preparation; this was not a significant predictor of persistence in S.E.M. major.

Therefore, the continuing need to identify predictors of persistence in STEM majors

becomes important. If the United States could simply reduce the number of non-

persisters in STEM majors by fifty percent it could solve the STEM field worker problem

(Atkinson, 2012). Therefore, it is imperative for the nation's colleges and universities to

find a way to keep those freshmen pursuing a STEM career interested and motivated to

persist in a STEM major.

Gender Gap in STEM

There is an urgent need for STEM graduates in the United States; however, the number of STEM graduates is declining for various reasons. Adding to the issue of the number of students enrolling and persisting in STEM courses are the inequities in gender of students in these courses. Upon graduation, students are finding a growing gender gap in STEM careers. STEM fields have been traditionally male-dominated, and this gender gap in STEM careers is even more pronounced at the university level. Male professors are dominant in STEM courses, and male students graduate with STEM degrees at higher rates than female students (Hoffmann & Oreopoulos, 2009). Graduate degrees show a gender discrepancy as well with 28% of doctorates earned in physical sciences conferred to women, 25% in mathematics and computer science, and 20% in engineering (Miyake et al., 2010).

As the National Science Foundation (NSF) report on pre-college STEM education shows, the gender gap in STEM achievement begins to be significant at the postsecondary level. As far as differences in male and female students taking math and science courses in the twelfth grade, there was only a slight difference in science courses; females are more likely to take biology and chemistry, and males are slightly more likely to take physics. There was not a significant difference in males and females completing math courses. Looking at the differences in pre-college math and science achievement, again, there were no significant differences in mathematics courses between males and females in the twelfth grade, and only a slight difference between male and female average science achievement scores (152 and 148, respectively) (National Science Foundation, 1999). These science achievement scores measured knowledge of facts,

concepts, analytic reasoning, ability to communicate scientific information, perform

investigations, and application of problem-solving skills as measured on the National

Assessment of Educational Programs (NAEP) science assessment. Therefore, it appears

the gender differences, that apparently are not ability related, begin to manifest at the

college level, leading to the pronounced gender gap in STEM graduates. In a recent

report by the NSF, women are more likely than men to graduate with a bachelor's degree;

however, men earn bachelor's degrees in physical sciences, mathematics, computer

sciences, and engineering fields at a higher rate than women (National Science

Foundation, 2011).

Not only is there a gender gap at the university level, but there is also inequity

between the genders in STEM careers.   A recent report by the U.S. Department of

Commerce (2011) states that women are vastly underrepresented in STEM jobs at a rate

of 76% to 24%, even though women make up 47% of the entire workforce. (Beede et al.,

2011). Eccles (2011) uses Expectancy Value Theory to understand the discrepancy by

gender in the STEM work place. Females place more value on jobs that help others and

society, which is why the largest place that we see females in STEM fields is in

biomedical sciences. Another career choice that has high female participation for

students who major in mathematics or science is teaching, which is considered a STEM

career according to the NSF guidelines used for this study (National Science Foundation,

n.d.) In the same study, Eccles (2011) states that males place more value on jobs that

make more money, that improve status, or that challenge them, contributing to their

STEM field career choice. According to Eccles (2011), these gendered differences in

values and motives for choosing a career should lead to the students' intrinsic value for

their major courses. Females indicated that they would be more willing to sacrifice their career goals for the needs of family more than the males, which could be a factor in persistence (Eccles, 2011).

Choosing a STEM major

There are many lucrative job opportunities available to those with a STEM degree. Many studies have been conducted as to the effect of potential wage earnings in STEM careers and choice of major. In Seymour & Hewitt's (1997) longitudinal study, the most commonly cited factor for pursuing a STEM major was the influence of others. The influence of others varied by high school math or science teachers, counselors, but the most significant influence on choice of major was parents. Some students reported "feeling pressured" into a STEM major, unfortunately these were among the ones expressing the strongest desire to switch majors (Seymour & Hewitt, 1997, p. 60). Female students in this study were twice as likely as men to choose a STEM major because of the influence of others, while men were twice as likely as women to choose a STEM major because of their mathematical ability. However, according to Zafar (2013) in a more recent study, gender differences regarding mathematical ability explain a small and insignificant part of the gender differences in STEM majors.

Regarding potential wage earnings, this factor seems to be the least significant for women in choosing a major (Dickson, 2010; Montmarquette, Cannings, & Mahseredjian, 2002; Seymour & Hewitt, 1997; Zafar, 2013). This echoes Eccles' (2011) findings about women placing more value on helping careers, and men placing more value on status in

their career. For males, wage-earning potential explains about half of the choice of

STEM major, while less than 25% of females choose their major because of wage-

earning potential (Zafar, 2013). Zafar goes on to state that the most important outcomes

in the choice of major are enjoying coursework, enjoying work at potential job, and

gaining approval of parents. Enjoying coursework is a factor that universities can control

to an extent. The present study will attempt to explore perceived classroom experiences

that might improve enjoyment in the coursework, hopefully leading to better persistence

in STEM courses.

Persistence in STEM Courses

There are many job opportunities available to students who graduate with a

STEM degree. For this reason, many national, state, and local initiatives have been put

into place in our educational system to provide opportunities for students to seek STEM

career fields. However, the number of STEM graduates continues to decline;

furthermore, the gender inequities in STEM fields are apparent. Adding to this issue, it is

more likely for first-year students declaring a STEM major to later change to a non-

STEM major than any other major, especially if the university has a higher percentage of

graduate students than undergraduate students (Griffith, 2010). If the university has a

higher ratio of graduate students to undergraduate students, they are less likely to focus

on undergraduate education. Those universities with more undergraduate students tend to

create a more welcoming environment with full professors teaching entry level STEM

courses at the undergraduate level, improving persistence rates in these universities over

graduate heavy universities (Griffith, 2010). In the classic longitudinal study by Seymour

& Hewitt (1997), the lack of persistence in science, math, and engineering (S.M.E.) was

apparent in the 1990s. The study showed that 63% of declared math majors do not

persist past their sophomore year. In physical sciences and biological sciences the non-

persisters were just as dismal, 51.2% and 51%, respectively. The one major within

STEM they examined that had the lowest rate of non-persisters was engineering with

38.1% not persisting. These losses, due to lack of persistence, began to be known as the

"leaky pipeline." Researchers studying STEM persisters found that the number of

students who were being retained in STEM majors was seriously lacking to meet the

nation's future needs (Seymour & Hewitt, 1997, p. 2). This research compelled

universities to find a way to fix those leaks so the pipeline produces STEM graduates

equal to the science, technology, engineering, and mathematical needs of our nation's

global competitiveness.

The literature on persistence in STEM majors has conflicting studies when

examining persistence by gender.   One study found that females did not "leak" out of the

pipeline; they are just less likely to choose a science and engineering major.

Furthermore, they found that female students in science and engineering are more likely

than males to persist in their chosen STEM major (Huang, Taddese, & Walter, 2000).

Women consistently enrolled in science and engineering majors at a lower rate than

males in their first year out of high school, or first year postsecondary (7.6% and 20.4%,

respectively). However, once they were in the science and engineering "pipeline," the

study revealed that their completion of the science and engineering degree was

significantly higher than males (48.6% to 40.4%, respectively). They also studied

environmental factors that might lead to persistence in science and engineering majors.

Females enrolled in science and engineering programs were shown to have strong family

support, high expectations, healthy self-confidence, and solid academic preparation (Huang, Taddese, & Walter, 2000). This study examined persistence of male and female students in science and engineering only and did not explore the gender of their professors to see if that affected persistence.

As was previously stated, STEM fields are male-dominated and none more so than STEM departments at the university level. A 2012 report of our nation's top 200 research universities states that 87% of the department chairs in STEM departments are male ("Bayer Facts of Science Education XV," 2012). Perhaps the male-dominated STEM departments are a factor that leads to persistence of students, especially to female students. Two particular studies looked at persistence by student gender and professor gender with differing results. Price (2010) hypothesized that students experience better educational outcomes when taking courses taught by faculty of their own gender, especially in STEM courses. If students had better educational outcomes, would that lead them to have a higher rate of persistence? While Price (2010) did find that female students performed better in courses taught by female instructors, there was not an increase in performance in subsequent STEM classes. Contrary to his initial assumptions about persistence, he actually found that female students were less likely to persist when more of their STEM courses were taught by female faculty. Conflicting with the findings of this study, Carrell et al. (2010) found that professor gender does not have a profound effect on male students academic performance, however, it has a powerful effect on female students' performance in STEM courses, their likelihood of taking future STEM courses, and persistence in their STEM major. When female students are high-performing as defined by SAT scores, and are assigned to female professors, "the gender

gap in course grades and STEM majors is eradicated" (Carrell et al., 2010, p. 1101).

Perhaps there is valuable information to retain when looking at these two studies that

appear to conflict in their findings. Price (2010), in fact, tried to replicate the findings of

Carrell, et al. (2010) and did find the negative relationship between own-gender

professors and persistence of female student no longer existed when he examined

students with ACT scores greater than 30. Therefore, thes e two studies might suggest

that high ability female students are not negatively affected by female professors. Carrell

et al. (2010) speculates the classroom environment that female STEM professors create

resonates with high ability female students with no negative effects on male students.

They state that this is extremely important given the fact that high ability math and

science students are the ones most needed in the STEM career pool. For those female

students with less than 30 ACT scores who are less likely to persist in STEM courses

when taught by female faculty, Price (2010) suggests that females' sensitivity to grades

might be the reason. Given the more rigorous curriculum in STEM courses, the

competitive nature of the STEM courses, and the possibility of lower grades in STEM

courses, then, perhaps, these reasons lead to less persistence for female students with

female faculty in STEM courses.

  University students change their majors (Seymour & Hewitt, 1997; Simon, 2012).

In the STEM majors, lack of persistence is the highest of all disciplines, creating a leaky

pipeline to the STEM fields which are in desperate need of workers. Some studies

indicated that if the female student is high-achieving then studying under female

professors increases their likelihood of persisting, while other studies found that female

students are less likely to persist if they had female professors in their STEM courses

(Carrell et al., 2010; Price, 2010). Questions still remain as to the dilemma of persistence in STEM majors. Upon entering college, perhaps there are gender differences that effect the student's overall experience in college.

Gender Differences at the University

Males and females are different (Gray, 1992; Kimmel, 2000). But how do these differences play out once the students get to college? How do the stereotypical views of our society affect the students that walk on our campuses? Michael Kimmel (2000) tackles the issue of "nature versus nurture" from the perspective of biological differences and socially constructed differences in males and females. At the foundational level there are cell differences in gender. The impact of these biological differences has been discussed throughout history, even in the educational arena. There was the belief that educating women would cause damage to their uterus and reproduction systems which obviously led to less educated women in the late 1800s. Thankfully, the American viewpoint slowly, and painfully, evolved over the next centuries to where we stand today. There are still gender inequities, however, researchers continue to explore the biological differences and socially constructed differences with interesting results. Some differences report that men are more left-brained, causing them to be more mathematically gifted and females are more right-brained, causing them to be more verbal. However, after studies were conducted they found no gender differences in verbal abilities and slight differences in mathematical ability with females slightly outperforming males in mathematical ability (Kimmel, 2000). The one consistently occurring theme in these male/female studies was the biggest differences occurring

among the males and females themselves, rather than between the male and female groups.

There are certain traits that have become attributed to be more masculine or feminine. In Bem's Sex Role Inventory (BSRI) these attributes are scaled and personalities can be described as masculine/feminine (high on one scale low on the other), undifferentiated (low on both scales), or androgynous (high on both scales). The stereotypically feminine traits for the BSRI are affectionate, gentle, understanding, sensitive to the needs of others, etc. The stereotypically male traits are ambitious, self-reliant, independent, assertive, etc. (Bem, 1981). The American culture has conveniently grouped these attributes into two mutually exclusive categories. According to Bem (1981), the individuals themselves vary as to their response to these stereotypes.   The sex-typed individual might modify his or her behaviors to keep behavior consistent with a particular sex; alternately, the individual might avoid behaviors that violate that image. However, androgynous individuals understand these differences, but will be less likely to modify their behavior or avoid behaviors to maintain image of masculinity/femininity (Bem, 1981). This is an important distinguishing feature between individuals and will be referred to later when discussing classroom experiences at the university.

Gender is more than just individuals and their differences; the workplace and our institutions of learning are also gendered. The gendered differences in college have been explored in many studies with interesting results. Before examining the gendered differences in the classroom, the broader view of students interacting with their professors/advisors will be explored. The one difference that reoccurs in the literature is the differential effects of faculty-student interaction. In one study, student-faculty

interaction was explored examining the types of interaction and the impact of those interactions (Sax, Bryant, & Harper, 2005). Researchers have shown that female students reported more frequent and more positive interactions than the male students and the impact from those interactions resulted in female students reporting more emotional support from faculty. However, one interesting difference was that among female students only, the more frequent faculty interactions was positively related to an increase in traditional female gender roles, such as the attitude that married women should stay at home and raise a family (Sax et al., 2005). STEM career fields are male-gendered, therefore less traditional female roles. This raises question to this faculty interaction being positively correlated with traditional female roles for female students and the effect on female students choosing STEM career paths. Does this have a role to play in female persistence in STEM majors? This particular study did not investigate the gender of the faculty nor did the study distinguish between the faculty of different majors, but their findings have been replicated in other studies.

Bryant (2003) conducted a study among college students hypothesizing that four years in college would lead to more egalitarian views and hypothesized several predictors of more egalitarian views. As hypothesized, both male and female students became more egalitarian after four years in college. Males, however, did enter college and exit college with more traditional views than women. The one dependent variable that they looked at was their agreement with the statement "the activities of married women are best confined to home and family" (Bryant, 2003, p. 134). The participants could "agree strongly," "agree somewhat," "disagree somewhat," or "disagree strongly" with the first two categories considered traditional female views and the last two categories considered

egalitarian female views. Males went from 26.2% traditional views as freshmen to 22.4% traditional four years later, while, females went from 14.5% traditional views as freshman to 10.5% traditional views. These differences were not tested for significance; the focus of the study was on the predictor variables that lead to more egalitarian views. The study had several independent variables that were regressed onto the dependent variable. The only major that was a significant predictor for egalitarian views was a male majoring in humanities. The replication of Sax et al.'s study came when examining the faculty interaction. They hypothesized that increased faculty-student interaction would increase egalitarian views which was the case when faculty provided intellectual stimulation. However, when faculty increased time spent with students outside of the classroom, more traditional views of female roles increased. Again, what is happening in these interactions that are affecting the student's views of women, with students embracing the more traditional view of women at home with family? This could have a detrimental effect on female students pursuing careers in general, but more specifically careers in STEM fields.

Not only was increased faculty-student interaction shown to increase more traditional views of females, in another study by Sax (1994), faculty interaction was also shown to be a negative predictor of mathematical self-concept in female students. In this study, Sax looked at factors in college that influence mathematical self-concept hypothesizing that the college experience decreases student's mathematical self-concept. Some of the gender differences this study brought out were that women did have lower self-ratings than men upon entry into college. Upon graduation, or four years later, both males' and females' self-ratings of mathematical ability decreased. When examining

possible predictors for this decrease, many factors were explored. An interesting finding was for women only; the more the female students reported faculty interaction, the mathematical self-concept decreased. Therefore, a negative correlation was found between faculty interaction and mathematical self-concept for female students only.

Faculty interactions that increase more traditional, less egalitarian views, toward women by female students have been explored. Faculty interactions that decrease mathematical self-concept in female students have been explored. What is happening to female students as they spend more time with faculty? Since the gender of the faculty was not distinguished in these studies, perhaps a more close-up view of these interactions needs to be explored by gender of the faculty. Assuming that faculty are male, perhaps female students embrace the stereotypical view that females should be at home the more time they spend with male faculty, especially in STEM majors as they feel the competition from their male counterparts. Conversely, assuming that a faculty member is female, the female student might embrace the more traditional view by observing the time spent away from family by the faculty member.

Perhaps, the perceived classroom experiences in the STEM courses themselves have an effect on persistence in STEM courses. Perhaps these perceived classroom experiences have differing effects depending on the gender of the student, and even the gender of the professor.

Classroom Experiences by Gender

Many studies have been conducted that focus on the classroom experiences of students by gender. Basow (2000) looked at gender differences in a qualitative approach by asking college students to describe their best and worst professors. She then coded the

descriptors that were used for both categories to determine the five main teaching factors

that distinguished the best professors and the worst professors. The findings of this study

were that female students were more likely to choose female professors as "best" than

expected and that male students were less likely to choose female professors as "best"

than expected (Basow, 2000). However, there were no significant gender differences in

the choice of "worst" professors. The main quality, or teaching factor, for best professor

that emerged from the data was that the professor cares. For the female professors, 53%

of the students identified this characteristic for their best professor which was the highest

of all teaching characteristics. For the male professors, 43% of the students identified

this characteristic for their best professor which was the highest of all teaching factors for

best male professors (Basow, 2000). This study grouped the teaching factors according

to the Bem Sex-Role Inventory (Bem, 1981) which describes attributes as stereotypically

masculine (instrumental-active) and stereotypically feminine (expressive-nurturant). One

of the interesting findings of this study found that the best professors were strong in both

instrumental-active (masculine) and expressive-nurturant (feminine) revealing, perhaps,

that students value such "androgynous" professors, regardless of their gender. The caring

trait, highest rated teaching characteristic, fell into the expressive-nurturant category and

thus considered feminine. Previous studies have stated that the expressive-nurturant

qualities matter more for female professors, especially by male students (Bachen,

McLoughlin, & Garcia, 1999; Rubin, 1981). This study revealed that this caring trait in

professors is important regardless of the gender of the professor (Basow, 2000). The

question still remains as to the results of this study when focusing on STEM courses.

Because STEM courses have been labeled as masculine and male-gendered (Hill,

Corbett, & St. Rose, 2010), will the caring characteristic still be of value, regardless of student gender, instructor gender, and perhaps persisters/non-persisters in STEM majors?

In a similar study, Bachen et al. (1999) examined the influence of stereotyping or gender schema on students' evaluation of male and female professors across five teaching characteristics. Their findings suggest that female student's rate female faculty higher on the caring/expressive teaching trait than they do male professors. In the quantitative follow-up questions, the females revealed that they expect their male professors to be the same as female professors in the caring/expressive or nurturing traits of teaching. This challenges the stereotypical view that female professors possess the nurturing teaching traits more often than male professors. Male students, however, expect the female professors to be more nurturing or caring than their male counterparts, which is the stereotypical view of female gender schema (Bachen et al., 1999). This study was done among 486 undergraduate students where half of the participants had female professors and the other half had male professors. They asked the students to describe the "general case" for their ratings rather than the ideal case when responding to the given survey. Does this mean that female students in male-dominated STEM courses expect their male professors to be caring and nurturing and when they do not receive the expected caring they decide to change their major and thus become a non-persister in STEM? The current study may shed more light into this gender schema expectation for both male and female students and the role these expectations might play in persistence.

Classroom experiences in STEM courses. The classroom experiences of students in STEM courses have been explored from many different angles with varying reasons as to college student's persistence, or lack thereof, in STEM majors. Carrell et

25

al. (2010) stated that professor gender has a large effect on female students and their performance in math and science courses but has little effect on male students. They attributed this difference in performance to the gendered differences of professors and their teaching styles, academic expectations of male/female professors, or the advice and encouragement given by the different male/female professors. In a similar study, Bettinger and Long (2005) attributed positive influences on female students who had female instructors to the role-model effect. These researchers examined students being influenced to take additional courses and persist in their initially chosen major when they had a female professor after taking one course in that chosen major. In the sciences, female students with female instructors were less likely to take additional courses in biology and physics; however, in geology, math, and statistics, which they called the most quantitative majors, their likelihood of taking additional courses nearly doubled (Bettinger & Long, 2005). Questions remain as to the influence that female professors have on male students taking additional STEM courses and persisting in a STEM major. Role model effects, gender differences in expectations in STEM course professors, and females reporting that science courses are too competitive and too rigorous have all been studied to explore the nature of perceptions of gendered differences in the STEM classroom (Strenta, Elliott, Adair, Matier, & Scott, 1994). Perhaps, there are stereotypes and social norms at work, as well.

The STEM fields are male dominated and can be described stereotypically, as "masculine" jobs and male-gendered (Hill et al., 2010), regardless of the sex of the worker, student, or professor. The social norms associated with this stereotype can have a profound effect on both male and female students in STEM courses and how they

perceive classroom experiences. In one such study, the researchers hypothesized that when people view a woman in a male-gendered job, they either view her as competent in her job or likeable, but not both (Heilman, Wallen, Fuchs, & Tamkins, 2004). They stated that social norms relay the message that there are things females should do: be socially sensitive and service-oriented in their job. There are also things that females should not do: be self-assertive and tough on the job. Their hypothesis was supported by their data; they found that when men and women were thought to be successful in their male-gendered job, men and women were equal in their ratings of competence. However, when rated on a "likeable" scale, women were rated significantly lower than males. The reverse happened when the subjects under study did not know if the men or women were successful in their male-gendered job; men and women were rated equal in likeability but women were rated significantly lower than males on their competence (Heilman et al., 2004). These results seem to suggest that stereotypes do have effects on perceptions of females in a male-gendered job such as STEM fields. Teaching STEM courses offers a dichotomy of two stereotypes. Teaching is not male-gendered, however, STEM professors are teaching courses that lead them to male-gendered career fields. Does the finding of Heilman et al.'s (2004) study transfer to the STEM classroom, a male-gendered job, with male and female professors? Will students expect female professors to be socially sensitive, show care and concern for their success, encourage them in their endeavors, and be likeable? If they do have these expectations of their female STEM professor, will they think them less competent than their male STEM professors? On the other hand, will students who believe their female STEM professors are competent see them as unlikeable, uncaring, and discouraging?

In a preliminary, unpublished study on predictors of students' value for a STEM course, instructor gender was shown to have a significant main effect (Fowlkes, 2012). ANOVA tests revealed that when students have a male instructor rather than a female instructor in their STEM course, their value for the course is significantly higher. If the students value the course more if the professor is male, is there anything the female STEM professor can do in the classroom that will increase the students' valuing the course? Does this main effect significantly affect persistence in STEM courses and does it do so differently across student gender groups? In the male-gendered STEM classroom, the students have a multitude of experiences that affect each one differently, depending on the student's gender and the gender of the instructor. Three perceived classroom experiences were explored in the present study. One is a typical male-gendered STEM experience and the other two are atypical of a male-gendered STEM classroom. Hands-on learning is a typical classroom experience in STEM courses that was explored, as well as the students' perception that the professor cares about their success and encourages their contributions. Perhaps a more thorough understanding of gendered classroom dynamics will help educators in the STEM classroom encourage persistence in STEM majors.

Opportunities for hands-on learning. In the STEM classroom, one of the more common classroom experiences is the use of hands-on learning, especially in the sciences with the use of lab-based coursework. According to Pritchard (2010), educators must realize that different disciplines, especially STEM courses such as mathematics, will require lessening the practices of lectures, homework, and tutorials. In this study of boredom among college students, he found that lecture-only classrooms were the most

boring. When students are bored, perhaps, this increases the likelihood that they will not

be motivated to learn the material and to persist in STEM courses (Pritchard, 2010). The

classrooms that are student-centered, student-constructed with hands-on laboratory

experiences, were compared to the traditional classroom with traditional, lecture-only

instruction in a study conducted by McManus, Dunn, & Denig (2003). This study

showed that the hands-on classroom was more beneficial to the students' learning;

furthermore, students self-reported a more positive attitude toward the classroom

learning. This attitude is very important because students with better attitudes toward the

subject area have shown greater effort, resulting in higher achievement scores (McManus

et al., 2003). This finding is supported by research that cooperative learning

environments, such as active hands-on learning experiences, allow students to experience

their own accomplishments rather than just listening to the sage on the stage (Schunk,

1989).

Hands-on learning opportunities, as beneficial as they might be, in the STEM

classroom can be experienced differently, depending on the gender of the student,

according to some studies. In these cooperative learning environments, such as active

hands-on learning experiences, female students report perceived competition issues with

their male counterparts (Strenta et al., 1994). Perhaps, these competition issues have a

role to play in the persistence of women; additionally, the gender of the instructor

facilitating the hands-on learning experience might have a role to play in the perception

of hands-on learning opportunities. Colbeck, Cabrera, & Terenzini (2001) reported that

male students tend to devalue the contributions of female peers in STEM courses, and, in

turn, female students tend to avoid group work and are disappointed by their experiences

in cooperative hands-on learning environments. In this study, they explored specific teaching practices in STEM courses and found that hands-on cooperative learning groups have differing effects on female and male students. They found that within the mixed-gender cooperative learning groups, students perceived gender equity in faculty-student interactions but gender discrimination among the students' themselves. In fact, the female students reported a "chilly climate" due to peer interactions, not faculty/student interactions (Colbeck et al., 2001, p. 180). They also found that the more students perceive gender equity in faculty/student interactions, the more the students' responsibility for their own learning increased, and their motivation to persist in STEM courses increased (Colbeck et al., 2001).

In a pilot study for the present study, a regression analysis was conducted hypothesizing that hands-on learning would be a significant predictor of student's value for the course and that it would function differently across instructor gender groups (Fowlkes, 2012). The results revealed that the opportunities for hands-on learning were a significant predictor in student's value for the course; however, opportunities for hands-on learning did not function differently across instructor gender groups. According to this preliminary study, when an instructor, regardless of gender, provides opportunities for hands-on learning in a STEM course, the student's value of the course will rise (Fowlkes, 2012). Questions still remain as to opportunities for hands-on learning increasing the student's value; does this increase persistence in STEM courses, as well? Further investigation is also needed to determine if opportunities for hands-on learning as a predictor for student's value is different across student gender groups.

Perception professor cares. The statement has been made that people do not care how much you know unless they know how much you care (Roosevelt, n.d.). The masculine, male-gendered nature of STEM courses might have another side. Perhaps students need the caring and encouraging side of their STEM professor, even though it might not be something that comes naturally. The other two variables, or perceived classroom experiences, address "caring" and "feeling cared for" in the STEM classroom and how that is affected by gender. In a preliminary, unpublished study, the student's perception that the instructor cares about their success was not a significant predictor of student's value for the STEM course (Fowlkes, 2012). The question still remains as to the gendered aspects of student's perception that the instructor cares about their success. In a K-12 study, Klem & Connell (2004) stated that students need to feel that teachers are involved in their lives and that the teacher cares about their success. Their hypothesis was confirmed when they found that secondary students were three times more likely to have high levels of engagement in a course when they felt like they had high levels of teacher support and that the teacher cared about their success (Klem & Connell, 2004). This study was conducted in a secondary classroom that was not specific to STEM courses; however, the question can still be asked at the university level in STEM courses as to the effects of the college STEM student feeling high levels of support and that the instructor cares about their success. Is it more important for the female STEM professor to show their "caring" side in the classroom because the stereotypical women should be socially sensitive and service-oriented when looking through the social norm lens (Heilman et al., 2004)? At the collegiate level, a study was conducted on learning communities and their effectiveness (Baker & Pomerantz, 2001). One of the results that

came from this study was that the students felt more connected with their professors when engaging in learning communities. One of their most significant findings from the survey results was that a professor who motivates and shows they care about the student does help the student be more successful in their college experience (Baker & Pomerantz, 2001).

In the study by Basow (2000) that was previously explored, the caring characteristic was shown to be of particular importance because it was the single most used descriptor of the best professor in their qualitative study. In this particular study by Basow, the sample interviewed consisted of 61 female students and 47 male students with the largest percentage of their sample majoring in the natural sciences (26%) and the smallest percentage of their sample majoring in engineering (13%). One might assume that 39% of their sample was STEM majors, however, they did state that an undisclosed percentage of the natural science majors did include psychology majors. This study found that caring was the single most used descriptor of the best professor but less than half of the study were STEM majors. So, the question still remains as to the caring characteristic and its value in persistence and reported differences by student gender and the interaction with professor gender.

In developing a model of academic motivation, Jones (2010) suggests five critical components that use the acronym MUSIC. The MUSIC model consists of eMpowerment, usefulness, success, interest, and caring. These five components are the critical components to student engagement in academic settings, according to Jones, and if universities can increase student engagement this will lead to increased learning. In regard to the caring component that is so critical to increased learning, Jones states that

professors need to demonstrate they care about the student's success as well as the student's welfare (Jones, 2010).

If the statement is right that people (students) do not care how much you know unless they know how much you care, it becomes important for professors to exhibit an attitude of caring to their students. Perhaps, if professors knew the importance of this classroom experience, which might be different depending on the students gender and the gender of the professor, and that this classroom experience might increase persistence they could be intentional in their STEM classroom to show the students they do care about their success.

Perception professor encourages contributions. A typical classroom experience in STEM courses is hands-on learning. The other two perceived classroom experiences that were explored in the present study are not as typical in a STEM course, based on the stereotypical "masculine" nature of STEM. One that has already been explored in the literature is the perception that the instructor cares about the student's success. The other classroom experience that is a more "emotion-based" experience is the perception that the professor encourages the student's contributions in the classroom. Instructor interaction with students and instructor feedback (encouragement) were determined to be significant predictors in five areas of student self-perceptions in a study conducted on engineering majors (Colbeck et al., 2001). Those five areas of student self-perception were their intent to persist, perceived responsibility, their expected grade, their confidence, and motivation to become an engineer. When instructor feedback and interaction were separated by student gender groups there was a significant difference in favor of the male students. Even though instructor feedback and interaction was a significant predictor, it

functioned differently across the student gender groups. Instructor feedback and interaction increased the confidence in male students more so than the female students (Colbeck et al., 2001). The question still remains, does this same effect remain regardless of the instructor's gender?

Fiore (1999) believes that the instructor has an enormous role to play in building self-confidence in the mathematics classroom. He stated that students lacking confidence in their math skills can increase their confidence simply by encouragement and positive talk of their instructor. Students had told him that it was the encouragement of the instructor that had kept them going, and professors can never underestimate the power of encouragement in the mathematics classroom (Fiore, 1999). Questions still remain as to the gendered nature of encouragement in all the STEM courses. Is encouragement more important for the female or male students as Colbeck (2001) found, and is the effect different by the gender of the instructor?

In an unpublished, preliminary study, Fowlkes (2012) found that when the instructor encourages the student's contributions, the student's value for the course was significantly increased. Not only was instructor encouragement a significant predictor, it did so differently across instructor gender groups. When female instructors encourage their students' contributions, a significant increase in the student's value of the course is predicted by a regression model ($t_{223} = 4.103$, $p < .001$) while male instructors who encourage their students' contributions do not significantly increase the students' value of the course ($t_{126} = 0.644$, $p = 0.521$) (Fowlkes, 2012). A follow-up study that examines this effect on persistence and the nature of differences of instructor encouragement on

student gender needs to be conducted to further explore the importance of instructor encouragement on students' persistence in STEM courses.

The Present Study

The literature in STEM topics is vast; many studies have been conducted to understand the need for STEM fields, declining STEM graduates, and perceived classroom experiences in STEM courses. The need for STEM majors and STEM graduates and the declining trends in our STEM graduates perpetuating the leaky "pipeline" into the STEM careers was one focus of the literature review. Furthermore, the gender gap in STEM fields and STEM majors is growing and studies have been conducted to focus on the gender gap at the collegiate level. Males and females alike are not persisting in STEM majors for various reasons which usually differ by the student's gender. Finally, the need for the current study was apparent when viewing the literature on classroom experiences and how they differ by gender. This study compared student gender differences and instructor gender differences in perceptions of classroom experiences. Studies have been conducted on persisters and non-persisters in STEM majors but none by instructor gender and student gender. The present study examined these groups at the multivariate level to explore the nature of differences across three perceived classroom experiences. The three perceived classroom experiences explored were the opportunities for hands-on learning, the perception that the instructor cares about their success, and the perception that the instructor encourages their contributions. An understanding of the nature of differences in these three perceived classroom experiences and how they are different based on student gender, professor gender, and

persisters/non-persisters may help educators focus on the needs of their STEM students to help them persist and obtain the STEM degree.

CHAPTER III

METHODOLOGY

This chapter explains the methodology that was used to conduct the present study. The research context, including the institutional context and research participants are described. The data collection process, as well as the data analysis process, is discussed.

General Perspective

The purpose of this study was to examine the nature of differences of three perceived classroom experiences in STEM classrooms across student gender, instructor gender, and those who persist/do not persist in STEM majors. To understand these differences, the world was viewed from a causal perspective, in that the perceived classroom experiences of the students were different due to their gender, the gender of the instructor, and their persistence, or lack thereof in STEM courses. This encompasses the postpositivist worldview that identifies and assesses the causes that influence outcomes and quantitatively measures variables to find the objective reality that exists (Creswell, 2009). In this study the causes that influence the perceived classroom experiences of students based on their gender, the gender of their instructor, and their persistence in STEM courses were quantitatively measured to find this objective reality. The postpositivist worldview challenges the positivist worldview acknowledging that we cannot be

"positive" about our claims of knowledge when studying human behaviors. This quantitative study began with the hypothesis that there would be differences in vector means of three dependent variables across three categorical independent variables. The three dependent variables were opportunities for hands-on learning, instructor cares about the students' success, and instructor encourages students' contributions. The three categorical variables were instructor gender, student gender, and persisters/non-persisters in STEM majors.

$$H_0: \begin{bmatrix} \mu_{11} \\ \mu_{21} \\ \mu_{31} \end{bmatrix} = \begin{bmatrix} \mu_{12} \\ \mu_{22} \\ \mu_{32} \end{bmatrix} = \begin{bmatrix} \mu_{13} \\ \mu_{23} \\ \mu_{33} \end{bmatrix}$$

$$H_1: \begin{bmatrix} \mu_{11} \\ \mu_{21} \\ \mu_{31} \end{bmatrix} \neq \begin{bmatrix} \mu_{12} \\ \mu_{22} \\ \mu_{32} \end{bmatrix} \neq \begin{bmatrix} \mu_{13} \\ \mu_{23} \\ \mu_{33} \end{bmatrix}$$

This study tested the hypothesis that there would be differences in vector means of the three dependent variables across three categorical independent variables using statistical analyses, and, then, based on the findings, suggests future studies to understand the differences.

The differences that were expected lie in the two-way interactions. Based on the literature regarding the male-gendered nature of STEM courses and the needs of students based on their gender the differences in instructor cares about students' success and instructor encourages students' contributions were hypothesized to be significant between instructor gender x student gender interaction (Colbeck et al., 2001; Heilman et al., 2004; Klem & Connell, 2004). The differences in the instructor encourages students' contributions was hypothesized to be significant across instructor gender x persisters/non-persisters based on the preliminary study by Fowlkes (2012) where instructor

encouragement was a significant predictor of students' value of the course and it did so differently across instructor gender groups.

There were hypothesized significant main effects based on the literature examined. Based on the stereotypical male/female traits, the differences in instructor cares about students' success and instructor encourages students' contributions were hypothesized to be significant by instructor gender (Bem, 1981). According to Bem's Sex Role Inventory (BSRI), the classroom experiences of caring and encouraging are stereotypical feminine attributes and would expect to be perceived differently by students according to the gender of the instructor (Bem, 1981). Differences in opportunities for hands-on learning were hypothesized to be significant across those who persist/do not persist in STEM courses. Based on previous studies of boredom in the STEM classroom, hands-on learning being beneficial in the STEM classroom, and opportunities for hands-on learning found to be a significant predictor of students' value in the STEM course, hands-on learning opportunities were hypothesized to be perceived differently by persisters/non-persistors in the STEM classroom (Fowlkes, 2012; McManus et al, 2003; Pritchard, 2010).

Institutional Context

The statistical analysis began in the spring semester of 2014 using an existing data set from a large university in Midwestern United States that has a "Research University-high research activity" Carnegie classification (Carnegie Foundation for the Advancement of Teaching, 2010). The first round of data was collected in the fall semester of 2012 in classrooms of STEM courses. A subsequent survey of the same students was conducted in spring 2013 via email. No new data was collected.

Participants

The participants were students enrolled in a gateway (1000 or 2000) level STEM course. In the initial fall 2012 data collection, there were a total of 548 participants, of whom 134 were freshman, 124 sophomores, 218 juniors, 68 seniors, and four listed "other" as their classification status. The mean age of the sample was 20.33 (SD=3.04). There were 299 female students and 249 male students who participated; if the participants did not reveal their gender, their responses were discarded for this study. In terms of enrollment in STEM courses, 390 were in science, 116 in engineering, and 42 in mathematics courses. The gender of participants' professors was listed as follows: 202 participants had male professors, while 346 had female professors. Of the 548 participants, 419 self-identified as white, 40 were multi-racial, 32 Native American, 23 Hispanic, and 17 were Black. *Persisters* was defined as those students whose major remained in STEM; *non-persisters* was defined as those participants whose major switched from STEM to non-STEM. Gender, ethnicity, declared major in the fall of 2012, declared major in the spring of 2013 data were gathered from the Institutional Research and Information Management (IRIM) department at the institution where data were collected.

The process of elimination of participants from the data set began with elimination of all participants who did not report a major upon the initial data collection in the fall semester of 2012, as well as elimination of participants who did not report a major in the longitudinal data collected in the spring semester of 2013. The first step of elimination resulted in removing 619 of the original 2,145 participants who completed the survey. The second step in elimination was to eliminate all those that reported their

classroom experiences in non-STEM courses, resulting in the removal of 612

participants. Thirdly, participants that were enrolled in STEM courses but were not

reported by IRIMs data as being in a STEM major upon the initial data collection, fall

2012, were removed, resulting in another 366 participants removed from the data set.

After elimination, the sample consisted of 548 participants: 180 students (33%) in

psychology courses, 138 students (25%) in life science courses, 116 students (21%) in

engineering courses, 72 students (13%) in social science courses, and 42 students (8%) in

mathematics courses (Table 1). Of the 548 participants, the declared majors in the fall of

2012 were as follows: Life Sciences – 197 students (36%), Psychology – 146 students

(27%), Engineering – 135 students (25%), Social Sciences – 37 students (7%), Computer

and Information Science and Engineering - 28 students (5%), Geosciences – 2 students

(0.4%), Mathematical Sciences – 2 students (0.4%), Chemistry - 1 student (0.2%) (Table

2). Appendix B provides a detailed listing of the STEM majors used in this study.

Table 1
Number of Students in each STEM course

NSF STEM category	Course Code	Number completed survey
Engineering	ENGR1412	67
	IEM3503	49
Life Science	ANSI3333	18
	ENTO2003	2
	NREM1012	34
	NREM3513	16
	ZOOL3204	68

Mathematics	MATH1613	42	
Psychology	HDFS2113	58	
	HDFS2443	33	
	HHP3223	3	
	HHP3613	3	
	PSYC1113	22	
	PSYC2313	25	
	PSYC3214	17	
	PSYC3914	19	
Social Sciences	ECON1113	3	
	GEOG2253	22	
	GEOG3703	8	
	SOC1113	9	
	SOC3113	18	
	SOC4733	12	
TOTAL		**548**	

Table 2

Number of Students in each STEM major in the fall of 2012 and spring of 2013

NSF STEM category	**Number in fall of 2012**	**Number in spring of 2013**
Chemistry	1	2
Computer and Information Science	28	24
Engineering	135	128

Geosciences	2	4
Life Sciences	197	185
Mathematics	2	1
Psychology	146	138
Social Sciences	37	36
TOTAL	**548**	**518**

Data Collection

The data collection process began in the fall semester of 2012 when all campus instructors who taught face-to-face sections of undergraduate students with 30 or more students were emailed regarding participation in a survey. For convenience of the researchers and to obtain larger sample sizes per course, the criterion of 30 or more students was imposed. There were three researchers involved in the initial data collection who gave permission to use the completed data set for this study. The sample includes the students of those instructors who replied and agreed to have their classes surveyed. The STEM sample used for this study was gathered from those students who were enrolled in the STEM courses under study with greater than 30 students face-to-face. Students were recruited in person during class in the fall semester of 2012. Data were collected at the beginning of the class period. A researcher introduced the study to the students who were asked to read an informed consent document, determine whether they wished to participate, and then complete the series of survey questions. After completing the surveys, a researcher collected the surveys. No extra credit was offered to the students for their participation; however, those who participated were entered into a

drawing for a $50 cash award. All procedures were approved by the University

Institutional Review Board. The same participants who consented and provided email

addresses were then emailed a second survey with the same questions in the spring

semester of 2013 to complete the longitudinal data collection. Unless the participants

graduated or transferred to another institution, persistence in STEM majors was

measurable on all participants through the IRIM data report.

Data Collection Instrument

Seven classroom experiences were measured in the study. Although seven reported

classroom experiences were gathered, only three of these classroom experiences were

analyzed for the present study. This study focused on three perceived classroom

experiences, opportunities for hands-on learning, instructor cares about students' success,

and instructor encourages students' contributions. These three were chosen utilizing the

holistic pedagogical model based on the Jungian personality processes of four functions

in the classroom. These four functions are sensing, intuition, thinking, and feeling that

can be used effectively in the classroom, however, this study focused on the sensing and

feeling domains in STEM courses. The sensing function can be integrated into the

curriculum by using hands-on learning activities and the feeling function can be

integrated using "emotion-based" learning such as caring and encouraging (Montgomery,

Strunk, Steele, & Bridges, 2012). The complete survey is attached in Appendix A,

however, the seven classroom experiences were as follows:

Please rate your level of agreement or disagreement with each of the following items
using the scale provided.

Strongly						Strongly

Disagree						Agree
1	2	3	4	5	6	7

_____1. I feel my instructor cares about my success.

_____2. I feel connected to other students in this class.

_____3. There are many opportunities for interaction in this class.

_____4. My instructor encourages my contribution in this class.

_____5. Students in this class work together to learn.

_____6. This class provides many opportunities for creativity.

_____7. This class offers opportunities for hands-on learning.

The three experiences that were used for this study were 1) this class offers opportunities for hands-on learning, 2) I feel my instructor cares about my success, and 3) my instructor encourages my contributions in this class. The students' perceptions of these classroom experiences were measured on a Likert scale rating from one to seven (1 = Strongly Disagree, 7 = Strongly Agree). The single item measures used in this study might be considered less reliable than multiple item measures. However, students are self-reporting facts about their perceptions rather than measuring a psychological construct, which is a commonly accepted practice in the social sciences (Wanous & Reichers, 1996). When the construct is conceptually narrow and there is no ambiguity to the respondent, a single item measure may be used (Sackett & Larson, 1990). The single-item measures for this study - opportunities for hands-on learning, instructor cares about

my success, and instructor encourages my contributions - were self-reported, conceptually narrow and there is no presumed ambiguity to the participants. These classroom experiences were chosen based on a qualitative study that reported teachers' experiences at the post-secondary level when an integrated, holistic view of teaching was used (Montgomery, Strunk, Steele, & Bridges, 2012). They reported that teachers had greater success and greater interaction with students when they used the holistic pedagogical model based on the Jungian personality process of four functions. These four functions of sensing, intuition, thinking, and feeling were integrated into the curriculum by using hands-on learning, reflective journals, cognitive activities, and "emotion-based" learning. The perceived classroom experiences that were chosen for this study used the sensing and feeling domains of the Jungian model.

Data Analysis

To explore the nature of differences in the three reported perceptions of classroom experiences across student and instructor gender groups and those who persist/do not persist in STEM majors, a three-way factorial Multivariate Analysis of Variance (MANOVA) was computed. A factorial MANOVA was appropriate for this study because its primary use is to explore the effects of two or more independent or categorical variables on a set of dependent variables (Stevens, 2009). The categorical variables were student gender, instructor gender, and persist/not persist in STEM effecting how the students perceive the three dependent variables of opportunities for hands-on learning, professor cares about success, and professor encourages contributions. Stevens (2009) also recommends using a multivariate analysis when the dependent variables make sense as a group and are correlated. The three dependent variables in this

case were all reported perceptions by students of classroom experiences with their professor in their gateway STEM course. Multiple univariate tests on each variable could be conducted; however, this greatly increases the type I error rate which is the probability of rejecting the null hypothesis when it is true. This happens because the univariate tests ignore correlation among dependent variables, whereas multivariate analyses account for the correlations among the dependent variables (Stevens, 2009). There would appear to be correlations between the students' reported perceptions of the opportunities given for hands-on learning, the professor cares about my success, and the professor encourages my contributions. Another reason for utilizing a multivariate approach is that there may not be statistically significant differences when run as multiple univariate tests; however, because multivariate analyses account for correlations among the set of dependent variables there may be a statistically significant result. In other words, small differences at the univariate level might lead to statistically significant differences at the multivariate level when these small differences are combined (Stevens, 2009). Lastly, Stevens (2009) states that one way of improving power, the probability of making a correct decision, in a multivariate design is by conducting a factorial MANOVA, the chosen method for this study.

There are three assumptions that must be met for a MANOVA. The first assumption is that observations must be independent. This is an assumption that violations would lead to serious questions regarding the results (Stevens, 2009). The collected data for the present study were independent and one participant's observation does not depend on another participant's observation. The second assumption whose violation is not as serious is that the observations on the dependent variables follow a

multivariate normal distribution in each group (Stevens, 2009). According to Stevens (2009), skewness has minimal effect on the level of significance due to the *Central Limit Theorem*, as the number of observations increases the sum of the independent variables approaches a normal distribution. SPSS scatterplots were obtained for pairs of variables to determine multivariate normality. The third assumption in MANOVA tests is that the population covariance matrices for the three dependent variables are equal, often referred to as the *homogeneity of variance* assumption. SPSS applies Box's test for homogeneity and a non-significant Box test supported this assumption.

The data was analyzed using SPSS at the multivariate level, first exploring interactions (student gender x instructor gender x persister/non-persister) on the three perceived classroom experiences looking at Wilks Lambda statistic for significance. "A significant three-way interaction implies that the two-way interactions for the different levels of the third factor are different" (Stevens, 2009, p. 283). There were no differences at the multivariate level, therefore, no post-hoc tests were conducted to explore where the differences occur. Two-way interactions were analyzed for significance. The two-way interactions computed were instructor gender x student gender, instructor gender x persisters/non-persisters, and student gender x persisters/non-persisters. There were no significant two-way interactions, therefore, no post-hoc tests were conducted to reveal where the differences lie. Finally, main effects were analyzed with one significant univariate main effect of instructor gender found.

Conclusion

To explore the nature of differences in three perceived classroom experiences across student gender groups, instructor gender groups, and persisters/non-persisters, a

three-way (2 x 2 x 2) factorial MANOVA was conducted. The existing data set was

further analyzed to assist STEM educators in understanding the classroom experiences

that students need to help them persist in STEM majors. Additionally, educators may

have a broader understanding of the role that student and instructor gender plays in how

students perceive classroom experiences and if gender impacts a student's decision to

persist/ not persist in a STEM major. In chapter four the results of the study are

discussed.

CHAPTER IV

FINDINGS

The purpose of this study was to explore the nature of differences in students'

reported classroom experiences in STEM courses across student gender, instructor

gender, and those who persist in STEM majors. A reminder to the reader that the

researcher recognizes that gender is typically used with reference to social and cultural

differences rather than biological ones, for the purposes of this study gender was defined

as the biological differences between male and female. The initial hypothesis was that

there would be differences in vector means across three categorical independent

variables. These hypothesized differences were based in the literature; several two-way

interactions were expected. Hypothesized two-way interactions were instructor gender

and student gender on the dependent variable of instructor cares about students' success

and instructor encourages students' contributions. Another hypothesized two-way

interaction was instructor gender and persisters/non-persisters on instructor encourages

students' contributions. Hypothesized main effects were instructor gender on the

dependent variable of instructor cares about students' success and instructor encourages

students' contributions. Another main effect hypothesized to be significant was

persisters/non-persisters and their reporting of opportunities for hands-on learning.

The one significant difference that was found was in the students' reported opportunities for hands-on learning; female professors mean (M = 4.1, SD = 2.1) for opportunities for hands-on learning was significantly higher than male professors mean (M = 3.6, SD = 2.0) for opportunities for hands-on learning, $F(1,540) = 4.886$, $p = .027$ (Table 4).

To determine the nature of differences across student gender, instructor gender, and persisters/non-persisters in three perceived classroom experiences a 2x2x2 factorial MANOVA was conducted. The process of elimination of participants, description of participants in each factorial group, and assumptions met in the multivariate analysis of variance are described. This chapter presents the results of the analysis.

Assumptions for MANOVA

The three assumptions that must be met for MANOVA are (1) the observations must be independent; (2) the observations on the dependent variables follow a multivariate normal distribution in each group; (3) the population covariance matrices for the three dependent variables are equal. The first assumption was met in that the collected data for the study are independent and one participant's observation does not depend on another participant's observation. The assumption of multivariate normality was violated on all three dependent variables by observing the Shapiro-Wilk test for three bivariate normality tests (Table 3). However, when examining the graphical measures such as boxplots and normal probability plots there does not appear to be serious violations in univariate normality which is sufficient in determining multivariate normality (Stevens, 2009). Stevens also states that deviations from multivariate normality have only a small effect on type 1 error rate. With respect to power, they type of deviation from normality

determines the effect on power, with platykurtosis having a substantial effect, whereas, skewness has a negligible effect on power. Upon examination of the normal probability plots, the deviation from normality appears to be by skewness, therefore, a transformation was deemed unnecessary. The third assumption for MANOVA is that the population covariance matrices for the three dependent variables are equal. A non-significant Box's M test (p=.163) indicates homogeneity of covariance matrices of the three dependent variables across the three independent variables.

Table 3

Tests for Normality

Variable	Group	Shapiro-Wilk	Sig.	Skewness	kurtosis
Cares	Male Instructor	.825	.000	-1.213	1.181
	Female Instructor	.759	.000	-1.599	2.443
Encourages	Male Instructor	.915	.000	-.499	-.702
	Female Instructor	.906	.000	-.590	-.569
HOL	Male Instructor	.905	.000	.193	-1.235
	Female Instructor	.900	.000	-.063	-1.352
Cares	Male Student	.778	.000	-1.566	2.840
	Female Student	.790	.000	-1.365	1.389

Encourages	Male Student	.914	.000	-.618	-.379
	Female Student	.904	.000	-.517	-.780
HOL	Male Student	.893	.000	-.066	-1.390
	Female Student	.911	.000	.118	-1.253
Cares	Persister	.787	.000	-1.456	2.005
	Non-persister	.735	.000	-1.498	1.524
Encourages	Persister	.909	.000	-.560	-.617
	Non-persister	.899	.000	-.536	-.727
HOL	Persister	.903	.000	.039	-1.333
	Non-persister	.918	.000	.042	-1.245

The descriptive statistics revealed small group sizes for the non-persister groups with the largest percentage of non-persisters from the female students with female professors (13/165, 8%), more than double the percentages of non-persisters for each of the other 3 groups: male students with male professors (3/68, 4%), female students with male professors (6/134, 4%), and male students with female professors (8/181, 4%). However, the test of proportions for each pair revealed that the percentage difference was not significant as revealed in Table 4.

Table 4

Proportion of Non-persisters

Group	Number of Non-persisters	Number in Group	$\hat{p}$
Male Student, Male Instructor	3	68	4.4%
Female Student, Male Instructor	6	134	4.5%
Male Student, Female Instructor	8	181	4.4%
Female Student, Female Instructor	13	165	7.9%
Total	**30**	**548**	**5.5%**

The descriptive statistics for each of the 8 groups are listed in table 5.

Table 5

Means for groups

		Male Student				Female Student			
		Persist		Non-Persist		Persist		Non-Persist	
Group	Dependent variable	M	SD	M	SD	M	SD	M	SD
Male Instructor									
	Instructor Cares	5.72	1.28	6.00	1.00	5.79	1.37	6.00	2.00
	Instructor Encourages	4.54	1.82	4.33	2.08	4.80	1.79	4.81	1.79
	Hands-on Learning	3.35	2.00	1.67	1.16	3.71	2.01	4.00	2.37
Female Instructor									
	Instructor Cares	6.00	1.31	6.38	1.19	5.84	1.50	5.62	1.61
	Instructor Encourages	5.00	1.62	5.00	0.76	4.91	1.82	4.67	1.87
	Hands-on Learning	4.40	2.16	4.13	2.03	3.82	2.07	4.31	1.80

Interactions

The first hypothesis analyzed was that there would be differences in the reported classroom experiences across student gender, instructor gender, and those who persist/do not persist in STEM majors. To test this hypothesis a three-way interaction between student gender, instructor gender, and persisters was explored across the three classroom experiences at the multivariate level. The Wilks Lambda revealed that there was not a significant multivariate three-way interaction, $\Lambda = .999$, $p = .908$. The univariate three-way interactions were not significant for instructor cares, $F(1,540) = .1944$, $p = .659$, instructor encourages, $F(1,540) = .0974$, $p = .755$, nor for opportunities for hands-on learning, $F(1,540) = .46755$, $p = .494$ (Table 6).

Two-Way Interactions

The hypothesized differences in the two-way interactions will be explained; however, all two-way interactions were explored for significant differences and will be displayed. All tests were conducted at the alpha $= .05$ level of measurement. The first two-way interaction that was hypothesized to be significant was the interaction of instructor gender and student gender on dependent variable of instructor cares about students' success and instructor encourages students' contributions. The multivariate Wilks Lambda was not significant for instructor gender by student gender interaction, $\Lambda = .994$, $p=.367$. The univariate tests for the hypothesized differences on instructor cares and instructor encourages were not significant, $F(1,540) = .692$, $p = .406$ and $F(1,540) = .614$, $p = .434$, respectively. The third univariate test for instructor gender by student gender on opportunities for hands-on learning was not significant, $F(1,540) = 3.008$, $p = .083$. There was not enough evidence to support the hypothesis that there would be

differences in the students' report of instructor cares about success and instructor encourages contributions by instructor gender and student gender.

Another two-way interaction hypothesized to be significant was instructor gender and persisters/non-persisters on instructor encourages students' contributions. This univariate two-way interaction was not significant, $F(1,540) = .002$, $p = .967$. The other univariate interactions were not significant on instructor cares and opportunities for hands-on learning, $F(1,540) = .079$, $p = .779$ and $F(1,540) = .809$, $p = .369$, respectively. The multivariate Wilks Lambda was not significant for instructor gender by persisters, $\Lambda = .998$, $p = .772$. There was not enough evidence to support the hypothesis that there would be differences in the students' report of instructor encourages contributions by instructor gender and persisters.

The third two-way interaction analyzed was student gender by persisters and analysis revealed the multivariate interaction was not significant, $\Lambda = .994$, $p = .348$. The three univariate interactions for instructor cares, instructor encourages, and opportunities for hands-on learning were not significant, $F(1,540) = .3042$, $p = .582$, $F(1,540) = .054$, $p = .816$, and $F(1,540) = 2.381$, $p = .123$, respectively (Table 6).

Main Effects

The first main effect hypothesized to be significant was instructor gender on the variable of instructor cares about students' success and instructor encourages students' contributions. The multivariate test was not significant for instructor gender, $\Lambda = .991$, $p = .177$. The hypothesized univariate main effect of instructor gender on instructor cares and instructor encourages was not significant, $F(1,540) = .070$, $p = .791$ and $F(1,540) = .527$, $p = .468$, respectively. There was not enough evidence to support the hypothesis

56

that there would be differences in the students' report of instructor cares about success and instructor encourages contributions by instructor gender. There was a significant univariate difference for instructor gender on the dependent variable of opportunities for hands-on learning, $F(1,540) = 4.886$, $p = .027$, $\eta^2 = .009$. The mean reported score on opportunities for hands-on learning with female professors (M = 4.1, SD = 2.1) was significantly higher than the mean reported score on opportunities for hands-on learning with male professors (M = 3.6, SD = 2.0). However, in the absence of a significant multivariate test for the main effect of hands-on learning, the univariate significance is not meaningful because the univariate F's ignore the correlation among the other dependent variables (Stevens, 2009).

Another main effect hypothesized to be significant was persisters/non-persisters; the multivariate main effect of persistence was not significant, $\Lambda = .998$, $p = .807$ (Table 6). The univariate main effect of persistence on opportunities for hands-on learning was not significant, $F(1,540) = .446$, $p = .505$, as well as the other univariate variables, instructor cares, $F(1,540) = .287$, $p = .592$, and instructor encourages, $F(1,540) = .002$, $p = .965$. There was not enough evidence to support the hypothesis that there would be differences in the students' report of opportunities for hands-on learning by persisters/non-persisters.

Table 6
Results for Factorial Manova

Instructor gender*student gender*persistence	Multivariate	Wilks λ=0.999	P=0.908
	Univariate	*F*	*p*
	Instructor Cares	0.194	0.659
	Instructor encourages	0.097	0.755

	Opportunities for Hands-on learning	0.468	0.494
student gender*persistence	Multivariate	Wilks λ=0.994	P=0.348
	Univariate	*F*	*p*
	Instructor Cares	0.304	0.582
	Instructor encourages	0.054	0.816
	Opportunities for Hands-on learning	2.381	0.123
Instructor gender*persistence	Multivariate	Wilks λ=0.998	P=0.772
	Univariate	*F*	*p*
	Instructor Cares	0.079	0.779
	Instructor encourages	0.002	0.967
	Opportunities for Hands-on learning	0.809	0.369
Instructor gender*student gender	Multivariate	Wilks λ=0.994	P=0.367
	Univariate	*F*	*p*
	Instructor Cares	0.692	0.406
	Instructor encourages	0.614	0.434
	Opportunities for Hands-on learning	3.008	0.083
persistence	Multivariate	Wilks λ=0.998	P=0.807
	Univariate	*F*	*p*
	Instructor Cares	0.287	0.592
	Instructor encourages	0.002	0.065
	Opportunities for Hands-on learning	0.446	0.505
Student gender	Multivariate	Wilks λ=0.994	P=0.389
	Univariate	*F*	*p*
	Instructor Cares	0.520	0.471
	Instructor encourages	0.204	0.652

	Opportunities for Hands-on learning	1.653	0.199
Instructor gender	Multivariate	Wilks λ=0.991	P=0.177
	Univariate	*F*	*p*
	Instructor Cares	0.070	0.791
	Instructor encourages	0.527	0.468
	Opportunities for Hands-on learning	4.886	0.027*

significant at the α=.05 level

The 2x2x2 factorial MANOVA explored the nature of differences in students'

perceptions of classroom experiences in STEM courses across instructor gender, student

gender, and persisters/non-persisters in STEM majors. The hypotheses that there would

be differences, specifically in two-way interactions, were not supported by this analysis

given that no statistically significant differences were present.

CHAPTER V

CONCLUSION

STEM fields are growing and have lucrative job opportunities for college

graduates. The number of students in STEM majors and persisting in those majors,

however, is declining, as well as a growing gender gap in STEM graduates (National

Science Foundation, 2011;National Science Foundation, 2003). Educators in STEM

courses may not understand the classroom experiences that students in STEM courses

need to persist in the courses and ultimately the STEM degree. Furthermore, educators

may not understand how classroom experiences are perceived differently depending on

gender of the student and instructor.

This study explored the nature of differences in means of three student

perceptions of classroom experiences: opportunities given for hands-on learning,

instructor cares about students' success, and the instructor encourages students'

contributions. The overall differences were explored with no statistically significant

mean differences found. In this chapter, these results are discussed and related back to

the results of relevant studies explored in Chapter 2. Also, limitations of the study are

stated, practical and theoretical implications are presented, as well as, implications for

future research.

Persistence in STEM Courses

There are many job opportunities for those students graduating with a STEM degree; however, the literature reveals the number of STEM graduates declining due to lack of persistence in STEM majors (Griffith, 2010; Huang, Taddese, & Walter, 2000; Price, 2010). The lack of persistence in STEM majors was not confirmed by the data in the present study which revealed 30 out of 548 (5%) non-persisters in STEM majors. When examining the non-persistors by student gender/instructor gender the data showed 4% non-persisters in the male student/male professor group, 4% in the female student/male professor group, 4% in the male student/female professor group, and the largest group of non-persisters came from the female student/female professor group doubling the other percentages at 8% of non-persisters.

Persistence by Student Gender

When Huang, Taddese, & Walter (2000) explored persistence by student gender, they found that while a smaller percentage of female students declared STEM majors as freshman, they are more likely to persist in their chosen STEM major than male students. The question remained as to the persistence of male and female students being affected by the gender of the professor. The data from the present study showed that of the thirty non-persisters, 19 were female students (63%) and 11 were male students (37%) which was a reversal of the findings of Huang, Taddese, & Walter (2000). The data from the present study also showed that 21 of the 30 (70%) non-persisters were taught by female professors and 9 out of 30 (30%) were taught by male professors.

Persistence by Instructor Gender x Student Gender Interaction

In conflicting findings, Price (2010) found that female students were less likely to persist in STEM majors when more of their STEM courses were taught by female faculty. Carrell, et al. (2010) found that when high ability females have female professors their likelihood of persisting increases. In the present study, the largest percentage of non-persisters was in the group with female students and female professor (8%), however, a test of proportions revealed there was not a significant difference of this proportion of non-persisters when compared with the other groups.

Another deviation from the literature that was found in the present study was the male-dominated nature of STEM fields. Of the 548 students that participated in this study of STEM majors, there were 299 female students and 249 male students, 55% and 45%, respectively, and 346 of these students were taught by female professors (63%), 202 were taught by male professors (37%). The data were not supportive of the male-dominance in STEM majors, or in STEM professors that the literature predicted.

There was not enough evidence to support the hypotheses presented in this study. Perhaps the small number of non-persisters in the data set had an effect on the findings of this study and with a larger data set the findings would differ.

<div align="center">

Classroom Experiences

</div>

The mean ratings by students of three classroom experiences, opportunities given for hands-on learning, the instructor cares about the students' success, and the instructor encourages students' contributions, were hypothesized to be different across student gender, instructor gender, and persisters/non-persisters in STEM majors. There was not

enough evidence to support this hypothesis after running a 2x2x2 factorial MANOVA due to lack of significant p-values at the .05 level.

The three perceived classroom experiences were explored through a multivariate lens identifying differences across student gender, instructor gender, and persistence. In a study by Bachen et al (1999) the influence of stereotyping on students' evaluation of male and female professors was explored and findings suggested that female students' rate female faculty higher on caring/nurturing traits than male faculty. They found that male students expect female faculty to be more nurturing than male faculty. The question was raised as to this gendered expectation of nurturing traits by both male and female students and in male-dominated STEM courses does it play a role in persistence? The present study showed that there was not an interaction between instructor gender, student gender, and persisters on the nurturing classroom experiences of instructor cares about students' success nor instructor encourages students' contributions. Perhaps there is stereotyping that occurs in the STEM classroom, however, this study did not find significant differences on the caring/nurturing traits across student gender, instructor gender, and persisters. A future study, with a larger data set and a larger number of non-persisters might find a significant difference across these groups on these caring/nurturing traits of professors that were studied.

One hypothesized difference based on the literature that was expected to occur was in the two-way interaction of instructor gender x student gender on the dependent variables of instructor cares and instructor encourages. This was based on literature regarding the male-gendered nature of STEM courses and the needs of students based on their gender (Colbeck et al., 2001; Heilman et al., 2004; Klem & Connell, 2004). There

was not a significant two-way interaction found in the present study. The data set was not male-gendered, however, with more female faculty represented than male faculty, 346 to 202, respectively. There were also an equal number of female students to male students, 299 to 249, respectively.

Bettinger and Long (2005) studied female students with female faculty in STEM courses and the effect same-gendered instructors have on persistence in females only. They found that female students were less likely to persist in biology and physics, but in more quantitative courses, such as geology, math, and statistics, their likelihood of persisting in STEM courses almost doubled when the professor was female. Questions, however, remained as to this role model effect and the influence of female professors on male students. This present study found a non-significant difference in the perceptions of classroom experiences across the three-way interaction of instructor gender, student gender and persisters/non-persisters. Perhaps, with a larger data set with a greater number of non-persisters, significant differences in perceptions of classroom experiences might be found by student gender.

The dependent variables as a group and in pairs, such as the nurturing variables of instructor cares and encourages, were discussed. The literature also revealed studies conducted by the three specific classroom experiences, opportunities for hands-on learning, instructor cares about students' success, and instructor encourages students' contributions. These individual perceived classroom experiences will be discussed and what was found in the present study.

Opportunities for Hands-on Learning

The use of hands-on learning is a common classroom experience in STEM courses. Previous studies have shown that hands-on learning opportunities are beneficial to students' learning, especially, in the STEM classroom (McManus, Dunn, & Denig, 2003; Pritchard, 2010). A difference, therefore, was hypothesized to be significant across persisters/non-persisters. Fowlkes (2012) had also found, in a preliminary study, that opportunites for hands-on learning was a significant predictor of students' value for the STEM course, but it did so at the same rate when examined by instructor gender. Questions still remained as to the effect of increased value for the course due to an increase in hands-on learning opportunities, and that increased value effecting student's persistence. The present study did not find significant differences in the student reported means of opportunities for hands-on learning when examining the main effect of persistence. In other words, there was no difference in opportunities for hands-on learning between those who persisted in a STEM major and those who switched their major to non-stem after taking the STEM course. Perhaps, with a larger data set with more non-persisters differences in reported means of opportunites for hands-on learning might be found across persisters/non-persisters.

There was a significant univariate difference in opportunities for hands-on learning across instructor gender, $F(1,540) = 4.886$, $p = .027$, $\eta^2 = .009$. The mean rating for opportunities for hands-on learning for male instructors was 3.6, while the mean rating for opportunities for hands-on learning for female instructors was 4.1. However, in the absence of a significant multivariate difference for instructor gender, Wilks $\lambda = .991$, $p = .18$, a significant univariate difference is rendered not meaningful.

65

Perception Professor Cares

Bem's (1981) Sex Role Inventory has attributed the caring trait as stereotypically feminine. The male-gendered nature of STEM fields led to the hypothesized mean differences in the students' perception the professor cares across instructor gender. There was not, however, evidence to support this hypothesized difference in students' perception of caring when comparing means of male professors and female professors. The caring trait was not gendered among STEM professors in the data set. The data set, however, was not male dominated as expected with 346 female instructors and 202 male instructors.

In Basow's (2000) study, the caring trait in the STEM classroom was the single most used descriptor of the best professor. However, in Basow's study, less than half the participants were STEM majors and the question remained as the caring trait and the perceived differences in this caring trait by the instructor's gender in STEM courses. In the present study of STEM courses, regarding the reported differences in students' perception the instructor cares about their success by instructor gender; there were no significant differences in this caring trait in the STEM classroom.

Perception Professor Encourages Contributions

The encouraging trait is also a nurturing trait which is stereotypically feminine (Bem, 1981). Based on this stereotypical female trait of encouraging and the male-gendered nature of STEM courses, there was a hypothesized difference of means in the perception the instructor encourages students' contributions across instructor gender. In the present study, the data did not support the hypothesis that there would be differences in means of students' reported perception of encouraging across instructor gender.

In Colbeck's (2001) study, instructor feedback and encouragement increased the confidence in male students more so than the female students. In a similar study, Fiore (1999) reported that students' lacking confidence in STEM courses can increase their confidence by encouragement from the professor. If encouragement was more important to confidence in male students, and it was shown to increase confidence in students' lacking confidence in STEM, the question still remained as to the encouragement trait being perceived differently based on the gender of the instructor. The present study found that there was not a significant difference in how students' perceive encouragement in the classroom by the gender of the professor.

In a preliminary study, Fowlkes (2012) found that the professor encourages contributions was a significant predictor of students' value for the STEM course. Not only was it a significant predictor, it did so differently across instructor gender. Female instructors who encourage their students' contributions significantly increased the students' value of the course, while male instructors who encourage their students' contributions did not significantly increase the students' value for the course. If the professor encourages contributions increases students' value, did that have a significant effect on persistence in STEM? Due to this preliminary study, differences in reported means of professor encourages students' contributions were hypothesized across the two-way interaction of instructor gender x persisters/non-persisters. There were, however, no significant differences in reported means of instructor encourages contributions across instructor gender x persisters/non-persisters. Although encouragement by the STEM professor increases the students' value for the course, there was not enough evidence to support the hypothesis that this in turn had an effect on persistence in STEM majors.

Limitations

The generalizability of the present study is limited due to the representative sample expected from the literature obtained from one single university. The representative sample from STEM majors is not representative of the population of STEM fields expected from the literature being typically male-dominated, in that 37% of the STEM professors were male and 63% were female professors.

The study was also limited in that the dispersion of the STEM majors and STEM courses were heavily weighted in the sciences (70%), far less engineering majors (25%), technology (5%), and less than one percent mathematics majors.

The inequalities of the groups were another limitation in the study. The number of non-persisters in each of the four categories was very small when compared to the other group sizes (Table 3).

Implications

Practical Implications

The present study has implications for practitioners educating STEM majors in their introductory STEM courses. Educators in STEM courses ought to understand the types of classroom experiences that students need to persist in STEM courses and ultimately to the STEM degree. There was not enough evidence to support the claim that there would be gendered differences in students' perception that the instructor cares about their success, encourages their contributions, or provides opportunities for hands-on learning. Also, there were no significant mean differences in these same reported classroom experiences by those who persisted or did not persist in STEM majors. The one significant univariate difference that was noteworthy was the reported perceptions

that female professors provide more opportunities for hands-on learning than their male counterparts. The review of literature highlighted the importance of hands-on learning opportunities in the STEM classroom, leading to higher persistence rates (McManus, Dunn, & Denig, 2003: Pritchard, 2010). In Pritchard's (2010) study, he found that the lecture-only classrooms were the most boring and professors need to utilize best practices to help their students succeed in the classroom. The present study did not show a difference in opportunities for hands-on learning between the persisters and non-persisters group, however, further studies with a larger group size for non-persisters might show differences between these groups on the dependent variable of opportunities for hands-on learning.

The non-gendered nature of the nurturing side of teaching is information that adds to the literature. The male dominance and male-gendered nature of STEM courses was not evident in the present study. The feminine qualities, as determined by Bem (1981), of caring and encouraging were not gendered in this study as expected. Both female professors and male professors alike were perceived by male and female students to care for students' success and encourage students' contributions at the same rate. However, the preliminary study by Fowlkes (2010) did reveal that encouraging students' contributions was a significant predictor of students' valuing the STEM course for female professors, although, the MANOVA did not show a difference in persistence.

The number of STEM non-persisters and the non-gendered nature of the STEM classroom found in this study was not consistent with the literature leading to non-significant results and lack of support for hypotheses. This raises questions as to the population under study. Efforts have been made to increase the number of STEM

graduates over the next decade and to eradicate the gender gap in STEM fields. Perhaps these efforts are beginning to pay off and a shift is beginning to occur. Perhaps future studies will continue to support the present study and the lack of non-persisters in STEM majors and the new "normal" can be defined in the STEM population with equality among gender in STEM graduates and non-gendered STEM classroom experiences.

Theoretical Implications

Bem's (1981) Sex-Role Inventory identified attributes as stereotypically masculine (instrumental-active) and stereotypically feminine (expressive-nurturant). Basow (2000) used these attribute groupings and that the best professors, as described by students, were strong in both masculine and feminine attributes regardless of their gender. Two expressive-nurturant dependent variables, caring and encouraging, were explored in the present study with no significant mean differences found among students' perceptions. The STEM professors, in the present study, did not seem to modify their behavior. Female professors, in a male-gendered field, continue to display the caring and encouraging traits to their students. These caring and encouraging traits were also perceived in male professors at the same rate as their female counterparts. The present study revealed that for this data set the students perceived them as "androgynous" professors.

Bachen et al. (1999) theorized that gender schema, or stereotyping, influences students' evaluations of their professors. The findings of their study suggested that female and male students will rate female faculty higher on the caring/expressive teaching trait than male faculty simply because of their gender schema. The present study did not support this theory of gender schema influencing students' evaluations on

the caring teaching trait. The dependent variable of the instructor cares about the students' success was non-gendered across student gender and instructor gender with no significant mean differences found. There was no significant mean difference found in persisters/non-persisters on this caring trait as well.

Implications for Future Research

The present study explored the nature of differences in students' perceived classroom experiences in STEM courses across student gender, instructor gender, and persisters/non-persisters in STEM majors. The hypotheses were tested and no significant multivariate mean differences were found in opportunities for hands-on learning, instructor cares about students' success, and instructor encourages students' contributions. There are, however, questions that remain regarding these perceived classroom experiences, gendered differences in STEM, and gendered differences in persisters/non-persisters in STEM majors.

The data set used for the present study was limited in that it was gathered at one setting. Perhaps differences might be found in the same dependent variables with a larger data set, with a greater sample size for non-persisters in each of the groups. A future study could be conducted with surveys collected from many universities across different regions of the United States to get a more representative sample consistent with the literature on STEM majors and persistence.

The present study explored the nature of differences in three perceived classroom experiences by instructor gender, student gender, and persisters/non-persisters. The literature explored the gendered differences expected in STEM courses and this study found no significant differences within STEM majors. The participants were all STEM

majors in STEM courses. Perhaps there are gendered differences in the students'

perception of these same three classroom experiences when comparing these perceptions

to non-STEM majors in non-STEM courses. The same factorial MANOVA could be

conducted on the three perceived classroom experiences of opportunities for hands-on

learning, instructor cares about students' success, and instructor encourages students'

contributions but across student gender, instructor gender, and STEM/non-STEM majors.

There were no significant mean differences found in the nurturing qualities of

caring and encouraging in the present study. Perhaps students view these nurturing

qualities differently, and perhaps these are gendered differences by student gender and

instructor gender. A qualitative study could explore these differences with interviews

and observations and asking the question, "what does caring about students' success look

like in the STEM classroom", and "what does encouraging students' contributions look

like in the STEM classroom".

STEM courses, because of the lab-based components of the courses, tend to use

more hands-on learning activities. The present study did find a significant univariate

mean difference in the students' perceived opportunities for hands-on learning between

the female professor's class and the male professor's class. A future study might delve

into this discrepancy and qualitatively assess these gendered differences in hands-on

learning activities, both from the student perspective and the professors. Do students just

perceive that female professors give more opportunities for hands-on learning because

the female professor is more engaged, or the male professor is more "lecture-only" in the

classroom? How do professors feel about the usefulness of hands-on learning activities

in their STEM classroom? Do they identify gender differences in hands-on learning

activities in the STEM classroom? Do they think that the gender of the professors encourages or discourages the effectiveness of the hands-on learning teaching approach? There are many themes that might emerge when asking these types of questions regarding hands-on learning to STEM students and STEM professors.

Conclusion

This chapter has discussed the findings of the present study regarding persistence in STEM courses with contributions that this study brings to the conversation. The small group size for non-persisters led to non-significant results; however, it is informative to note the small number of non-persisters at the setting where this data was gathered when previous studies predicted more non-persisters.

The hypothesized differences in the three perceived classroom experiences were discussed, identifying contributions to the literature and support for previous findings, or questions raised by the non-gendered aspects of the classroom experiences that were expected. Finally, the practical and theoretical implications were discussed and the questions raised for future research.

The hypothesized mean differences in the students' perceptions of opportunities for hands-on learning, instructor cares about students' success, and the instructor encourages students' contributions by student gender, instructor gender, and persisters/non-persisters were found to be non-significant. The purpose of this study was to explore these differences to understand the types of classroom experiences that students need to persist in pursuing a STEM degree. Furthermore, this study's purpose was to understand how these classroom experiences are perceived differently depending on the gender of the student and the instructor. The present study did add to

understanding of persistence, in that there were no differences in students' perceptions of hands-on learning, caring, and encouraging by persisters and non-persisters. There were no significant differences in students' perception of hands-on learning, caring, and encouraging by male and female students, or male and female professors. Perhaps, there are other classroom experiences that need to be explored so that universities can assist STEM majors of both genders to complete their STEM degree and, ultimately, to the STEM workforce to meet the growing need of such workers in the United States. Universities can stand behind President Obama and his priority to increase the number of students pursuing careers in STEM fields over the next decade to once again place our nation at the forefront of the ever-changing global society.

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APPENDIX A
DATA COLLECTION INSTRUMENT

Information about the Study

Project Title: Contextual Determinants of Academic Behavior

Investigator(s): Kamden K. Strunk, M.S. Oklahoma State University
YoonJung Cho, Ph.D. Oklahoma State University

Purpose: The purpose of this study is to examine how students' motivation, goals, and academic behaviors change as they move from academic context to academic context across time to increase understanding of the role of context in student behavior.

Procedures: A survey that should take approximately 10-15 minutes to complete is attached to this information sheet. There are questions about your study habits, your learning style, your preferences, your personality, as well as some basic personal information such as education level, age, and gender. You will also be asked to provide your CWID so that we can access background information such as standardized test scores, GPA, and demographic information. Finally, you will be asked to provide your email address so that we can send you a follow-up survey next semester.

Risks of Participation: There are no known risks associated with this project which are greater than those ordinarily encountered in daily life.

Benefits: It is expected that this project will enhance understanding of motivation as well as the interrelationship of personal and environmental variables in influencing academic behavior. This may help to enhance future educational practice.

Inducements: Upon completion of the follow-up survey, you will be entered for a chance to win one of five $50.00 cash awards for your participation. These awards will be given at random to participants in the study at the conclusion of the follow-up study, which is administered in Weeks 6-8 of the Spring of 2013.

Confidentiality: All information will be anonymous as no names or identification numbers will be recorded on the survey. The surveys will be destroyed in August 2013 after the responses have been entered into a computer. No names or identification numbers will be recorded in the data file. The data will be stored in a lock room in Willard 413 until data collection has been completed or until August 2013, whichever comes sooner. All results will be reported as aggregated data and no individual responses will be reported. The OSU IRB has the authority to inspect consent records and data files to assure compliance with approved procedures.

Contacts: If you have any questions about the research or your rights as a participant in this study, please feel free to contact Kamden Strunk at 405-744-3485/ kamden.strunk@okstate.edu. or Dr. YoonJung Cho from Oklahoma State University at 405-744-9444 /yoonjung.cho@okstate.edu. If you have questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

Participant Rights: Your participation in this project is appreciated and completely voluntary. You may choose not to participate at any time without any penalty or problem. Your agreement to participate in this research study is signified by your participation.

Okla. State Univ.
IRB
Approved 9/6/12
Expires 9/5/13
IRB# ED-12-128

The following are the constructs measured on the survey. The participants were not given these labels.

Construct	# items	pages
Procrastination Approach/Avoidance	25	54-55
	12	55
	5	56
Subjective Task Value	11	56
Self-Efficacy	18	57
	11	58
Classroom Experiences (used for this study)	7	58

Please rate your level of agreement or disagreement with each of the following items using the scale provided.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

_____ 1. I do my work for this class well ahead of the deadline because I believe that is how I will do my best work.

_____ 2. I delay completing assignments in this class to increase the quality of my work.

_____ 3. I complete my assignments for this class ahead of the deadlines to help me be successful.

_____ 4. When I receive a new assignment, I try to complete it ahead of the deadline because I don't want to feel overwhelmed.

_____ 5. I put off starting class assignments in this course to increase my motivation.

_____ 6. I start my work early for this class because my performance will suffer if I have to rush through a task.

_____ 7. I start working on tasks in this class early because I'm afraid I will fail if I don't start right away..

_____ 8. I wait until closer to the deadline to start my work in this class because I can't even stand to think about it.

_____ 9. I start tasks for this class later because they are too hard to get going on.

_____ 10. I put off tasks for this class for later because they are too difficult for me to finish.

_____ 11. I work closer to the deadline for assignments in this class because it helps me feel a stronger state of "flow" in my work.

_____ 12. I delay starting assignments in this class because I am afraid of failure.

_____ 13. I intentionally wait until closer deadlines for this class to begin work to enhance my performance.

_____ 14. On extremely difficult work in this class, I begin work even earlier because I want to avoid the consequences of putting it off for later.

_____ 15. I postpone tasks in this class in order to more effectively utilize my time.

_____ 16. I delay starting work for this class because it is overwhelming.

_____ 17. I start working right away on new assignments for this class so that I can perform better on the task.

_____ 18. I work further ahead of deadlines for this class because I believe I will get the best results that way.

_____ 19. I start tasks closer to the deadline for this course because I find it more efficient to complete them.

_____ 20. I start things early in this class because otherwise it will be too difficult to finish on time.

_____ 21. I begin working on a newly assigned task in this class right away to avoid falling behind.

_____ 22. I put off my work for this class because I do not want to perform poorly.

_____ 23. I start work for this class immediately after it is assigned because doing so helps me successfully complete class work.

_____ 24. I delay starting work for this class because I perform better under more time pressure.

_____ 25. I begin working on difficult tasks in this class early in order to achieve positive results.

Please rate your level of agreement or disagreement with each of the following items using the scale provided.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

_____ 1. My aim is to completely master the material presented in this class.

_____ 2. I am striving to do well compared to other students in this course.

_____ 3. My goal is to learn as much as possible in this class.

_____ 4. My aim is to perform well relative to other students in this class.

_____ 5. My aim is to avoid learning less than I possibly could in this course.

_____ 6. My goal is to avoid performing poorly compared to others in class.

_____ 7. I am striving to understand the content of this course as thoroughly as possible.

_____ 8. My goal is to perform better than the other students in this class.

_____ 9. My goal is to avoid learning less than it is possible to learn in this class.

_____ 10. I am striving to avoid performing worse than others in this class.

_____ 11. I am striving to avoid an incomplete understanding of the course material.

_____ 12. My aim is to avoid doing worse than other students in this course.

Please rate your level of agreement or disagreement with each of the following items using the scale provided.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

_____ 1. I'm certain I can master the material taught in this class.

_____ 2. I can do even the hardest work in this class if I try.

_____ 3. I can do almost all the work in this class if I don't give up.

_____ 4. Even if the material in this class is hard, I can learn it.

_____ 5. I'm certain I can figure out how to do even the most difficult work in this class.

Please rate your level of agreement or disagreement with each of the following items using the scale provided.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

_____ 1. I like doing work for this class.

_____ 2. In general, I find work on assignments for this class interesting.

_____ 3. I enjoy the work we do in this class.

_____ 4. I am very interested in the content area taught in this class.

_____ 5. I like the subject matter taught in this class.

_____ 6. I think the material in this course is useful for me to learn.

_____ 7. This course is useful for what I want to do after I graduate and go to work.

_____ 8. The work we do in this class is important.

_____ 9. For me, doing well in this class is important.

_____ 10. What I learn in this course is useful for my daily life outside school.

_____ 11. What I learn in this course will be useful in other courses.

Please rate your level of agreement or disagreement with each of the following items using the scale provided.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

_____ 1. Compared with other students in this class I expect to do well.

_____ 2. I'm certain I can understand the ideas taught in this class.

_____ 3. I expect to do very well in this class.

_____ 4. Compared with others in this class, I think I'm a good student.

_____ 5. I am sure I can do an excellent job on the problems and tasks assigned for this class.

_____ 6. I think I will receive good grades in this class.

_____ 7. My study skills are excellent compared with others in this class.

_____ 8. Compared with other students in this class I think I know a great deal about the subjects.

_____ 9. I know that I will be able to learn the material for this class.

_____ 10. I ask myself questions to make sure I know the material I have been studying.

_____ 11. When work is hard I either give up or study only the easy parts.

_____ 12. I work on practice exercises and answer end of chapter questions even when I don't have to.

_____ 13. Even when study materials are dull and uninteresting, I keep working until I finish.

_____ 14. Before I begin studying I think about the things I will need to do to learn.

_____ 15. I often find that I have been reading for class but don't know what it is all about.

_____ 16. I find that when the teacher is talking I think of other things and don't really listen to what is being said.

_____ 17. When I'm reading I stop once in a while and go over what I have read.

_____ 18. I work hard to get a good grade even when I don't like a class.

Please answer each of the following questions using the scale provided.

Not Well At All						Extremely Well
1	2	3	4	5	6	7

_____ 1. How well can you finish homework assignments by deadlines?

_____ 2. How well can you study when there are other interesting things to do?

_____ 3. How well can you concentrate on school subjects?

_____ 4. How well can you take class notes of class instruction?

_____ 5. How well can you use the library to get information for class assignments?

_____ 6. How well can you plan your schoolwork?

_____ 7. How well can you organize your schoolwork?

_____ 8. How well can you remember information presented in class and textbooks?

_____ 9. How well can you arrange a place to study without distractions?

_____ 10. How well can you motivate yourself to do schoolwork?

_____ 11. How well can you participate in class discussions?

Please rate your level of agreement or disagreement with each of the following items using the scale provided.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

_____ 1. I feel my instructor cares about my success.

_____ 2. I feel connected to other students in this class.

_____ 3. There are many opportunities for interaction in this class.

_____ 4. My instructor encourages my contribution in this class.

_____ 5. Students in this class work together to learn.

_____ 6. This class provides many opportunities for creativity.

_____ 7. This class offers opportunities for hands-on learning.

Please provide the following information about yourself:

Age: _____

College Classification: Freshman

                            Sophomore

                            Junior

                            Senior

                            Other (please specify): _____

Please provide your CWID: _____

*Note: Your CWID is used only to access background information about you relevant to this study, like standardized admissions test scores, GPA, and demographic variables, and to match your responses on the follow-up survey.

Appendix B
Detailed list of STEM majors used in this study

NSF STEM category	Major Code	Major
Chemistry	BIOC	Biochemistry
	CHEM	Chemistry
Computer and Information Science	ARCH	Architecture
	CMT	Construction Management Technology
	CS	Computer Science
	EETE	Electrical Engineering Technology
	FPST	Fire Protection and Safety Technology
	MET	Mechanical Engineering Technology
	MIS	Management Information Systems
Engineering	AERS	Aerospace Engineering
	ARCE	Architectural Engineering
	BAE	Biosystems Engineering
	CHEN	Chemical Engineering
	CIVE	Civil Engineering
	CPE	Computer Engineering
	ELEN	Electrical Engineering
	IEM	Industrial Engineering
	MEEN	Mechanical Engineering
Geosciences	GEOL	Geology
Life Sciences	AGBU	Agriculture Business
	AGCM	Agriculture Communication
	AGED	Agriculture Education
	ANSI	Animal Science
	BIMB	Biochemistry and Molecular Biology
	BIOL	Biological Science
	BOT	Botany
	ENVR	Environmental Science
	FDSC	Food Science
	MCMB	Microbiology and Molecular Biology
	NREM	Natural Resource

		Ecology and Management
	NSCI	Nutritional Science
	PHSL	Physiology
	ZOOL	Zoology
Mathematics	MATH	Mathematics
Psychology	CDIS	Communication Science and Disorders
	HDFS	Human Development and Family Science
	PSYC	Psychology
Social Sciences	ECON	Economics
	GEOG	Geography
	POLS	Political Science
	SOC	Sociology

VITA

Carol Fowlkes

Candidate for the Degree of

Doctor of Philosophy

Thesis: DIFFERENCES IN STUDENTS PERCEIVED INSTRUCTIONAL
PRACTICES BY INSTRUCTOR GENDER, STUDENT GENDER, AND
PERSISTENCE IN STEM COURSES

Major Field: Higher Education

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Higher Education
at Oklahoma State University, Stillwater, Oklahoma in December/May/July,
Year.

Completed the requirements for the Master of Science in Education at
MidAmerica Nazarene University, Olathe, KS in 1995.

Completed the requirements for the Bachelor of Science in mathematics at
MidAmerica Nazarene University, Olathe, KS in 1989.

Experience:

Taught mathematics at SpringHill High School, SpringHill, KS. 1989-1998

Associate Professor of mathematics at Mid-America Christian University,
Oklahoma City, OK. 1998-current

Professional Memberships:

National Council of Teachers of Mathematics (NCTM)