THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF CURRICULUM AND INSTRUCTION

GENDER-SPECIFIC DIFFERENTIATION OF TEACHERS' PERSPECTIVES OF AND INTERACTIONS WITH STUDENTS

SAMANTHA ELIZABETH TIMLIN
SPRING 2012

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Secondary Education
with honors in Secondary Education

Reviewed and approved* by the following:

Rose Mary Zbiek
Professor of Education
Thesis Supervisor/Honors Adviser

E. Frances Arbaugh
Associate Professor of Education
Faculty Reader

* Signatures are on file in the Schreyer Honors College

ABSTRACT

As an essential part of the classroom environment, teacher–student interactions influence students' experience with mathematics. Thus, it is important to discover factors that affect interactions between teachers and students. The purpose of this study was to provide more developed insight into teacher–student interactions than that found in existing research, such as (Hart, 1989; Becker, 1981; Duffy, Warren, & Walsh, 2001; Jungwirth, 1991). In particular, this study aims to discover if and, if so, how the gender of the student influences the teacher's interaction with the student by using a novel application of Jaworski's (2002) teaching triad.

While some research has been conducted on gender differences in teacher–student interactions, none has looked at the three dimensions that this research considers: affective sensitivity, cognitive sensitivity, and mathematical challenge. To investigate whether teachers' perceptions of and interactions with students differed based on gender, teachers were interviewed and asked to characterize high- and low-performing female and male students. The teachers' classes were observed, and teacher–student interactions with female and male students were categorized as positive or negative instances of each of the three dimensions. These instances were analyzed for both qualitative and quantitative differences between the genders.

The results of this study suggest that teachers more frequently interact with female students than with male students both in total number of interactions and in number of instances of cognitive sensitivity. The research also suggests that teachers more frequently interact with students they perceive to be high and low performers than with other students in the class. More thorough research is needed to confirm these results but these findings have implications for how secondary mathematics teachers communicate with students

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank my advisor and thesis supervisor Dr. Rose M. Zbiek, who was instrumental in the every stage of the process of constructing this thesis. I am extraordinarily grateful for her unwavering support, guidance, and faith in me, as well as the opportunities that she provided me both as an honors student and as a future mathematics educator. This thesis would never have come together without Dr. Zbiek. I would also like to thank Dr. Arbaugh for serving as my second reader and for her encouragement and confidence in me. Additionally, I would like to thank the participating schools and teachers for allowing me to conduct this research. I would finally like to thank my friends and family for being there for me through this entire process.

Chapter 1: Background

Introduction

Classroom interactions between teacher and student play a substantial role in a student's educational experience. It is through this relationship that students experience mathematics in schools. As such, the nature of these interactions affects the students' learning. Therefore it is important to consider the factors that influence the nature of teacher–student interactions, which thus influences students' mathematics education.

One such influence is teachers' perceptions of students. Teachers' actions in the classroom and with students are affected by their beliefs and perceptions about students. More specifically, we can consider how teacher perceptions may differ based on students' gender and whether there is a gender-specific differentiation between how teachers interact with female and male students. If a distinction does exist among teachers' interactions with female and male students, it influences how students experience and learn mathematics. Therefore, it is important to discover if these gender differences exist in teachers' perceptions and interactions with students as such a discovery could impact classroom practices as they currently exist, which in turn could impact student learning.

The outcome of this research applies to my own personal classroom practice as a secondary mathematics teacher, and to the practice of others in the profession. Understanding to what extent teachers' perceptions of students influence their interactions with students as related to the students' gender will allow me to recognize how personal factors affect my teaching of and students' experience with my mathematics. Thus this research will help me to interact with my

students in the most effective and sensitive way possible. It will similarly serve as a benefit to other mathematics educators.

Framework

This thesis aims to explore the existence of gender-specific differences in teacher–student interactions as related to teachers' perceptions of students. To investigate this idea, I consider three questions:

1. To what extent do teachers' perceptions of students differ based on students' gender?
2. To what extent does gender-specific differentiation exist between teachers' interactions with female and male students?
3. If there are differences, how, if at all, do teachers' perceptions relate to their interactions with students?

In exploring these questions, I use elements of the teaching triad, a theoretical construct developed by Barbara Jaworski that links characteristics of investigative teaching to three "domains of activity" in which teachers engage (Potari & Jaworski, 2002, p. 352). Of these three domains, I look at two: sensitivity to students and mathematical challenge.

Definition of Sensitivity to Students

As defined by Potari and Jaworski (2002), sensitivity to students involves the "teacher's knowledge of students and attention to their needs" (p. 353). This domain can be further divided into two subcategories of sensitivity: affective and cognitive.

Affective sensitivity to students describes the teacher's demonstrating knowledge of, caring for, and respect for individual students and their needs. A teacher can demonstrate both

positive and negative affective sensitivity in teacher–student interactions. Examples of positive affective sensitivity include giving students positive feedback and encouragement when appropriate, acknowledging students' difficulties, and maintaining student engagement by involving all students. Examples of negative affective sensitivity are those such as giving affirmative feedback when a student is incorrect, providing inappropriately harsh or negative feedback, or ignoring off-task student behaviors. These lists of examples, and those to follow, are not all encompassing, but rather they serve to give an idea as to the type of interaction that would qualify in each category. Potari and Jaworski (2002) similarly described and exemplified the concepts rather than defined them.

Cognitive sensitivity to students describes the teacher's demonstrating an understanding of students' individual intellectual and mathematical needs. This differs from affective sensitivity in that it directly relates to the mathematical aspect of classroom interactions. As with affective sensitivity, a teacher can demonstrate both positive and negative instances of cognitive sensitivity. Teachers demonstrate positive cognitive sensitivity in interactions with students when they exhibit an awareness of the students' mathematical abilities and provide students with opportunities to explain their mathematical thinking. Positive cognitive sensitivity can appear as allowing students to discuss ideas and argue viewpoints, giving students the chance to ask questions, and differentiating instruction based on identified need or Individualized Education Program (IEP). Negative instances of cognitive sensitivity may be seen in not allowing students to discuss a concept or question, giving away answers too easily, and not honoring IEPs or differentiating instruction for no clear reason.

Definition of Mathematical Challenge

While sensitivity to students deals with teachers' knowledge of students, mathematical challenge is described as "the challenges offered to students to engender mathematical thinking and activity" (Potari & Jaworski, 2002, p. 353). Mathematical challenge consists of providing students appropriate opportunities to engage in mathematics. In interactions with students, teachers can maintain high levels of mathematical challenge or increase or lower the level of mathematical challenge presented.

Examples of maintaining a high level of mathematical challenge include providing students with the opportunity to form and justify conjectures, using guiding—but not leading—questions to help students make a mathematical discovery, and planning lessons that involve hands on explorations designed to promote conceptual understanding. Examples of lowering mathematical challenge could involve providing only direct instruction of formulas and procedures, giving away answers without providing the students opportunity to derive them on their own, or over simplifying a task for certain or all students. For the remainder of this thesis, maintaining a high level of mathematical challenge will be referred to as positive mathematical challenge, while lowering the level of mathematical challenge will be referred to as negative mathematical challenge.

Discussion of Existing Literature

While some research has investigated gender differences in teachers' interactions between teachers and students (Hart, 1989; Becker, 1981; Duffy, Warren, & Walsh, 2001; Jungwirth, 1991), none have looked at the three dimensions that I consider, namely mathematical challenge, affective sensitivity, and cognitive sensitivity as conceptualized by Jaworski and colleagues

(Potari & Jaworski, 2002). Additionally, there is little research that addresses the influence of teachers' perceptions of students on student–teacher interaction, as related to student gender.

Hart (1989), Becker (1981), and Duffy, Warren, and Walsh (2001) each looked at instances of positive and negative feedback, which falls under the affective sensitivity to students umbrella. Duffy, Warren, and Walsh (2001) found that male students received not only more criticism from teachers but also more instances of acceptance. These researchers also found that female students more frequently than male students received remediation. Similarly, Becker (1981) found that males received both more praise and more criticism than females. However, Becker also found that male students received more encouraging comments from teachers and females experienced more discouraging interactions with teachers. The results from these two studies show that teachers demonstrate more positive and negative instances of feedback related to affective sensitivity toward male students than toward female students. No research was found that considered cognitive sensitivity in terms of gender differences in teacher–student interactions.

Hart (1989) and Becker (1981) considered interactions that involved high and low levels of mathematics, which is similar to the idea of mathematical challenge. Hart considered high levels of mathematics to be mathematics at the comprehension, application, and analysis levels of Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). These involve interactions that deal with students demonstrating understanding, making use of existing knowledge in novel situations, and investigating and generalizing ideas. For Hart, the lower level of mathematics consisted of computational, yes/no, and multiple-choice questions from teachers to students. In the study, Hart found no gender difference between teacher–student interactions dealing with high-level and low-level mathematics using these definitions. Becker considered

levels of questioning employed by teachers. Two categories used are relevant to mathematical challenge: process questions, defined as higher-order teacher questions, and product questions, defined as lower-order teacher questions. Process questions required an answer that dealt with student thought process, while product questions asked for a numerical answer. While Becker found no significant difference for product, or lower-level, questions, the researcher did find that male students were asked more process, or higher-level, questions than female students.

Researchers have also found differences in the interactions of teachers with female and male students that do not directly relate to the ideas of sensitivity to students and mathematical challenge. Hart (1989); Becker (1981); and Duffy, Warren, and Walsh (2001) all found that teachers interacted more frequently with male students than with female students. Duffy, Warren, and Walsh identified more specifically that while there were more total interactions with male students and more total teacher-initiated interactions with male students, there was no gender difference in the frequency of student-initiated interactions. However, Hart found that male students initiated more interactions with teachers than female students, while Becker found the converse. Thus there is no consensus in the research on gender differences in the frequency of student-initiated interactions with teachers.

Jungwirth (1991) found multiple differences in teacher–student interactions based on gender, none of which directly relate to sensitivity to students or mathematical challenge. Most of these differences depend on the student's participation in the interaction, and so are not influenced by teachers' perceptions on students. For example, one of these differences is "blocking the task constitution," in which Jungwirth found that female students are less likely than male students to make suggestions about potential solution methods when using a trial-and-error method to solve a problem as a class (Jungwirth, 1991, p. 269). This is a gender-specific

difference in the teacher–student interaction, but it is not related to the teacher's perceptions or influence on the interaction, and so it is not directly connected to the research questions of this study.

Another difference considered by Jungwirth that does apply to the research question is the distinction between "argumentative insistence on the desired answer" and "authoritative insistence on the desired answer" (Jungwirth, 1991, p. 274). These phrases denote responses by teachers to answers given by students that are correct in theory but not applicable to the problem or discussion at hand. Teachers more frequently used "argumentative insistence on the desired answer" when interacting in this way with male students. Argumentative insistence involves the teacher and (male) student coming to an agreement about a correct solution through negotiation and discussion.

When interacting with female students, teachers more often used "authoritative insistence on the desired answer," in which teachers acknowledged the (female) students' contribution, but used their authority to give the correct solution, rather than working with the student to find it. This is reminiscent of the ideas of mathematical challenge as male students were more frequently allowed to discuss and argue for their viewpoints on the problem. If we consider Jungwirth's empirical difference in Jaworski's terms, teachers more frequently demonstrated positive instances of mathematical challenge when interacting with male students and negative instances when interacting with female students.

Chapter 2: Methodology

In this chapter, I outline the overall structure of the study as well as more specifically discuss participant selection, interview procedures, observation procedures, and data analysis conducted in the study. I explain the process for recruiting and enrolling participants and describe the participants used in the study. I also explain the procedure used in conducting interviews and observations of classes. Finally, I discuss the process employed in analyzing the data collected.

Overall Structure

Once selected, the participants took part in three components of the study. Participating teachers met with me for an introductory interview, allowed me to sit in on the equivalence of three consecutive class periods, and then finished with a post-interview. After the observations and introductions had been conducted, I analyzed the data collected to determine any conclusions that could be made. More thorough descriptions of each of these components are given in the sections below.

Participant Selection

Participants in this study are secondary mathematics teachers. No such teachers were excluded in the search for participants unless scheduling conflicts did not permit the observation of their classes. To identify potential participants, my thesis supervisor contacted local school districts on my behalf. A nearby private high school agreed to participate and put me into contact with possible participants, and I sent out a recruiting letter through email to these volunteer teachers. A description of participants can be found in chapter 3.

Interview Procedures

Participants completed two interviews as part of the study, each lasting approximately 20 minutes. A copy of the interview questions can be found in the appendix. The first interview took place before any observations were completed. This interview gave participating teachers the chance to ask any questions about the study before signing the consent form. Additionally, this interview gave me the opportunity to gain insight into teachers' perceptions of students.

In the initial individual interview, each participating teacher was asked about the lesson goals and content for the classes to be observed, including information about the topic for the lesson and the teacher's plan for the class period. Additionally, the teacher was asked to discuss the student audience of the class. I asked questions about the demographics of the class, such as the total number of students and the number of male and female students. The teacher was asked to identify one low performing female student and one low performing male student, as well as one high performing female student and one high performing male student. Then the teacher described what about these students' performances tells that they are low- or high- performing mathematics students. Finally, the teacher was asked logistical questions, such as where would be an appropriate place for me to sit and place the audio recorder.

A second interview was carried out after the observations were completed. This post-interview was conducted in the spirit of the common practice of teachers debriefing about a class after an observation. The goal was to clarify confusing moments and obtain missed aspects of the lesson. In these interviews, I was able to ask the participating teacher any questions about moments about which I, as an outsider to the class, was unsure regarding how they relate to general classroom procedures.

Observation Procedures

After the initial interview was conducted, I planned to observe three consecutive class periods (i.e., the equivalent of three consecutive lesson days with the same class) for each participating teacher. Due to the nature of the scheduling in the participating school, I observed two consecutive block classes. The length of time of these classes was equivalent to the length of time of three traditional classes. During these observations, the participants were not expected to do anything outside of their typical lesson. The class periods were audio recorded.

During the class periods of observation, I focused on what the teacher said and did when interacting with both genders. I looked for both positive and negative instances of affective sensitivity, cognitive sensitivity, and mathematical challenge, using those terms as described in chapter 1. At this time, I characterized the instances I observed according to these concepts and recorded codes and timestamps for each. Table 1 contains the collection of possible codes. I also made note if the interaction was between the teacher and one of the students whom the teacher labeled as high- or low- performing in the initial interview. I added an H or L to the end of the existing respective code. Finally, I determined whether the interaction was initiated by the student or the teacher and recorded SI or TI, respectively.

Table 1. *Observational Codes*

	Positive Affective Sensitivity	Negative Affective Sensitivity	Positive Cognitive Sensitivity	Negative Cognitive Sensitivity	Positive Mathematical Challenge	Negative Mathematical Challenge
Female	FAS+	FAS-	FCS+	FCS-	FMC+	FMC-
Male	MAS+	MAS-	MCS+	MCS-	MMC+	MMC-

After the class period, I re-listened to the audio recordings and made any changes necessary to the codes and added a brief identifying description for each. Examples of the descriptions include "involving student in discussion of student's question," "acknowledgement of student's alternative process," and "use of guiding questions," among others. This re-listening also provided me the opportunity to listen for subtleties in the interactions that may have been overlooked during the observation. Through this process, I was able to determine that I had mislabeled some interactions during the class observation. For example, during the direct observation, I had recorded an instance of negative affective sensitivity in which the teacher moved on without answering a student's question. During re-listing, I corrected this instance to be one demonstrated negative cognitive sensitivity.

Data Analysis

In analyzing the data collected through interviews and observations, I focused on both quantitative and qualitative data that addressed the research questions. I analyzed the frequency of each of the six types of interactions considered for each gender, with special attention to the interactions between the teacher and the identified high- and low-performing students. These interactions give insight into how teachers' perceptions of students influence their interactions with students as related to gender. I also compared instances of the same type of interaction between males and females to see if any qualitative differences occurred.

To address the first research question, I analyzed teachers' responses to the question from the initial interview that asked them to identify high- and low-performing students and to describe what made the students high- and low- performing. Teachers' replies to this question gave insight into their perceptions of students. In examining these responses, I looked for

differences between how teachers described male students and how they described female students.

To address the second research question, I focused on the data involving teachers' interactions with students recorded using the codes (see Table 1). In addition to comparing the number of counts of interactions with males and the number of counts of interactions with females, I sorted the instances based on the codes for affective sensitivity, cognitive sensitivity, and mathematical challenge. Furthermore, to analyze the interactions qualitatively, I used constant comparative analysis (with results reviewed by a mathematics educator for verification) to compare instances of each type of interaction for male students and for female students.

To address the third research question, I paid special attention to the data involving teachers' perceptions as represented by L and H in the codes (see Table 1). This data was similarly analyzed quantitatively by comparing frequency counts and qualitatively using constant comparative analysis as in the examination of data for the second research question.

Chapter 3: Findings

In this chapter, I consider the evidence obtained through the interview and observation sequence. I describe each teacher's perceptions of her students as obtained through the first interview as well as the sequence of events that occurred in each observed lesson. I look at differences between genders regarding the number of interactions between teachers and students for each of the three considered domains: affective sensitivity, cognitive sensitivity, and mathematical challenge. I detail differences in the interactions between the teachers and the identified high- and low-performing students. In addition to analyzing the frequency counts of interactions, I also look at qualitative differences within the categories. When citing interviews and observations, I use the format YYMMDD to report the date of the event, such as 120327 for March 27, 2012.

Mrs. Carraway

The first teacher observed for this study will be referred to as Mrs. Carraway, a pseudonym. Mrs. Carraway teaches mathematics at a small private high school in central Pennsylvania. At this school there are 60 students in grades 9–12. The school day is organized into a block schedule. The duration of the block means that observing two block classes results in the same amount of data as three classes of normal length. For this reason, I planned to observe two classes for Mrs. Carraway.

Mrs. Carraway's Class and Identified Students

I observed Mrs. Carraway's calculus class, containing six students. Five of these students were male and the remaining student was female. Mrs. Carraway described the overall achievement level of the class as “varied” (Initial interview, 120327). She felt that the class was made up of students ranging from low- to high-levels as a result of the small school population.

When asked to identify a low-performing male student, Mrs. Carraway described a student who "doesn't work up to his ability level" (Initial interview, 120327). She explained that this student has differing levels of abilities in different instructional areas. He is successful in most other classes but consistently struggles with mathematics. This difference in struggle results in frustration and a lack of perseverance when he is confused or reaches a point where his level of understanding does not allow him to proceed.

Mrs. Carraway described a male student in the class as being high performing based on having "natural ability." This student is able to demonstrate his understanding through both his participation in class and his written work.

Because there was only one female student in the class, the teacher was unable to identify high- and low-performing female students. She described the lone female student as being neither high nor low performing, but "middle of the road" (Initial interview, 120327). She also described this student as being typical of other average-performing female students that she instructs.

Discussion of Observed Optimization and Newton's Method Lesson for Mrs. Carraway

Due to the block scheduling at Mrs. Carraway's high school, I planned to observe two lessons for this teacher. However, unavoidable circumstances resulted in her being unavailable for a second observation. Therefore, I observed only one lesson for Mrs. Carraway.

The observed class period focused first on optimization, which was a topic in which students had already received some instruction. Later in the class, Mrs. Carraway introduced Newton's method of approximation. The class began with a brief discussion of optimization and how it can be used in the real world to solve problems. Then, the teacher assigned the class three

optimization problems from the textbook, James Stewart's *Single Variable Calculus* (2008). The first two problems asked students to find the dimensions of a poster with maximized area given certain margins, and the final problem dealt with maximizing profit. Students worked individually on each problem as the teacher walked around and stopped to observe and occasionally speak with each student. After students had time to work on each problem, the teacher brought the class back together to discuss a solution to that problem.

In the second half of class, the teacher conducted a lecture on Newton's method. She referred students to a section in the textbook and they read passages aloud together. The teacher drew upon students' prior knowledge of the quadratic formula to create motivation for the use of Newton's method and then introduced the formula to use. The students and teacher worked through an example as a class. During the discussion of the example, the teacher demonstrated how the method is used to find more precise approximations of the roots of a function. Then students worked on an example individually, after which time the teacher worked through the solution with the class.

Findings from Mrs. Carraway's Lesson

When comparing the number of interactions between Mrs. Carraway and female and male students, I considered the proportion of interactions per student. Table 2 provides the number of interactions per female student and per male student in each of the six categories.

Table 2. *Number of Proportional Interactions with Female and Male Students*

	AS+	AS-	CS+	CS-	MC+	MC-	Total
Female	4	0	12	4	3	0	23
Male	4.6	0.8	2	1.4	2.2	0.4	14.25

In general, Mrs. Carraway interacted more frequently per female student than per male student. The numbers for positive and negative instances of both affective sensitivity and mathematical challenge are comparable for female and male students. In considering the proportional frequency counts, there seems to be a gender difference only in instances of cognitive sensitivity. This difference is suggested by the considerably different number of instances of both positive and negative cognitive sensitivity for female and male students. During this class period, there were six times as many instances of positive cognitive sensitivity per student for females than for males. There were nearly three times as many instances of negative cognitive sensitivity per student for females than for males.

This trend continues when we consider the initiator of the interaction. Tables 3 and 4 reveal the number of interactions per female student and per male student respectively that were initiated by the student or the teacher.

Table 3. *Initiator of Interactions with Female Student*

	FAS+	FAS-	FCS+	FCS-	FMC+	FMC-	Total
Student Initiated	1	0	9	4	1	0	15
Teacher Initiated	3	0	3	0	2	0	8

Table 4. *Initiator of Interactions with Male Student*

	MAS+	MAS-	MCS+	MCS-	MMC+	MMC-	Total
Student Initiated	1	0	1.4	0.8	0.2	0.2	3.6
Teacher Initiated	3.6	0.8	0.6	0.6	2	0.2	7.8

In terms of affective sensitivity and mathematical challenge, the numbers of interactions per student that are student initiated or teacher initiated are similar for both female and male

students. Regarding positive cognitive sensitivity, the female student more frequently participated in both student initiated and teacher initiated interactions than male students. There were 6.4 times as many instances of student initiated interactions of this type between the female student and Mrs. Carraway than similar instances between the male student and Mrs. Carraway. There were five times as many instances of teacher-initiated interactions of this type for the female student than similar instances with male students. This is consistent with the total number of interactions in this domain being higher for the female student.

However, the distribution of positive cognitive sensitivity interactions by initiator is similar for both genders of students. The female student initiated three times as many interactions with the teacher as Mrs. Carraway did with the student. Proportionally, each male student initiated 2.3 times as many interactions as Mrs. Carraway did. There is not a gender-specific difference for the initiator of interactions categorized as positive cognitive sensitivity when we consider frequency counts.

We can look more closely at the nature of the interactions to determine if a qualitative difference occurred in instances of positive cognitive sensitivity. While 33% of these interactions with the female student occurred when Mrs. Carraway involved the student in a discussion student-posed question, only 10% of the interactions with male students occurred in this way. The following conversation observed on March 27, 2012 exemplifies this type of interaction. The students were working on finding the dimensions of a maximized area of a poster and had just discovered the value of the maximum area. A male student reminded the class that they were not yet finished with the problem.

> Female student: We found the maximum area. Why do we need to solve for anything else?
>
> Mrs. Carraway: Think back to the problem. What are we asked to find?
>
> Female student: The dimensions.
>
> Mrs. Carraway: So we're looking for the dimensions. How are they represented in the equation? (Observation, 120327)

Mrs. Carraway used questions to involve the female student in a discussion of her question, rather than simply answer it outright.

Male students experienced, however, more interactions in which students were asked to explain their reasoning. In 30% of the positive cognitive sensitivity interactions with male students, compared to no such interactions with female students, Mrs. Carraway led a discussion with students about their reasoning in solving a problem. This type of interaction occurred when the male student volunteered an answer or when Mrs. Carraway read what the student had written in individual work. Mrs. Carraway asked the male students questions like, "why did you take that step" and "how did you know that you were able to do that?"

While we do not see a difference quantitatively for positive cognitive sensitivity, there is a difference between number of student-initiated and teacher-initiated interactions of negative cognitive sensitivity per female student and per male student. While the number of teacher-initiated interactions of this type is comparable for the genders, there were five times as many student-initiated interactions per female student than per male student. This indicates that the female student initiated more interactions with the teacher that resulted in a display of negative cognitive sensitivity.

Furthermore, all four of the interactions demonstrating negative cognitive sensitivity between Mrs. Carraway and the female student were initiated by the student in the form of a question posed to the teacher. In two of these interactions, Mrs. Carraway moved onto the next problem without further discussion of the question. In the other two instances, Mrs. Carraway answered the student's question without involvement from or discussion with the student. The following interaction that took place during the introduction of Newton's method of approximation on March 27, 2012 demonstrates this.

Female student: Why are we finding x_2? What's the purpose?

Mrs. Carraway: So that we can find x_3. (Observation, 120327)

In this interaction, Mrs. Carraway directly answered the student's question without any involvement from the student.

In interacting with the male students, there were nearly equal numbers of student-initiated interactions and teacher initiated interactions. The male students experienced a form of negative cognitive sensitivity that the female student did not. This occurred in nearly 43% of this type of interaction with male students, when the teacher asked a question and the male student responded, but the teacher gave the correct (anticipated) answer before giving the student an opportunity to explain his response. An example of this type of interaction is given below.

Mrs. Carraway: So now we need to differentiate the function. What's the derivative of $\frac{1}{x^2}$?

Male student: $\frac{2}{x^3}$

Mrs. Carraway: Actually, it should be $-\frac{2}{x^3}$. (Observation, 120327)

In this interaction, Mrs. Carraway corrects the student's response, but does not inquire as to how the student obtained the incorrect response or involve the student in a discussion of the solution.

It is also worthwhile to compare the interactions between Mrs. Carraway and the male students she identified as high and low performing. Table 5 lists the frequency counts per student for these male students, the female student identified as an average performer, and the other students in the class.

Table 5. *Comparison of Identified Students*

	AS+	AS-	CS+	CS-	MC+	MC-	Total
Female Student	4	0	12	4	3	0	23
High Performing Male Student	6	1	3	2	3	0	15
Low Performing Male Student	7	2	4	3	4	0	20
Other Students (proportionally)	3.3	0.3	1	0.7	1.3	0.7	7.3

Across the categories, the numbers are comparable for the male students identified by Mrs. Carraway as high and low performing. While there were five more total interactions between the low performing student and the teacher, there was no large difference in any of the specific categories. There are some differences, however, when comparing the high and low performing male students' interactions with Mrs. Carraway with those of the female student and the other students, who were described as average performers.

In each category excluding negative mathematical challenge, the male students not identified as low or high performers experienced the fewest proportional number of interactions with Mrs. Carraway. In total, there were greater than twice as many interactions with the high

performing student and greater than 2.7 times more interactions with the low performing student as per each non-identified student. We see that in this class period, Mrs. Carraway was more likely to interact more frequently with the students she felt were high and low performing than with the intermediate students. This finding calls for more thorough study, particularly given that there was only one female student in the class.

When compared to the female student, the high performing male student, and the intermediate students, the male student identified as low performing by Mrs. Carraway most frequently experienced interactions characterized as affective sensitivity, positive and negative. Nearly 43% of the interactions with this student that were characterized as positive affective sensitivity occurred after the student correctly responded to a teacher-initiated question. In these instances, Mrs. Carraway acknowledged the student's correct response. This was expressed using words like, "good," "right," and "yes" (Observation, 120327). The remaining 57% of these interactions occurred when Mrs. Carraway used encouragement to persuade the student to keep trying. The increased focus on affective sensitivity in interacting with the identified low performing student is something that warrants further attention.

While the high-performing male student experienced only one fewer positive affective sensitivity interaction with Mrs. Carraway than the low-performing male student, the nature of the interactions differed. In each of the six instances of positive affective sensitivity with the high-performing male student, Mrs. Carraway initiated the interaction by posing a question to which the student responded correctly. Mrs. Carraway then acknowledged the student's correct answer using words as described above. There were no instances in which the teacher offered encouragement to the student as he worked.

Ms. Mann

Due to a family emergency taking Mrs. Carraway out of school, the planned second observation of her class did not occur. Instead, I was able to interview and observe Ms. Mann, a student teacher placed in the high school and working with a mentor other than Mrs. Carraway. Ms. Mann had been teaching various mathematics classes at the school, but had not frequently instructed this particular calculus class.

Ms. Mann's Class and Identified Students

Ms. Mann was not as familiar with the students in the class as Mrs. Carraway because she had not regularly observed or instructed the class, but she had some knowledge of the students. With her limited experience with the class, similar to that as a teacher at the beginning of a school year, she identified the same low-performing male student and high-performing male student as Mrs. Carraway. Ms. Mann observed that the low-performing male student seemed to struggle more with new ideas soon after they were introduced. She described the high-performing male student as having a better understanding of the abstract, three-dimensional ideas than other students in the class. Similar to Mrs. Carraway, she described the female student as being an average performer in the class. These perceptions were obtained in an initial interview conducted March 29, 2012.

Discussion of Observed Anti-Derivatives Lesson for Ms. Mann

Due to the circumstances previously described, I observed one lesson that Ms. Mann instructed for this calculus class. During this class period, the identified high performing student was absent.

Prior to this lesson, students had watched a video that introduced the topic of anti-derivatives. During the class period, Ms Mann instructed the class on the topic by having students work on examples from *Single Variable Calculus* of finding anti-derivatives of functions (p. 279). Ms. Mann asked the students to individually solve from one to three problems at a time. After each section of problems, Ms. Mann led the class in discussing the solutions.

Students first completed examples in which they found the most general anti-derivative of given functions, such as integrating $f(x) = x - 3$ to obtain $F(x) = \frac{1}{2}x^2 - 3x + c$. The next set of problems asked students to find a function given its first or second derivative by producing (successive) anti-derivatives. The third section gave students a graph of a function *f* and possible graphs of its anti-derivative. Students were asked to determine which of the graphs was the graph of the anti-derivative of *f*. In the final group of items, students considered relationships between anti-derivatives and the physics concepts of position, velocity, and acceleration.

Findings from Ms. Mann's Lesson

When comparing the number of interactions between Ms. Mann and female and male students, I considered the proportion of interactions per student. Table 6 demonstrates the number of interactions with Ms. Mann per female student and per male student in each of the six categories.

Table 6. *Number of Proportional Interactions with Female and Male Students*

	AS+	AS-	CS+	CS-	MC+	MC-	Total
Female	2	0	7	0	2	0	11
Male	2.5	0.5	3.75	1.25	3	0.5	11.5

Proportionally, Ms. Mann interacted with students of each gender a comparable number of times in total. When I dissect the data into categories, there is only one type of interaction in which there exists a substantial quantitative difference between female and male students: positive cognitive sensitivity. In all other categories, there was no considerable difference in number of interactions. There were nearly twice as many interactions that demonstrated positive cognitive sensitivity between Ms. Mann and the female student than interactions of this domain between Ms. Mann and each male student.

Nearly 72% of the interactions demonstrating positive cognitive sensitivity between the female student and Ms. Mann occurred through Ms. Mann's involvement of the student in answering the student's question. Only approximately 7% of interactions in this category with male students happened in this way. Another way that Ms. Mann demonstrated positive cognitive sensitivity was in asking students to explain their reasoning or process for finding their solution. These often appeared in the form of "why" and "how" questions. While 40% of the positive cognitive sensitivity interactions with male students occurred in this way, only 14% of such interactions with the female student did.

While there is not a substantial difference in the number of interactions of Ms. Mann with students of different genders in the other five categories, it is interesting to note a pattern that emerged in Ms. Mann's interactions with the female student. Of the eleven interactions, none demonstrated a negative instance of a domain.

It is also worthwhile to consider the initiator of the interactions considered in Table 6. This is seen in Tables 7 and 8. As seen in Table 7, the female student initiated 4.5 times as many interactions with Ms. Mann as Ms. Mann initiated with her. The opposite is seen for male

students in Table 8. Greater than 1.5 times as many interactions between Ms. Mann and male students were teacher-initiated rather than student-initiated. We also see that Ms. Mann more frequently initiated interactions with male students than with the female student.

Table 7. *Initiator of Interactions with Female Student*

	FAS+	FAS-	FCS+	FCS-	FMC+	FMC-	Total
Student Initiated	1	0	6	0	2	0	9
Teacher Initiated	1	0	1	0	0	0	2

Table 8. *Initiator of Interactions with Male Student*

	MAS+	MAS-	MCS+	MCS-	MMC+	MMC-	Total
Student Initiated	0.25	0.5	1.5	0.75	1.25	0.25	4.5
Teacher Initiated	2.25	0	2.25	0.5	1.75	0.25	7

While the number of student-initiated and teacher-initiated interactions that demonstrated positive affective sensitivity is evenly distributed for the female student, teacher-initiated interactions in this domain for male students occurred nine times as often as student-initiated interactions for male students. While Table 6 shows that there was not a considerable gender difference in the total number of interactions categorized as positive affective sensitivity, Tables 7 and 8 reveal that Ms. Mann much more frequently initiated these interactions with male students than with the female student.

Both of the instances categorized as positive affective sensitivity between Ms. Mann and the female student involved the teacher's acknowledgement of the student's correct response. Only 30% of such interactions between Ms. Mann and the male students occurred in this manner. 40% of the male student–teacher interactions in this domain were initiated by Ms. Mann through

attempts to maintain student engagement and involvement in the class. These appeared as the teacher asking a male student either to read a passage aloud or produce their solution on the white board. This type of interaction did not occur between Ms. Mann and the female student.

We saw in Table 6 that there were more total instances of positive cognitive sensitivity in Ms. Mann's interactions with the female student than with male students. Tables 7 and 8 demonstrate a gender difference in the initiator of the interaction in this domain. Nearly 86% of the interactions between the female student and Ms. Mann categorized as positive cognitive sensitivity were student-initiated, while 60% of such interactions with the male students were teacher-initiated.

We can also compare Ms. Mann's interactions with the identified low-performing student and her interactions with the intermediate students. This comparison is seen in Table 9. Interactions with the high performing student are excluded because this student was not present for this observation.

Table 9. *Comparison of Identified Students*

	AS+	AS-	CS+	CS-	MC+	MC-	Total
Female Student	2	0	7	0	2	0	11
Low Performing Male Student	3	1	8	2	7	1	21
Other Students (proportionally)	2.3	0.3	2.3	1	1.7	0.7	8.3

When we consider the total number of interactions, Ms. Mann interacted more frequently with the student identified as low performing than with any other student. This is also true for instances of positive mathematical challenge. The low-performing male student experienced

greater than 4 times as many interactions with the teacher that demonstrated positive examples of this domain than other male students and 3.5 times as many as the female student. While interactions in this domain were more frequent with the low-performing male student, the nature of the interactions did not greatly differ among the students. Approximately 50% of the interactions between the teacher and each group of students that demonstrated positive mathematical challenge appeared in the teacher's use of guiding questions to help students reach a solution.

For the categories of positive and negative affective sensitivity, negative cognitive sensitivity, and negative mathematical challenge, there was not considerable difference between the female student, the identified low-performing male student, and the intermediate students in the class. However, there is a noticeable difference in the number of instances of positive cognitive sensitivity among these students. For this category, both the female student and the low-performing male student experienced at least three times as many interactions as the intermediate students.

A more thorough discussion of the data and findings is found in chapter 4.

Chapter 4: Discussion

In this chapter, I use the findings provided in chapter 3 to conjecture possible answers to my research questions. These questions are presented below for easy reference.

1. To what extent do teachers' perceptions of students differ based on students' gender?
2. To what extent does gender-specific differentiation exist between teachers' interactions with female and male students?
3. If there are differences, how, if at all, do teachers' perceptions relate to their interactions with students?

I use information gathered from my interviews with teachers to look at the first question. The second question is approached using both quantitative and qualitative data gathered in observations of lessons. Using this data in connection with teachers' perceptions gathered in interviews, I address the third question.

Due to the small sample size, I am not able to make any definitive conclusions from the data I collected. However, I use what I gathered through my research to speculate about possible answers to these research questions. These speculations warrant further investigation.

Gender-Specific Differences in Teachers' Perceptions

The nature of the population of the class that I observed makes it difficult to attempt to make any conclusions about gender differences in teachers' perceptions of students. While there were six students in the class, only one student was female. Because of this, the teachers were unable to identify and describe high- and low-performing female students. Therefore, it is not possible to compare teachers' perceptions of female and male students in terms of performance to

determine if gender-specific differences in teachers' perceptions of students exist. I am unable to make any conclusions about this research question.

Gender-Specific Difference in Teacher–Student Interactions

While the total number of interactions per female student and total number of interactions per male student in Ms. Mann's class are close in magnitude, Mrs. Carraway interacted more frequently with the female student than per male student. When assembling the data for both teachers, the female student overall experienced more total interactions with teachers than each male student experienced. This finding contrasts the research of Hart (1989); Becker (1981); and Duffy, Warren, and Walsh (2001), who all found that teachers more often interacted with male students than female students. Of course, this may say something about the particular female student's participation in the class more than the teachers' interactions with students. It is interesting, then, to look at the initiator of the interaction.

When considering the data from each teacher's lesson, interactions with the female student were more frequently initiated by the student. Contrarily, interactions with male students were more frequently initiated by the teacher. This is in support of Becker's (1981) research, which found that female students initiated more interactions with teachers than male students, and differs from Hart's (1989) study, which found the opposite relationship. Because the female student initiated more interactions, it is possible that the higher number of female student–teacher interactions is a result of the particular female student's participation in class.

In 87.5% of the student-initiated interactions by the female student, the student began the interaction by asking a question of the teacher. This is only the case in 47.2% of interactions initiated by male students. The female student often asked "why" questions, which was not

observed for male students. For example, when Mrs. Carraway was working through the first example of using Newton's method of approximation, the female student asked the questions, "Why are we doing this? What is the goal?" She wanted to understand the reasons for using the procedure. Male students did not ask this type of question in either lesson, but the female student did in both. This finding might be related to gender differences in student behavior as they influence the student–teacher interaction. Alternatively, it might be related to the particular female student's curiosity level.

In order to answer this second research question, it is also necessary to look into gender differences in interactions as they relate to affective sensitivity, cognitive sensitivity, and mathematical challenge. The studies conducted by Duffy, Warren, and Walsh (2001) and Becker (1981) both found that male students more frequently received praise (positive affective sensitivity) and criticism (negative affective sensitivity) in interactions with teachers than female students. This is observed in the findings from both teachers' lessons. In each case I observed a slightly higher frequency of both positive and negative affective sensitivity for male students. There was not a substantial difference in any of the situations, however. More research is needed to look into the claim that teachers provide male students with more instances of affective sensitivity.

While there was not a substantial gender difference in the number of instances demonstrating positive affective sensitivity, the nature of these interactions differed for female and male students. Male students experienced interactions of this type in which the teacher initiated the contact seemingly in order to maintain the students' involvement and engagement in this class. For example, the teacher specifically called on a male student to read a passage aloud. The teacher also asked male students to write a solution on the board. This type of interaction

was not observed between the teachers and the female student. The use of this type of interaction with only one gender is intriguing and warrants further research. It is possible that the teachers believed that the female student was engaged in class without the need for prompting, while more attention needed to be given to male students' engagement.

Of the three categories I consider in this research, the most considerable gender difference occurred in instances of cognitive sensitivity, which the literature has yet to explore. The female student experienced substantially more interactions with both teachers that indicated positive cognitive sensitivity than male students experienced. The female student frequently experienced this category of interactions by initiating the contact through posing a question where the teacher involved the student in a discussion about that question. This could occur through the use of follow up questions, a discussion of the student's prior knowledge as it relates to the problem, or the use of an example to guide the student through the idea. The teachers demonstrated an understanding of the female student's intellectual needs by giving the student the opportunity to ask questions and discuss the ideas at play rather than by giving the answer immediately and succinctly.

While male students did experience this type of interaction, it more frequently occurred between the teachers and female students. However, male students were more likely to experience interactions that exhibited positive cognitive sensitivity in which the teacher initiated a discussion with the student on the student's method for solving the problem. An example of this type of interaction occurred when Ms. Mann talked with a male student and noticed his solution during time when students were completing individual work. Ms. Mann asked the student, "How did you get your answer?" and followed up with questions to prompt the student's discussion of

his solution. Through interactions like this, the teachers more frequently gave male students an opportunity to discuss their viewpoints and ideas about the problem.

When considering data from both teachers, there is little difference in number of interactions demonstrating positive and negative mathematical challenge between female and male students. The data shows a slightly higher incidence of such interactions for male students, but it is not substantial. Additionally, the nature of interactions demonstrating positive and negative mathematical challenge did not differ by gender. The female student and male students experienced similar interactions with both teachers, most frequently in the teachers' use of guided questions to help the student come to a discovery. This type of interaction was observed in a comparable frequency and nature for both genders. This research uncovered no gender difference in teacher–student interactions that relate to mathematical challenge.

Through my observations, I determined that the teachers interact more frequently with female students than with male students. The one female student initiated a higher percentage of her total interactions with teachers than teachers initiated with her. The reverse is seen for male students. In terms of the three considered domains, the most substantial differences occurred in instances of cognitive sensitivity, in which the female student experienced both more and different types of interactions than male students. I see in my data that gender-specific differentiation exists in the student–teacher interaction both in total interactions and in those demonstrating cognitive sensitivity. This conjecture warrants further research. No currently existing literature was discovered that examines gender differences in terms of cognitive sensitivity. As this is where the majority of differences were found, it is worth pursuing this finding through further study.

Influence of Teachers' Perceptions on Teacher–Student Interactions

To examine the influence of teachers' perceptions on teacher–student interactions, I considered differences in the interactions with the identified high and low performing students. Because the high performing student was absent during Ms. Mann's lesson, I looked at the data from Mrs. Carraway's lesson to determine if differences existed between the interactions between the teacher and the identified students. There were five more total interactions with the low performing student than the high performing student, but none of the categories considered had any substantial difference. This may indicate that the teachers' perceptions of students based on performance do not majorly influence their interactions as they fit in these categories. However, when we compare the interactions with these two students with the interactions with the intermediate performing students in the class, there is a difference.

Mrs. Carraway interacted more frequently with the students she perceived to be high and low performers than with the remaining students in the class. It is possible that Mrs. Carraway's high incidence of interactions with the high-performing student is caused by the student's confidence in his ability in mathematics leading to more frequent participation in class than other students. However, Mrs. Carraway initiated twice as many interactions with the high-performing student as the student did with her. This is a comparable proportion to the initiator of interactions with the low-performing student and with the intermediate students, which indicates that the high-performing student is not initiating more interactions than other students in the class. Therefore the high-performing student's participation in the interaction is not enough to explain the increased incidence of interactions. This indicates that Mrs. Carraway's perception of her students based on performance may have an impact on which students she chooses to interact with during class. Alternatively, the greater number of interactions with the identified high- and

low-performing male students might simply be a consequence of the teacher being more aware of the students—conscientiously or not—after having recently identified these students to me.

This increased incidence of interactions with the high- and low-performing students remains true for each of the six categories. Mrs. Carraway interacted more frequently with both the high-performing student and the low-performing student than with the other male students in the class in each of the categories of interest. This is not true, however, when compared to interactions with the female student, who is also perceived to be an average performing student by the teacher.

When compared to the average performing male students, the female student experienced substantially more total interactions and interactions demonstrating cognitive sensitivity. This is also true on a smaller scale when compared to the high and low performing students. However, it is interesting to note the gender difference that appears when comparing the intermediate level of students, as perceived by teachers. These students, perceived to be average performers, experienced considerably different numbers and types of interactions with the teacher. This indicates that the gender of the student has an impact on the teacher–student interaction, even when teachers' perceptions are taken into account.

Chapter 5: Conclusion

In this final chapter, I discuss the implications that this research has for secondary mathematics education practice. I explain how teachers' understanding of the findings of this study may impact their interactions with students in the classroom. I also discuss the limitations of my research and suggest further research.

Implications for Practice

In chapter 4, I discuss the more substantial findings from my research in terms of the second and third research questions. Understanding these findings can impact the practice of secondary mathematics classroom teachers by creating more awareness of the differences in the types of interactions that occur.

Teachers may be unaware of any differences that exist in their interactions with students. Thus understanding that they interact with one gender more than the other may allow them the opportunity to change their classroom interactions. Teachers may want to be sure that students of each gender receive an equal opportunity to communicate with the teacher. Therefore, they may be more actively thoughtful about the students with whom they choose to initiate interactions.

It is possible that teachers believe that students require different types of interactions based on gender. For example, I found that the teachers employed a type of positive affective sensitivity with male students but not with female students. This may be a purposeful decision by teachers who believe male students need more prompting and physical involvement than female students to remain engaged in class. Even though this difference may be deliberate, it is advantageous for teachers to be aware that it occurs.

An implication of this research that has great consequence is the influence of teachers' perceptions on their interactions with students. I found that teachers more frequently interacted with the students perceived as high and low performing than with other students in the class. It is unclear whether teachers are intentionally interacting with these students more often because of their perceived performance or if teachers' perceptions are unknowingly influencing their interactions. In either case, it is important for teachers to understand how their perceptions of their students influence their interactions with students. The teacher–student interaction impacts student learning, and so teachers need to be aware of things that may have an effect on their interactions with students.

Limitations of the Study and Suggestions for Further Research

My study had several limitations that restricted the data I was able to collect. I intended to research how effects of teachers' perceptions of students on the teacher–student interaction differed based on the students' gender. The class that I observed made it impossible for this to be researched fully. Because there was only one female student, it was difficult to obtain information about gender differences in teachers' perceptions of students. This complicated the study because it was then difficult to see whether these perceptions influenced interactions differently by gender.

Additionally, having one female student in the class makes it difficult to determine if gender differences in the teacher–student interaction occur because of students' gender or because of the personality and participation of this single student. In an interview, Mrs. Carraway described the teacher as being of average performance. She also stated a belief that this female student is typical of most average performing female students that she instructs. This

helps me to believe that the differences may be related to the student's gender. We cannot be sure, however, whether the differences seen are truly based on gender. There is no way to control students' personality traits in this study. However, a larger sample size in further research would help to be more conclusive about differences that exist.

Another limitation of this study is that I was unable to gain teachers' perspective of their interactions with students. While I found differences, it is unclear whether these are deliberate or unintentional. To investigate this idea further, I suggest that questions be included in the initial and final interview to address teachers' beliefs about their interactions with students. This will increase the understanding of teachers' role in influencing the teacher–student interaction.

Through conducting this research, I uncovered a need for further study into teacher–student interactions as they differ by gender. My research suggests that teachers more frequently interact with female students, both in total and in instances of cognitive sensitivity. However, I also found that female students more frequently initiate the interaction with the teacher. While more research is needed to overcome the limitations of this study, it is important for teachers of secondary mathematics to be aware of these findings. The interactions between teachers and students have a substantial impact on students' experience with mathematics, and so having a better understanding of what influences these interactions can help both current teachers and myself as a future educator to provide students with the opportunity to experience mathematics in the best way possible.

Appendix: Interview Questions

Initial Interview:

LESSON GOAL AND CONTENT

What is the mathematics topic of the class that I will observe?

How would you describe the overall achievement level of the class period that I will observe? What will students learn about <the topic>?

Would you outline your plan for what should happen today?

STUDENT AUDIENCE

How many students are in the class period that I will observe? How many are female? How many are male?

Can you identify a low performing female student in the class? and a low performing male student? What about the performance of these students tells us that they are low performing mathematics students?

Can you identify a high performing female student in the class? and a high performing male student? What about the performance of these students tells us that they are high performing mathematics students?

LOGISTICS

Where would be an appropriate place for me to sit? Where would be a good place for me to place the audio recorder?

Do you plan on using any kind of materials? If the answer is "yes," follow up with questions designed to let me learn more about what to expect, such as: May I see or have a copy of the material? May I see the physical model?

In the post-observation interview, I will ask questions to clarify any moments that occurred during the class periods that I as an outsider am unsure of as they relate to the general classroom procedures. Here are some examples:
If a teacher or student refers to a problem from a previous class, such as "the lemonade problem," without describing or providing the problem, I would ask, "What is 'the lemonade problem?"

If a teacher writes mathematical symbols on a paper while working with a group, I could ask, "What did you write when talking to the group <by the door, near the window>?

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ACADEMIC VITA of Samantha Elizabeth Timlin

Samantha Elizabeth Timlin
603 Meadow Creek Lane
Kennett Square, PA 19348
s.timlin42@gmail.com

Education: Bachelor of Science in Secondary Education, Penn State University, Spring 2012

Honors in Curriculum and Instruction

Thesis Title: Gender-Specific Differentiation of Teachers' Perspectives of and Interactions with Students

Thesis Supervisor: Dr. Rose Mary Zbiek

Related Experience:

Student Teaching at Norwin Middle School
Supervisor: Dr. Janet Bobango
Fall 2011

Pre-Service Student Teaching at Tuscarora Junior High School
Supervisor: Mrs. Mary E. Young
Spring 2011

Awards/Honors:

Dean's List (Fall 2008 - present)

Donald B. and Mary Louise Elder Tait Scholarship in Mathematics Education (2011-2012)

Praxis Recognition of Excellence Award (2011)

Activities:

Volé, the Penn State Ballet Club (2008 - present; Treasurer, 2010 - 2011)