11-12-2013

A Q-Methodology Approach to Investigating the Relationship Between Level of Reflection and Typologies Among Prospective Teachers in the Physics Learning Assistant Program at Florida International University

Geraldine L. Cochran
Florida International University, gcoch001@fiu.edu

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

A Q-METHODOLOGY APPROACH TO INVESTIGATING THE RELATIONSHIP

BETWEEN LEVEL OF REFLECTION AND TYPOLOGIES AMONG PROSPECTIVE

TEACHERS IN THE PHYSICS LEARNING ASSISTANT PROGRAM AT FLORIDA

INTERNATIONAL UNIVERSITY

A dissertation submitted in partial fulfillment of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

CURRICULUM AND INSTRUCTION

by

Geraldine L. Cochran

2013

To: Dean Delia C. Garcia
    College of Education

This dissertation, written by Geraldine L. Cochran, and entitled A Q-Methodology Approach to Investigating the Relationship Between Level of Reflection and Typologies Among Prospective Teachers in the Physics Learning Assistant Program at Florida International University, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

_____
Leonard Bliss

_____
Laird H. Kramer

_____
Eric Brewe, Co-Major Professor

_____
David T. Brookes, Co-Major Professor

Date of Defense: November 12, 2013

The dissertation of Geraldine L. Cochran is approved.

_____
Dean Delia C. Garcia
College of Education

_____
Dean Lakshmi N. Reddi
University Graduate School

Florida International University, 2013

DEDICATION

To William Earl Cochran

ACKNOWLEDGMENTS

I would like to acknowledge those whose support made this possible. This is not an exhaustive list of names. For all who have supported, encouraged, and guided me in my academic career and pursuit of scholarly activities, please, know that you are appreciated!

I would like to begin my thanks with my committee members. Dr. Eric Brewe, thank you for pushing me to stick to my timeline. Life threw me a number of twists and turns as you know, but you held me to the goal that I set from the very beginning. I smile now thinking about the couple times I "should have listened to you." You stuck with me. Thank you! Dr. David Brookes, you're awesome! You consistently set the highest of expectations for me. You have mentored me, supported me, and encouraged me through this entire process. I am so grateful!!! Dr. Leonard Bliss, thank you kindly for your support, your guidance, your honesty, your sense of humor, and your open door. I have grown to love research design and I am getting even better at critiquing the work of others. ☺ I look forward to our next discussion! Dr. Laird Kramer, I have learned a lot from you. "Always model good behavior and do not reward bad behavior." Thank you for telling me and showing me this multiple times. I think I have finally internalized it. Thank you for also being understanding. I have met very few people who "get it" and understand the complexity of having personal, academic, and spiritual lives that do not always mesh well!

To my mentors, thank you all! Dr. Mel Sabella, I recall the very first day I walked into your office at age seventeen. You have mentored and inspired me for more than a decade now. You have supported, guided, and encouraged me in my every

v

endeavor! I cannot put to words the impact you have had on my academic career and my life. I am confident that I would not be where I am today without you. Thank so very much!!! Leanne Wells you are a perfect friend and perfect boss! Absolutely fantabulous woman! Dr. Claude Brathwaithe, Dr. Kim Coble, Dr. Kathy Anne Jordan, Dr. Kelvin Gilchrist, Dr. Justin Akujieze, Dr. Mary Atwater, Dr. Malcolm Butler, Dr. Joyce Hilliard-Clark, Dr. Cornelius Williams, Dr. Roosevelt Johnson—my biggest fan, Romi Lowe, and so many more. I have been very fortunate to have so many mentors and positive people in my life.

I would like to thank so many supporters and friends at Florida International University. To begin with, Go Team!, Dr. Idaykis Rodriguez and Natan Samuels, thank you so much!!! I wish I could bring you all and the gazebo with me everywhere. I would also like to thank Jessica Bartley, if only we had more time… and more food, and more music. ☺ Dr. Adrienne Traxler thanks for the poptart talks. Dr. Renee Michelle Goertzen, I will carry so much of your advice with me forever. Thank you! Binod Nainabasti, I still can't belive your jokes are better than mine! Thanks for the support. Dr. Vasthi Sawtelle, you're an excellent teacher and an awesome person. I appreciate having had the opportunity to work with you. Jonathan Mahadeo, the overachiever! Thanks for inspiring me to stop procrastinating. You set a high bar! Sean Stewart, you rock! Thank you, thank you, thank you, and thank you again! It would take pages to thank you for all the things you helped me with. Let it be known, you are appreciated! D-D-D-DJ! Thank you. You brought your years of experience and tireless spirit to so many activities and work I engaged in at FIU. Thank you! Seth, thank you for the listening ear and the delicious food you brought to Alaska each week. You helped me

survive, literally. Thank you to all of the members of the Physics Education Research Group at Florida International University. Thank you Dr. Sonja Montas-Hunter, Dr. Isadore Newman, Dr. Linda Bliss, Caprila Almeida, Katie Schmidbauer, Rawha Mehari, Dr. Flavia Iuspa, Dr. Participa Barbetta, Chaundra Whitehead, Dr. Tonnette Rocco, Maria Test, Susy Torres-Vivas, Robert Brown, and Princess Briggs.

To my family, thank you all! Daddy you toughened me up and prepared me for anything! Mom, "we *will do* great things!" Sarah, you made me laugh when I wanted to cry and cry from laughing so hard! You make everything in my life so much better. Tina, thank you for the support! Deja Symone Scott-Ponton, you are my life's greatest joy! From the very day you were born you brought nothing but joy to my life. I love you unconditionally! Ryan Junior, you are a genius. You *will do* great things! Continue to inspire! G-Mama, I wish I could have talked to you these last few years. Thank you for the time we were able to spend together! It was not enough. I miss you so much! To Jerri Allen, my other mother, you picked me up when I was broken. You're a "heap of woman!" And, yes, this was the best way to give birth! ☺

Thank you to my friends! Esther Joseph, Tangie Gray Fleming, Summer Jones-Chapman, Dr. Fernanda Pineda, Yalda Amir, Mildred Boveda, Ling Ding, Heather Young, Virginia L. Hayes, Melissa Nickerson, Jennifer Hoyte, Melissa Davis, Xuan Jiang, Belarmino Gonzalez, Manuel Vilchez, Elizabeth Willis, Ildiko Barsony, Angela Moore, Alison Wynne, and Nancy Medina.

To the artists who have used their talents to create music that inspires, thank you! Research speaks to the power of positive affirmations. My life speaks to the power of music. Mos Def, I hope that I will use my talents to inspire and motivate others the way

your music inspires and motivates me. "Shine your light on the world! Shine your light

for the world to see." "There is a way!"

ABSTRACT OF THE DISSERTATION

A Q-METHODOLOGY APPROACH TO INVESTIGATING THE RELATIONSHIP

BETWEEN LEVEL OF REFLECTION AND TYPOLOGIES AMONG PROSPECTIVE

TEACHERS IN THE PHYSICS LEARNING ASSISTANT PROGRAM AT FLORIDA

INTERNATIONAL UNIVERSITY

by

Geraldine L. Cochran

Florida International University, 2013

Miami, Florida

Professor Eric Brewe and Professor David T. Brookes, Co-major Professors

The purpose of this mixed methods study was to understand physics Learning Assistants' (LAs) views on reflective teaching, expertise in teaching, and LA program teaching experience and to determine if views predicted level of reflection evident in writing. Interviews were conducted in Phase One, Q methodology was used in Phase Two, and level of reflection in participants' writing was assessed using a rubric based on Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" in Phase Three.

Interview analysis revealed varying perspectives on content knowledge, pedagogical knowledge, and experience in relation to expertise in teaching. Participants revealed that they engaged in reflection on their teaching, believed reflection helps teachers improve, and found peer reflection beneficial. Participants believed teaching experience in the LA program provided preparation for teaching, but that more preparation was needed to teach.

Three typologies emerged in Phase Two. Type One LAs found participation in the LA program rewarding and believed expertise in teaching does not require expertise in content or pedagogy, but it develops over time from reflection. Type Two LAs valued reflection, but not writing reflections, felt the LA program teaching experience helped them decide on non-teaching careers and helped them confront gaps in their physics knowledge. Type Three LAs valued reflection, believed expertise in content and pedagogy are necessary for expert teaching, and felt LA program teaching experience increased their likelihood of becoming teachers, but did not prepare them for teaching.

Writing assignments submitted in Phase Three were categorized as 19% descriptive writing, 60% descriptive reflections, and 21% dialogic reflections. No assignments were categorized as critical reflection. Using ordinal logistic regression, typologies that emerged in Phase Two were not found to be predictors for the level of reflection evident in the writing assignments.

In conclusion, viewpoints of physics LAs were revealed, typologies among them were discovered, and their writing gave evidence of their ability to reflect on teaching. These findings may benefit faculty and staff in the LA program by helping them better understand the views of physics LAs and how to assess their various forms of reflection.

TABLE OF CONTENTS

CHAPTER   PAGE

LIST OF TABLES

CHAPTER I

INTRODUCTION

In the previous decade, a weighty responsibility has been laid on teacher educators: The recruitment, preparing, and supporting of prospective science teachers for the purpose of ensuring an equal and high quality level of science education to all students. Although there has been a longstanding need for science teachers in America, this deficit was highlighted by the Committee on Prospering in the Global Economy of the 21st Century and the Committee on Science, Engineering, and Public Policy in the 2007, *Rising Above the Gathering Storm* (Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science Technology and Committee on Science, Engineering, and Public Policy, 2007). The committee was asked to identify

> the top 10 actions, in priority order, that federal policy makers could take to
> enhance the science and technology enterprise so that the United States can
> successfully compete, prosper, and be secure in the global community of the 21st
> century? (p. 2)

The committee's response was that the highest priority be assigned to annually recruiting 10,000 science and mathematics teachers.

Policy reflects the need for recruiting highly qualified teachers in particular. The *No Child Left Behind (NCLB) Act of 2001* required that schools hire highly qualified teachers with the purpose of providing a high quality education to all students and closing the gaps between minority and nonminority students, disadvantaged children and their

more advantaged peers, and low-performing and high-performing children (No Child Left Behind Act of 2001, 2004, emphasis added). In a letter to chief state school officers, Education Secretary Margaret Spellings wrote, "As you know, *No Child Left Behind (NCLB)* recognized that teacher quality *is one of the most important factors* in improving student achievement and eliminating achievement gaps between our neediest students and their more advantaged peers ..." (Spellings, 2007, emphasis added). In section 201 of The NCLB Act institutions of higher education are charged with recruiting and preparing "teachers who have the necessary teaching skills and are highly competent in the academic content areas in which the teachers plan to teach, such as mathematics, science, English, … [and other disciplines]" (No Child Left Behind Act of 2001, 2004).

Teacher quality and teacher preparation are still major concerns. In the Obama Administration's *A Blueprint for Reform: The Reauthorization of the Elementary and Secondary Education ACT* (BRRESA), it is stated that "we need more effective pathways and practices for preparing, placing, and supporting beginning teachers and principals in high-needs schools" (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). In his introduction to the BRRESA, President Obama linked teacher quality or effectiveness to student achievement. He said that we

>must have a great teacher in every classroom and a great principal in every school. We know that from the moment students enter a school, *the most important factor* in their success is not the color of their skin or the income of their parents—it *is the teacher at the front of the classroom.* (p. 1)

In regard to the role that teacher preparation plays in student achievement, the results of research have been in agreement with policy.

With the initiation of *Teach for America* and other alternative certification programs, several studies have been conducted on the relationship between teacher preparation and teacher effectiveness of student achievement. Many such studies indicate that teacher preparation is an important factor in student achievement (Clotfelter, Ladd, & Vigdor, 2009; Harris & Sass, 2007; Neild, Farley-Ripple, & Byrnes, 2009). Clotfelter et al. (2010) used 10th graders' North Carolina End of Course exam scores in their investigation. They found that "subject-specific certification, particularly in math and English, generate higher student achievement … and that, at least during their initial years of teaching, lateral entry teachers on average are less effective than teachers with regular licenses" (p. 675). Neild et al. (2009) analyzed middle grade students' learning gains in math and science in a large-city district and found that in science "students with secondary certified teachers substantially outscored those whose teachers had elementary certification, special education certification, another certification, or no certification at all" (p. 754). Harris and Sass (2007) used student-level achievement test data in Florida for Grades 3-10 over the course of 5 years in their investigation of teacher training and quality and concluded that

> colleges of education might improve the performance of the graduates, and
> schools might improve the productivity of existing teachers, by placing somewhat
> greater emphasis on content knowledge, including that which is pedagogically
> oriented [based on] the apparently positive effects of content-oriented courses in
> teacher preparation programs (p. 29)

These results indicate that teacher preparation is critical to student achievement (see also Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005).

Background of the Study

To answer the call for more qualified science teachers, the University of Colorado Boulder developed a Learning Assistant Model. According to Otero, Pollock, and Finkelstein (2010), the model "engages both physics faculty and education faculty in addressing the national challenges in science education" (p. 1218). The Learning Assistant Model translates into a program that hires undergraduate students as learning assistants (LAs). The program is specifically designed to identify, recruit, and train undergraduate students with a strong background in the sciences who are open to considering teaching as a career. During their first semester in the program these promising undergraduate students work as LAs in science and mathematics courses and simultaneously take a course on science education theory. Thereafter, they may continue to work in similar courses or more advanced courses. LAs are undergraduate prospective and preservice teachers who assist their peers in learning by facilitating group discussion, tutoring, and leading small group instruction sessions. Prospective teachers are students who are considering teaching as a career. Preservice teachers have committed to teaching as a career by enrolling in an education program or selecting education as a minor. As a part of the program, "LAs learn about the complexity of the problems involved in public science education and their potential roles in generating solutions to these problems" (p. 1220). One approach for accomplishing this as a part of the LA program is reflective practice. In teaching, reflective practice involves intentional thinking about and investigation of situations, actions, and consequences as a means for improving the practice of teaching. During reflective practice teachers reflect back on previous action

and make decisions that will guide future action in an endeavor to hone their teaching skills, improve instruction, and negotiate competing goals or responsibilities.

Over the last few decades, reflection has taken on an important role in teacher education and become an integral part of teacher education programs (Gore, 1987; Olson & Finson, 2009; Valli, 1997). Helping LAs to develop as reflective practitioners is an underlying goal of the LA Program. Teacher education programs have sought to encourage, promote, and develop reflective thinking and reflective practice in preservice teachers by means of a variety of pedagogical techniques, tools, and strategies including, but not limited to: cognitive coaching (Barnett, 1995), portfolios (Lyons, 2010), action research (Gore & Zeichner, 1991), and journaling (Moon, 2006).

Problem Statement

Although the Colorado LA Model was recently developed, the creation of programs based on the model has expanded rapidly. The first program was initiated in 2003 at the University of Colorado Boulder and the program has been fully implemented by at least five universities nationally (Otero et al., 2010) and at least 42 additional institutions (Finkelstein, 2012) have emulated the model by establishing LA programs. There is currently limited research investigating the effectiveness of this program in helping prospective science teachers to develop reflective practice. This study was undertaken to contribute to the body of literature on LA programs, and in particular the reflective practice of LAs, by means of a mixed methods design.

Purpose of the Study

The purpose of the study was to understand physics LAs' views on reflective teaching, the development of expertise in teaching, and their teaching experience in the

LA program and to determine if this is a predictor of the level of reflection evident in their writing. Although the LA program is designed to provide LAs with opportunities for developing reflective teaching practices, LA attitudes toward the program, reflective teaching, and the development of expertise in teaching may be important factors in determining what they will actually gain from the program. According to research by Ajzen and Fishbein (1972), a person's behavior intentions—and, therefore his or her overt behaviors—are significantly affected by his or her attitude toward the action and his or her belief about others' expectations. Thus, it is important to know how LAs understand the purpose of the LA program and if their views are aligned with the theoretical frameworks underlying the importance of the LA program.

In the first phase of the study physics LAs' views on reflective teaching, development of expertise in teaching, and teaching experiences in the LA program will be investigated by means of semi-structured interviews. The interview protocol consists of six main questions and several sub-questions regarding reflective teaching, development of expertise, and teaching experiences in the LA program. Interviews will be coded using a priori and inductive codes. Q methodology will be used to determine typologies among the physics LAs in regard to their views on reflective teaching, expertise in teaching, and their teaching experience in the LA program. Q methodology as a framework includes: a Q-sort, correlation, and factor analysis. This methodology allows for the determination of typologies or profiles of the participants based on their subjective sorting of items. This constituted the second phase of the study. In the third phase of the study physics LAs wrote two reflective assignments based on videos of LAs at a different institution assisting students during completion of an Open Source Tutorial

6

(Elby et al., 2013) similar to what is used at FIU. Their written assignments were analyzed using a rubric based on Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" to determine the level of reflection evident in their writing. The results of phases two and three of the study were then used to determine if typologies among the LAs were predictors for the level of reflection evident in their writing.

Research Questions

The following research questions will be addressed in this study:

1. What are physics LAs views on reflective teaching, development of expertise in teaching, and their teaching experience in the LA program at FIU?

2. What typologies exist among physics LAs participating in the LA program at FIU with regard to reflection on teaching, development of expertise in teaching, and their experience in the LA program?

3. Using a rubric based on Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing," what percentage of writing assignments submitted by participants will be characterized as having evidence of reflection?

4. Do factors determined by physics LAs' typologies predict the level of reflection evident in their writing?

Hypotheses

The hypotheses for the study are listed below. Research questions one and two are exploratory in nature and require no hypotheses.

1. (For Research Question #3) Using a rubric based on Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" at least 66% of the writing submitted by physics LAs will be characterized as having evidence of reflection.

2. (For Research Question #4) Analysis of ordinal logistic regression models will indicate that there is a set of factors determined by the physics LAs' typologies that produce a significant prediction of participants' level of reflection.

Physics LAs at Florida International University

FIU is a young university, established in 1965. It welcomed its first group of students in 1972. It is now a large university with over 1000 faculty that serves over 46,000 students (About FIU document, 2011). FIU is classified as an Hispanic-Serving Institution with 61% of the study body being Hispanic. It also serves students who are economically disadvantaged. Nearly 50% of undergraduate students receive financial aid and 60% of this group come from families with annual household income under $30,000 (p. 2). It is also classified as a commuter school. Though a fairly new university, FIU is classified as a research university. Moreover, research is a major component in the mission of the school. Physics LAs at FIU are a unique and desirable group to study for the following three reasons:

1. Most of the education reforms and research-based curriculum in physics education research are developed at traditional, research universities. Thus, it is important for researchers to test these tools at non-traditional universities that serve underrepresented students (Sabella, 2002; Sawtelle, Brewe, & Kramer, 2009; Wells et al., 2008). The Colorado LA Model was developed at the

University of Colorado-Boulder (UCB) and most of the research on it has been conducted at UCB. Being that FIU is a minority serving institution and the LAs are representative of the population at the university—69% of all LAs are Hispanic, physics LAs at FIU are a desirable group to study.

2. One of the major goals of LA programs based on Colorado LA Model is to prepare prospective and preservice teachers for teaching. Being that 50% of new teachers in Miami-Dade County receive degrees from FIU and FIU as an institution seeks to increase the number of highly qualified physics teachers in the Miami-Dade schools, FIU is an ideal location for this study.

3. Limited research on LA programs at FIU has been conducted. Research conducted on the physics LA program at FIU indicated that the implementation of LA programs along with open source tutorials have resulted in gains in student conceptual understanding in introductory physics courses (Goertzen, Brewe, Kramer, Wells, & Jones, 2011). Research on the LA program at FIU also indicated that physics, chemistry, and mathematics LAs are able to reflect on their teaching, as evident through their writing (Cochran et al., 2012). The current study was designed to contribute to this limited body of research on the physics LA program at FIU.

Theoretical Background

As a foundation for the study two models on reflection, a theory on expertise, and one program model were considered. To begin with, Dewey's model of reflection is provides a foundation for the understanding of reflection and indicates why reflection should be taught. Donald Schön's model of reflective practice highlights the importance

9

for practitioners to be reflective in their practice and applies specifically to teachers among other professions. A theory on expertise explains why reflection is an important skill for preservice teachers. Finally, the Colorado Learning Assistant Model aims to help prospective science teachers to develop as reflective practitioners.

Dewey's Model of Reflective Thinking and Action

According to Dewey reflective practice is something that must be taught. John Dewey is considered by most to be the father of reflection. The fact that Dewey is the key originator of the concept of reflection is not disputed in the literature on reflection (Carson & Fisher, 2006; Gore, 1987; Hatton & Smith, 1995; Valli, 1997). He initiated the conversation on reflection in his work, *How We Think and Act* (1933). In this work, Dewey characterized different modes of thinking. He asserted that reflection or reflective thinking is a special kind of problem solving that involves framing and reframing problems. He says that, "*active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends* constitutes reflective thought" (p. 9, italics original). According to Dewey, it is this kind of reflective thought that leads to reflective action.

Dewey (1933) asserted that in order to engage in reflective thinking one must be trained. In his discussion of reasons for training thought he said that, "thought needs careful and attentive educational direction" and he spoke to the "need of systematic training" (p. 22). However, he made the need for teaching reflection even clearer in his statement that "while we cannot learn or be taught to think, we do have to learn *how* to think well, especially *how* to acquire the general *habit* of reflecting" (p. 35, italics original). Thus, if prospective teachers are going to develop reflective teaching practices

it is the responsibility of teacher education programs to train them to engage in reflective

thinking and action. The connection between Dewey's work on reflective thinking and

action and reflection in teacher education is clear (Carson & Fisher, 2006; Gore, 1987;

Spalding & Wilson, 2002). This is illustrated in Valli's (1997) statement that "most

educators who write and do research about reflective teaching and teacher education

acknowledge their debt to John Dewey" (p. 68). Dewey's discussion of reflective

thinking and reflective action in teaching provided a sound basis for why reflection is a

necessary component for preparing prospective science teachers.

Schön's Model of Reflective Practice

Donald Schön has also been a major influence on reflection in teacher education.

He has been instrumental in laying a foundation for our understanding of reflection.

Whereas Dewey laid the foundation for reflective thinking, Schön laid the foundation for

reflective practice (Spalding & Wilson, 2002). Schön (1983) highlighted the need for

professionals to be reflective practitioners. He specifically applied this need to teachers

saying:

> Practitioners are frequently embroiled in conflicts of values, goals, purposes, and
>
> interests. Teachers are faced with pressures for increased efficiency in the context
>
> of contracting budgets, demands that they rigorously "teach the basics,"
>
> exhortations to encourage creativity, build citizenship, help students to examine
>
> their values. (p. 17)

As mentioned in the introduction, teachers are faced with numerous demands. Schön's

model of the reflective practitioners served as a conceptual framework for understanding

reflection as an approach for making decisions that are important—and often made on-

the-spot— while remaining cognizant of one's responsibility to several—sometimes competing—stakeholders.

Schön's (1983) model of *reflective practice* included reflection-in-action and reflection-on-action. For Schön, reflective practitioners reflect-in-action when in the course of their practice they are faced with a phenomenon and reflect on the phenomenon and respond with an action that is not necessarily based on theory or traditional, prior knowledge in their field. Reflection-on-action, on the other hand, takes place after reflection-in-action. After having acted in response to the phenomenon, people reflect on how they recognized the phenomenon and their response to the phenomenon. According to the model, this practice of reflecting in and on action will guide future action. In her discussion of the use of reflective journals in teacher education and nursing education, Moon (2006) made a connection between Schön's description of reflective practitioners and the demands of the teaching and nursing professions:

> Both professions rely on interpretive knowledge, which is socially constructed and not rooted in a body of 'fact' (Schön, 1987). Both also rely on decisions made 'on the spot' with unpredictable situations being relatively common. Action is what counts, but the consequences of action can be critical. (p. 72)

The connection between Schön's framework of the reflective practitioner and the teaching profession is clear: reflection is important for the purpose of influencing future action and teachers are in a profession that requires that weighty decisions be made quickly.

The Theory on Expertise

Although the reflective practitioner model describes a form of deliberate practice for teachers and other professionals, it is the theory on expertise that explains why it is important: Deliberate practice leads to the development of expertise. The theory on expertise explains what differentiates those who perform outstandingly in a domain from those who do not (Ericsson & Smith, 1991). Expertise has been studied in numerous and varying domains (Ericsson, Prietula, & Cokely, 2007). An important contribution of the research on expertise is the conclusion that experience alone does not lead to expert performance. Rather, it is years of "deliberate practice" that transform a novice into an expert. The importance of deliberate practice in developing expertise has been studied in the fields of chess (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005), sports (Hodges, Kerr, Starkes, Weir, & Nananidou, 2004), literary skills (Bereiter & Scardamalia, 1986), and music (Sloboda, 2000).

According to Ericsson (2009), engaging in deliberate practice includes: performing tasks outside one's current realm of reliable performance, performing tasks that can be mastered within a reasonable amount of time, receiving immediate feedback on the tasks performed, and engaging in repetitive completion of the tasks with gradual modifications. In teaching, reflective practice as a prospective teacher—a novice in teaching—can provide the "deliberate practice" necessary to learn expert performance in teaching. Sparks-Langer and Colton (1991) divided reflection into three parts: the cognitive element of reflection, the critical element of reflection, and teachers' narratives. Their review of the literature on reflection in these three areas suggested that these areas of reflection may be the missing element that differentiates novice teachers from expert

teachers. Sparks-Langer and Colton argued that "we should teach novices the schemata of experts … expert teachers probably draw on their own contextually developed knowledge and prior case-experience to develop their own wisdom of practice" (p. 39). The tools necessary to develop the kind of reflective practice that turns into this wisdom of practice can be taught in teacher education programs. The importance of helping preservice teachers develop skills in reflection is that teachers can use these tools long after they have left their teacher education programs to develop expertise in teaching.

The Colorado Learning Assistant Model

The Colorado LA Model was developed at the University of Colorado-Boulder (Otero et al., 2010). LA programs are experiential learning programs, which provide teaching experience early in the academic career of students considering teaching as a profession. The programs are designed to supply these LAs with pedagogical knowledge, content knowledge, and teaching practice. These three components are designed to help the students develop pedagogical content knowledge. The mechanisms used to accomplish this include weekly meetings with faculty members, a weekly seminar on science education and theory, and opportunities to teach. According to Otero et al.:

> Through the collective experiences of teaching as a LA, instructional planning with a physics faculty member, and reflecting on their teaching and the scholarship of teaching and learning, LAs integrate their understanding of content, pedagogy, and practice, or what Shulman calls *pedagogical content knowledge,* which has been shown to be a critical characteristic of effective teachers. (p. 1219)

The LAs gain experience that allows opportunity for engaging in reflection as a part of the program. Physics LAs, generally, facilitate small group discussion and assist their peers in learning physics content during weekly laboratory activities in introductory physics courses. During faculty-led weekly content meetings, LAs receive practice in reflection-on-action as they review challenges and successes with their peers and reflect to guide future action as they prepare for the next week's laboratory activity. In the science education and theory course, students further reflect on problems faced in science education and how the results of science education research can be used to improve teaching. As a part of this course, LAs also submit weekly reflective writing assignments on course readings—papers on science education research—and their teaching experiences. These assignments are designed to help the LAs engage in reflective thinking and feedback on these assignments encourage LAs to engage in reflective practice and deeper levels of reflection.

Definitions of Terms

The following terms were used in this study or are relevant to the topic of this dissertation.

Q factor analysis is a technique used for grouping people (Newman & Ramlo, 2010). It is not to be confused with Q methodology, which relies on Q sorting of statements to determine groupings of people.

Q methodology is a framework used for grouping people. This framework includes Q sorting, correlation, and factor analysis. Confusion between Q factor analysis and Q methodology exists because the factor analysis included in Q methodology is sometime referred to as Q factor analysis (Newman & Ramlo, 2010; Ramlo, 2008a).

Q sorting is the term used for one of the steps in Q methodology. In this step participants sort a series of items into a normalized grid. When statements are the items used in the grid, participants sort the statements according to their agreement or disagreement with the statement.

Reflection-in-action, according to Schön (1983), includes knowing-in-action while thinking about phenomenon at present (p. 50). In describing part of the reflection-in-action process, Schön wrote that as one "tries to make sense of it [the phenomenon], he also reflects on the understandings which have been implicit in his action, understandings which he surfaces, criticizes, restructures, and embodies in further action" (p. 50). He went on to write that this is a part of "the 'art' by which practitioners sometimes deal well with situations of uncertainty, instability, uniqueness, and value conflict" (p. 50). Although Schön's terminology has been utilized in studies on reflection (Hatton & Smith, 1995; Valli 1997), many have expressed concern with the use of this vocabulary (Court, 1988; Eraut, 1994; Kirby & Teddlie, 1989; Moon, 2008). In this dissertation, aspects of what Schön terms "reflection-in-action" were used in what is referred to in this dissertation as reflective action.

Reflection-on-action, according to Schön (1983), includes "reflecting on patterns of action" (p. 55) …"in a mood of idle speculation, or in a deliberate effort to prepare … [for] future cases" (p. 61). Ryan (2010) asserted that the term "implies a delay between the original action and the reflection" (p. 113). He went on to write that it "operates through a careful examination of experience, beliefs and knowledge, where details are recalled and analyzed to gain fresh insights and take action if necessary" (p. 113). In this

dissertation, aspects of reflection-on-action are also included in what is referred to as "reflective action".

Reflective action encompasses aspects of both reflection-in-action and reflection-on-action. More specifically, it refers to decisions made on the basis of reflective thinking and as a result of reflective practice. It can be juxtaposed with routine action—that is, actions carried out without thought or consideration.

Reflective practices, as used in this dissertation, refers to any practice that promotes reflective thinking and reflective action. A variety of practices that foster reflection are found in the literature including, but not limited to: cognitive coaching (Barnett, 1995), portfolios (Lyons, 2010), action research (Gore & Zeichner, 1991), study groups, and journaling (Moon, 2006). The use of the term "reflective practice" should not be confused with Schön's (1983) use of "reflecting-in-practice" (p. 59), which is a combination of knowing-in-action, reflecting-in-action, and reflecting-on-action. Furthermore, reflective practice should not be confused with the use of the term "reflective teaching practice", which when used in this dissertation refers to routinely engaging in reflective teaching as a part of one's career.

R*eflective practitioner* is a term that was popularized in Schön's (1983) work *The Reflective Practitioner.* In this work Schön discussed the habits of practitioners and asserted that some practitioners engage in reflection as a part of their practice. He mentioned several characteristics of reflective practitioners and asserted that reflective practitioners engage in reflection-in-action and reflection-on-action. He also claimed that practitioners possess knowledge-in-action that is evident in their practice. In this dissertation, the term "*reflective practitioner"* denotes an individual who engages in

reflective practices (see reflective practice above) as a routine part of his or her profession.

Reflective teaching has been defined in a variety of ways in the literature (Korthagen, 1985; Valli, 1997; Zeichner & Liston, 1987). In this dissertation, the term *reflective teaching* will be used to indicate reflective action in the teaching profession. Thus, reflective teaching will refer to making decisions in teaching that are based on reflective thinking and a result of reflective practices.

Reflective teaching practice is similar to reflective teaching. It is used in this dissertation to refer to routinely engaging in reflective teaching or routinely engaging in reflective thinking and reflective practices that are meaningful to one's teaching. Reflective thinking and reflective practices are considered to be meaningful to one's teaching when they result in one making decisions that will guide future practice.

Reflective thinking was defined by Dewey (1933) as "*active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends*" (p. 9; italics original). In this dissertation, the use of the term reflective thinking will carry a similar thought. In short, reflective thinking will refer to consideration of beliefs, events, or claims for the purposes of understanding, justifying, or making sense of them.

Summary

This dissertation was written as a seven chapter dissertation. This first chapter provided an introduction to the study by means of the problem statement, the background for the study, details regarding the study, the conceptual frameworks used to research the problem, and definitions relevant to understanding the study. Chapter 2 is a review of the

literature. In Chapter 2 the literature on learning assistant programs is discussed, the

models of reflection used in this study will be discussed and their limitations are

addressed in reference to the current study, salient studies on deliberate practice and

expertise are reviewed, and a review of selected studies on reflection in teacher education

that motivated the current study are discussed. Chapter 3 outlines the mixed-method

design for answering the research questions of the study. Chapter 3 includes a statement

of the purpose of the study, the research questions to be addressed, and a rationale for the

related hypotheses. Chapter 3 also includes a discussion of the research approach chosen

for the study, a description of the participants and sampling procedures, a rationale for the

methodology chosen in this study, and details on the analysis used to understand the

results. Chapter 4 provides the data analysis and findings resulting from semi-structured

interviews in the first phase of the study. In Chapter 5 the results of Q sorts,

determination of a three-factor model, and interpretation of the factors are discussed.

Chapter 6 provides the data analysis and results of the analysis of the writing assignments

submitted by the participants. Finally, Chapter 7 summarizes the results of the entire

study and discusses its implications.

CHAPTER TWO

LITERATURE REVIEW

The following literature review discusses theoretical and empirical work that support the current study. The review consists of four major sections. The first section is a summary of the theoretical framework discussed in Chapter One. The second section is a review of the literature on expertise in relation to the current study. Section Three is a discussion of limitations and criticisms of the models of reflection and how these will be addressed in the current study. This section also includes empirical studies related to reflection in teacher education. The fourth section is a review of empirical studies on Learning Assistant Programs (LA programs). The literature review concludes with a summary and a statement of the aims of the current study.

Theoretical Framework

The foundation for this study is based on two models of reflection, the theory on expertise, and the model for the LA program. Dewey's model of reflection provides an understanding of reflective thinking and an explanation for why preservice teachers should be taught to be reflective. Schön's model of reflection provides a basis for reflective action and why professionals should reflect on their practice in ways that will inform future action. The theory on expertise explains why reflective practice is an important tool for novice teachers. Finally, the Learning Assistant (LA) model provides a structure for engaging preservice and prospective teachers in reflective thinking, reflective action, and teaching experiences that allow for reflective practice. The purpose

of this literature review is to consider relevant literature related to this theoretical

framework.

The Theory on Expertise

The initiation of expertise as a research field is generally attributed to Chase and

Simon. In 1973 Chase and Simon explored expertise in the field of chess in their work

"The Mind's Eye in Chess" (Chase & Simon, 1973). Since then, the field of expertise

has evolved quite a bit. Moreover, the definition of expertise has changed. Expertise was

originally thought to be something that didn't come naturally. The "extra" that some

people possess in some fields. In 1986, Bereiter and Scardamalia wrote that "the need for

expertise … [is] the need for knowledge and skills that do not arise naturally through

experience. Expertise is now seen in terms of what differentiates the general public—

novices—from the very few that outperform them—the experts. In 1991, Ericsson and

Smith wrote that "the study of expertise seeks to understand and account for what

distinguishes outstanding individuals in a domain from less outstanding individuals in

that domain, as well as from people in general" (p. 2). Since it's initiation expertise has

been explored in a variety of fields including, but not limited to: sports (Hodges, Kerr,

Starkes, Weird, & Nananidou, 2004), music (Sloboda, 2000), literary skills (Scardamalia

& Bereiter, 1991; Wagner & Stanovich, 1996), chess (Charness, Tuffiash, Krampe,

Reingold, & Vasyukova, 2005), physics conceptual understanding (VanLehn & van de

Sande, 2009), problem solving in physics (Larkin, McDermott, & Simon, 1980), and

medicine (Patel, Groen, & Arocha, 1990; Boshuizen, 2009).   In the following sections,

we will discuss the results of research in expertise that are relevant to the current study.

In particular, the deliberate practice required to obtain expert performance, the 10-year

21

rule—the amount of time required to develop expertise, and problem solving ability—the

requirement for expertise in any field will be noted.

Deliberate Practice

      Hodges, Ker, Starkes, Weir, and Nananidou (2004) investigated expertise in

sports. Using a three-section questionnaire, Hodges et al. (2004) obtained information on

athletes biographical information, their current practice habits, and their training histories.

They found that accumulated practice estimates were the best predictors of performance.

Moreover, they found that hours spent in physical fitness related activities outside of

sport-specific practice in swimming, cycling, and running did not predict performance

times" (p. 227). These results indicate the importance of deliberate practice in obtaining

expertise in sports. Results indicating the importance of deliberate practice in developing

expertise have also been found in chess (Charness et al., 2005), medicine (Boshuizen,

2005), and music (Sloboda, 2000). According to Ericsson (2009) in deliberate practice

the expert performer must "be fully prepared for initiation of the task, be given

immediate feedback from the outcome, and then be allowed to repeat the same or similar

task with gradual modifications" (p. 416). Deliberate practice is also necessary for

developing expertise in teaching. In teaching, teachers are prepared to teach their lesson

in a variety of ways. In teaching, reflective practice requires that reflection on their

taught lesson provide them with feedback on their lesson and decisions and

determinations for future lessons. These decisions will also determine the gradual

modifications that will be made during future teaching experiences in which they

encounter that phenomena—rather that be the next time they teach that lesson, the next

time they encounter that difficulty, or the next time they teach a similar population of

students. This is what is referred to as reflection-for-action. In this way, each teaching

experience the teacher has can serve as training in their development of expertise.

The 10-Year Rule

According to Charness et al. (2005) "one needs about a decade of study in order

to acquire the necessary knowledge base to perform at very high levels of tournament

play" (p. 151) in chess. This is consistent with results in other fields (Bryan & Harter,

1899; Hayes, 1981; Ericsson, Krampe, & Tesch-Romer, 1993). As written by Ericsson

(2009), "even the most talented individuals, need to invest 10 years of active engagement

in a domain (10-year-rule) to become an expert" (p. 412). Because development of

expertise requires approximately 10 years, preservice teachers at not expected to gain

expertise before entering the field. Teacher education programs are generally only 4 or 5

years in duration. Moreover, preservice teachers may only engage in actual teaching

experiences for a year or two during their time in the program. This illustrate the

importance of helping preservice teachers to develop reflective practice during their time

in the program: reflective practice is a tool that preservice teachers can use long after

they have left the program to continue in their development toward expertise.

Problem Solving

Literary expertise is a unique field of expertise. In the majority of fields of

expertise, experts are known for their ability to perform faster than novices and recall

important, complex information faster and more easily than novices, and require less

attempts to perform correctly. However, this is not the case in literary expertise.

According to Scardamalia and Bereiter (1991) expert writers take more time to start

writing, have less access to what they have already written, and tend to write more

revisions than their novice counterparts. However, there is one key activity of expert writers that is common to and necessary for experts in all fields: problem solving. Scardamalia and Bereiter wrote that it "is the activity of constructing a problem representation – identifying and elaborating constraints, goals, relevant principles, and analogies" (p. 172). They also wrote that experts "acquire their vast knowledge resources not by doing what falls comfortably, within their competence but by working on real problems that force them to extend their knowledge and competence" (pp. 173,174). According to Schön, problem-solving of this kind is the purpose of reflective practice. Schön (1983) asserts that professionals are able to successfully practice in their profession when faced with phenomena and challenging cases by reflecting in and on action. He also differentiates reflective practitioners from those that rely solely on technical rationality by the ability of reflective practitioners to frame and reframe problems for the purpose of developing solutions to the problem and guiding future practice.

In summary, the theory on expertise provides a theoretical framework for understanding the role of reflective practice in teacher education. Reflective practice serves as the kind of "deliberate practice" that research on expertise has shown to be essential for developing expert performance. Furthermore, reflective practice is a tool that preservice teachers can use after they have left their teacher education programs. This is of importance because research on expertise indicates that it generally takes 10 years to develop expertise. Finally, the ability to perform successfully when faced with challenges or problem situations is essential for experts. Reflective practice is designed

to help teachers to perform successfully while faced with phenomena and to plan for successful future action when faced with the same or similar phenomena.

Models of Reflection

There are several models of reflection in the literature (Dyment & O'Connell, 2010). This section is a review of the models of reflection relevant to the current study. As discussed in Chapter One Dewey's process of Experiential Learning (1933) and Schön's Reflective Practitioner framework (1983) serve as conceptual frameworks for understanding reflection in this study. This section includes brief descriptions of the two models and a discussion of the limitations of these models. A more detailed look at Dewey and Schön's model in terms of its motivation of the current study is included in the sections on experience and attitude.

Dewey's Process of Experiential Learning

Dewey speaks of reflection as involving inquiring into a belief and searching for justification for acceptance of the belief (Dewey, 1933). Dewey refers to two stages of reflection: "(1) a state of doubt, hesitation, perplexity, mental difficulty, in which thinking originates, and (2) an act of searching, hunting, inquiring to find material that will resolve the doubt, settle and dispose of the perplexity" (p. 12). As mentioned in chapter one Dewey is considered the originator of the idea of reflective thinking and the foundation that he laid in this regard is credited in most models of reflection (Gore, 1987; Hatton & Smith, 1995; Valli, 1997).

Although Dewey's work is highly regarded in the literature, it has not escaped some criticism. Dewey's work has been accused of having a Western bias due to the little attention given to moral urgency and intuition by Valli (1997). However, Valli

acknowledges the rationale of Dewey's focus on cognitive, systematic aspects of reflection. She wrote that preparation, "for teaching has emphasized teachers' behaviors and skill development apart from thinking about those behaviors" (p. 69). There has been an emphasis on best practices and teaching skills more than the why and thinking behind theses. Thus, in this study I have relied on Dewey's model, specifically, for his ideas on reflective thinking, which is a critical component of preservice teachers' development of reflective teaching practices. In addition to this slight criticism of Dewey's model, limitations of his model have been discussed in the literature. The next section addresses some of these concerns.

Limitations of Dewey's Model

The major concern with Dewey's model of reflection is that it does not cover all aspects of reflection. That Dewey's model is a foundation combined with the fact that more recent models of reflection have expounded on his model, much of the literature focuses on the limitations of the more recent models. This is certainly the case with Schön's (1983) model of the reflective practitioner. Nonetheless, Hatton and Smith (1995) note four issues that arise as a result of the limitations of Dewey's model of reflection. These limitations and their relevance to the study will be discussed individually. However, many of them will be revisited in the section discussing the criticism's of Schön's model of reflection.

Action. The first issue noted by Hatton and Smith (1995) is the determination of whether reflection is limited to thinking about action or bound up in action. In regard to this issue, the current study relies on the models of both Dewey and Schön as conceptual frameworks for understanding reflection; and, therefore, consider reflective thinking that

takes place during action—or reflection-in-action—and reflective thinking that takes place apart from action—or reflection-on-action—to be reflection.

Time. The second issue identified by Hatton and Smith is a determination of when reflection should take place. McNamara (1990) argues that time is needed for teachers to think analytically about their work, but this likely cannot be done while they are in the classroom. Again, considering the conceptual frameworks for the current study, there is no preference for reflection that takes place during teaching, shortly after the experience, or long after an experience. Cochran, Brookes, Brewe, and Kramer (2012) found that Physics LAs at FIU engage in reflection at various times and in a variety of settings that is meaningful to their teaching. Moreover, it is not the aim of this study to distinguish between these various kinds of reflective activities. Thus, time is not a major consideration in this study. However, statements regarding time will be included in the Q sample given to participants.

Problem-based inquiry. Hatton and Smith identify determination of whether reflection is problem-based as an issue made apparent by Dewey's work. McNamara (1990) asserts that reflection should be concerned with the actual problems that teachers face in the study. The current study does utilize Dewey's claim that reflection is problem-based. However, in this study the definition of problem is extended to include understanding of phenomena. For example, in teaching understanding why a lesson went wrong is considered a problem, but understanding why a lesson went well is considered a problem as well. Thus, consideration of problem solving as a requirement for reflection does not limit the current study.

Critical reflection. Finally, the last issue addresses a determination of whether or not reflection should include a consideration of the broader contexts (i.e. social, political, and historical values and beliefs). Consideration of the broader contexts is usually referred to as "critical reflection." For Zeichner and Liston (1987) critical reflection is a requirement for reflection. Critical reflection and a consideration of the broader texts were seen as valuable in the current study. Thus, the current study used Dewey's model for a foundation for understanding reflection and utilizes Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing," as instrumentation for assessing reflection in writing, which includes the critical level of reflection. Furthermore, aspects of critical reflection are included in the Q statements to be used for the Q sort in the Q methodology phase of the study.

Schön's Reflective Practitioner Framework

According to Schön's (1983) model reflective practitioners possess two skills: the ability to reflect-in-action and the ability to reflect-on action. For Schön reflective practitioners reflect-in-action when, in the course of their practice, they are faced with a phenomenon and they reflect on the phenomena and respond with an action that is not based on theory or traditional, prior knowledge in their field. Reflection-on-action, on the other hand, takes place after reflection-in-action. After having acted in response to the phenomenon, people reflect on how they recognized the phenomenon and their response to the phenomenon (Schön, 1983). Schön's framework is similar to Dewey's idea of reflection in that they both require the framing and possible reframing of problems or phenomena as a part of reflective action. We rely on Schön's model of the reflective practitioner because this model provides a connection between present action

and future action. In her discussion of the use of reflective journals in teacher education

and nursing education, Moon (2006) makes a connection between Schön's description of

reflective practitioners and the demands of the teaching and nursing professions:

> Both professions rely on interpretive knowledge, which is socially constructed
>
> and not rooted in a body of 'fact' (Schön, 1987). Both also rely on decisions
>
> made 'on the spot' with unpredictable situations being relatively common. Action
>
> is what counts, but the consequences of action can be critical. (p. 72)

There is a clear connection between Schön's framework of the reflective practitioner and

the teaching profession because Schön discusses the importance of reflecting for the

purpose of influencing future action, which is vital in the teaching profession.

Criticisms of Schön's Model of Reflection

Unlike Dewey's model of reflection, Schön's model is designed to be a

theoretical framework for understanding reflection. Thus, many of the issues raised by

Hatton and Smith (1995) in regard to Dewey's model are sources of criticisms regarding

Schön's model. These issues will be revisited in this section. Dewey simply laid the

foundation and began the conversation in regard to reflection. Schön, on the other hand,

set forth a call to action. Furthermore, several education programs responded to Schön's

call for action. Thus, the limitations of Schön's model are highlighted in much of the

literature. The common criticisms of his model and their relevance to the current study

are discussed in this section.

Time. As with Dewey's model of reflection, time is an issue. It appears that

Schön does not take into account time when it comes to one's ability to engage in

reflection-in-action. As stated by Eraut (1994) "One important variable which Schön

effectively ignores is that of 'time'. When time is extremely short, decisions have to be rapid and the scope for reflection is extremely limited" (p. 145). Court (1988) asserts that when one is involved in "very demanding mental activity" it is difficult to engage in reflective thinking "without losing the thrust of one or both" (p. 145). Eraut (1994) illustrates this point by saying that "a teacher might need to respond rapidly in a classroom to a pupil's question or a disruptive action. If, however, we adjust this situation to one where the teacher is walking round a classroom of children quietly working on their own, the reflective process appears a little different" (p. 145). McNamara (1990) highlights this issue as well.

Critical reflection. When applied to education, a model on reflection must consider some of the issues integral to education (i.e. ethics, politics, values, etc.)—the broader contexts. These kinds of issues are related to what has been termed 'critical reflection'. Lauder (1994) criticizes Schön for not distinguishing "between practitioners who deal with inanimate objects … and practitioners who deal with human needs" (p. 92). Lauder (1994) argues that this has led to "the value system that underpins the latter not being explicated to any significant extent" (p. 92). In a similar vain, (2008) Moon argues that there needs to be a "concern for the universal—here, the principle of care contributing to the good of mankind" (p. 47). Gore and Zeichner (1991) criticize Schön for not including aspects of or requiring critical reflection in his model. They found that Schön did not have "much to say about what it is that teachers ought to be reflecting about, the kinds of criteria that should come into play during the process of reflection (e.g., what distinguishes good from unacceptable educational practice), and the degree to

which teachers' deliberation should incorporate a critique of the instructional contexts in which they work (Richardson, 1990)" (p. 120).

Terminology. The greatest concern with Schön's model of reflection is in regard to his terminology and the definitions he employs. Schön's definition of reflection-in-action is troubling in that it requires action to be taking place during the reflection. However, some of the examples he chooses to illustrate reflection-in-action imply otherwise (Court, 1998; Eraut, 1994; Moon, 2008). Furthermore, it is difficult to distinguish between his reflection-in-action and reflection-on-action (Court, 1988; Eraut, 1994; Moon, 2008). The terms 'reflection-in-action' and 'reflection-on-action' will not be differentiated in this study. I have chosen to use aspects of what Schön has described in both of these terms in my description of reflective action.

What has been especially troubling to critics in regard to Schön's definitions are his own inconsistencies. As stated by Eraut (1994), Schön "tends to stray away from his own definitions and evidence into making statements which are difficult to defend" (p. 143). Kirby and Teddlie (1989) note that "Schön's (1983) definition of reflective practice is presented in terms of other constructs also requiring definition" (p. 49). Moon (2008) is particularly troubled by this because "Schön fails to hold a consistent approach to the constructs such as reflection-in-action and reflection-on-action, which, as constructs, have been taken as models of practice by many researchers and commentators" (p. 46). Eraut goes on to say that Schön "does not have a simple coherent view of reflection but a set of overlapping attributes; and that he selects whichever subset of attributes best suits the situation under discussion" (p. 145). This results in difficulty when relying on terminology used in Schön's framework.

Although there seems to be many issues with the terminology that Schön uses, he does provide examples in the way of incidents and events to illustrate his points. However, as was noted by Eraut (1994), he does not include any counterexamples and he does not expound on the examples enough for the reader to determine what parts of the event constitute reflection and what parts do not. Schön's reliance on examples is also seen as a weakness because it appears that he chooses to proceed "mainly by example and metaphor rather than sustained argument" (Eraut, 1994, p. 143). Nonetheless, these examples and metaphors have impressed upon the minds of the readers what reflective practice may look like. Thus, it has been the goal of several programs to utilize this model in preparing teachers.

Implementation. Another major point of concern in regard to Schön's model of reflection is implementation in education programs. Harris (1989) argued that there were no institutional forms or structures that allowed for the development of the kind of practice of which Schön spoke. Lauder (1994) criticizes Schön for not providing a framework that could make implementation of his model more feasible in the nursing profession. Shulman (1988) expressed a similar concern when he wrote that "Schön argues for the creation of institutions that could be organized to foster the development of reflection-in-action. This is a worthy goal and one which I applaud. How one goes about creating such institutions, however, is a fascinating problem" (p. 35). However, since these criticisms in the late 1980s several education programs have adopted Schön's model. The problem in this regard is that the lack of a concrete framework—as suggested by Lauder—has resulted in numerous and varied programs that all claim to implement the program in education. Eraut (1994) says that one of the consequences of

Schön's (1983) book is "the proliferation of a wide variety of professional education programmes claiming to be based on his theory" (p. 148). He argued that this exists partly because of "the natural range of interpretations which results from putting any theory into use: but this natural variation has been exacerbated by the ambiguities and inconsistencies in Schön's theory" (p. 148). As a result of the diversity of programs aiming to encourage and promote reflection among preservice teachers, each program must be evaluated individually. Several studies have been conducted in this regard.

Dichotomies. The final critique of Schön's work to be considered is his use of dichotomies. Schön (1983) juxtaposes an epistemology of reflection with technical rationality. Schön describes technical rationality as "the dominant view of professional knowledge as the application of scientific theory and technique to the instrumental problems of practice" (p. 30). Schön argues against the dichotomy of theory and practice. However, Schön is accused of inducing a dichotomy between reflection-in-action and technical knowledge and science-based knowledge in his strong support for the importance of reflection-in-action in professional practice (Harris, 1989, p. 16). This was a cause of concern for Shulman too, who wrote, "I worry that his divided worlds are too neat, too clean—and quite misleading" (p. 33). In this study, a position is not taken on technical rationality versus reflective practice or whether or not the two are completely separate. This study relies on Schön's model of reflection as a conceptual framework because it is believed that reflective practices are important mechanisms for honing one's teaching skills and preparing for future action. Thus, reflective teaching is the focus of this study.

In this section, the models of reflection developed by both Dewey (1933) and Schön (1983) have been considered. Furthermore, the limitations and criticisms of these models have been discussed. It is not the goal of this study to overlook these issues, but to contribute to the body of literature on these issues by uncovering the perspectives of physics LAs in regard to these issues if possible. Because there are inconsistencies and some ambiguity with the terminology used in Schön's model of reflection, the terminology defined in Chapter 1 will be used in describing reflection in this study. Furthermore, in the Q sample terms relating to reflection will be avoided. Rather, statements describing reflection will be used instead. Although critical reflection appears to be left out of the two models used in the theoretical framework, the instrumentation to be used in the study, Hatton and Smith's (1995) "Criteria for Determining Types of Reflection in Writing" makes use of several models of reflection and includes critical reflection as the most difficult level of reflection to reach. Furthermore, aspects of critical reflection are also included in the Q sample to be used during the Q methodology phase of the study. Considerations of the timing of reflection are among the criticisms of both Dewey's model and Schön's model. In the current study, I do not attempt to address when reflection takes place. The purpose of the study is to understand physics LAs views in regard to reflective teaching. Although statements related to when reflection takes place will be included in the Q sample given to participants, it is not the focus of this study. The views of the participants in regard to expertise, reflective teaching, and teaching experience in the LA program, will determine the statements chosen for the Q methodology phase of the study and, thus, the topics covered in the study.

Reflection in Teacher Education

The literature on reflection in teacher education is vast. A search using the terms "reflection" and "teachers" yields 948,000 results on Google Scholar and 152,087 results on Proquest. The goal of this section is not to accomplish the daunting feat of thoroughly reviewing the literature on reflection in teacher education. Rather, the goal of this section of the literature review is to motivate the current study by highlighting the results of salient studies. This section will cover three topics: issues with promoting and assessing reflection in teacher education, success stories regarding reflection in teacher education, and critiques of education programs based on reflection.

Issues Regarding Reflection in Teacher Education

The emphasis on reflective teaching and reflective practice in teacher education programs has received much criticism (Cornford, 2002; Smyth, 1992; Zeichner & Liu, 2010). Smyth (1992) asserts that reflection is being used as a means of entrapping teachers rather than empowering them. He wrote that reflection has become a means of "focusing upon ends determined by others, not an active process of contesting, debating, and determining the nature of those ends" (p. 280). Furthermore, he discussed the use of reflective practices to blame teachers for problems with student achievement and to make up for the fact that educational researchers have been unable to operationalize effective teaching. He wrote that "rather than empowering teachers, what individual reflective processes actually do is send teachers on guilt trips in the vain search for the alchemist's equivalent of the philosopher's stone" (p. 287). He also claims that because of the human capital ideology—the theory that education directly affects economy—reflection is being used as another way to blame teachers for the troubled economy.

Smyth is not alone in his belief that reflection is being used to entrap teachers. Zeichner and Liu (2010) came to similar conclusions about the use of reflection in teacher education. Zeichner and Liu say that there "are several ways in which reflective teacher education has undermined the frequently expressed emancipatory intent of teacher educators" (p. 70). Zeichner and Liu list reasons similar to Smyth. According to them, reflection is used to force teachers to conform to a curriculum or teaching method found to be effective by the standards of others. Furthermore, they discuss that the individualist bias on reflections in teacher education programs causes teachers to look inward for an answer to the problems in education rather than to focus on the bigger pictures (i.e. the structure of education and social conditions). Although the idea of reflection being used as a means of entrapping teachers is a bit unusual and counterintuitive, considerations of teachers' experiences with reflection and development as reflective practitioners make this notion conceivable. For example, in discussing the tyrannical methods in which educational reform was introduced to the San Diego school district in the late nineties and the beginning of the twenty-first century Ravitch (2010) shares the sentiments of a principal in the district. She quoted him as describing the educational reform as "a regime of thought control. 'We learned to walk the tight-rope in regard to teacher talk.' He said his teachers learned to say over and over: 'I am a reflective practitioner. I am a reflective practitioner. (p. 2).'" This is hardly the kind of inclusion of reflection in teacher education encouraged by Dewey (1933) and Schön (1983). Nonetheless, consideration of the use of reflection as a means of entrapping teachers offers an explanation for the popularity of reflection in teacher education. Moreover, it motivates the goal of the current study to understand preservice teachers'

views on reflective teaching and their teaching experiences in a program designed to promote reflection and encourage them to develop as reflective practitioners.

There are other issues in regard to reflection in teacher education. To begin with, there is the consideration of whether or not teachers are able to engage in reflection. According to Elbaz (1988), teachers often "feel that the investigation and elaboration of their own knowledge is not altogether legitimate as a research activity" (p. 172). Furthermore, teachers are aware of varying perspectives of situations "but for them any way of looking at a situation is equally plausible, and equally hopeless. Their experience has taught them that the system cannot be changed and that only the naïve teacher will even try" (p. 177). Others studies have found issues with assessing whether or not teachers reflect and tools used to promote reflection in the classroom (Dyment & O'Connell, 2010; Olson & Finson, 2009; Sparks-Langer, Simmons, Pasch, Colton, & Starko, 1990).

One particularly troubling study concluded that preservice teachers are unable to reflect. In their review of the literature, Olson and Finson (2009) found that "research indicates that prospective teachers do not reflect on practice in ways that are meaningful or that will move their practices forward" (p. 45). Olson and Finson conducted a study with preservice elementary science education students to determine if they were developmentally able to reflect in ways that teacher educators expect of reflective practitioners. They assert that "efforts to promote effective reflective practices are likely to fail if those who are asked to reflect are developmentally unable to do so" (p. 45).

Olson and Finson (2009) conducted a qualitative study in which they analyzed the written essays in reflective portfolios of 38 elementary education students enrolled at a

private Midwestern university. Data were analyzed using Perry's model of development. According to the authors, the results of the study indicate that the majority of the elementary education students were in the dualistic level of intellectual development and that the level of reflection that students are expected to meet correspond with the relativism level of intellectual development, which is higher than the dualistic level according to the Perry model. Olson and Finson's study, although informative, did not address all variables that may have influenced the writing of their preservice teachers. For example, students—including preservice teachers—will often write to please the instructor if they are aware of what is required in the course (Creme, 2005; Madsen, 2005; Mills, 2008). Thus, it is possible that these teachers did not write in a way that gave evidence of reflection or readiness to reflect because they were not aware of the need to do so. Moreover, meaningful experiences are a requirement for reflection to take place according to both Dewey (1933) and Schön (1983). The results of the study of Cochran, Brewe, Kramer, and Brookes (2012) suggested that experience may have an impact on the level of reflection evident in the writing of preservice teachers. One of the goals of the current study is to address whether or not the writing of preservice teachers serving as Physics LAs at FIU gives evidence that they are engaging in reflection. Furthermore, this study seeks to determine if Physics LAs views on their teaching experience is related to the level of reflection that is evident in their writing.

Reflection in Teacher Education: Success Stories

Despite some failed efforts to promote reflection in preservice teachers, assisting preservice teachers to develop as reflective practitioners is still the goal of several education programs. The literature includes several studies showing that efforts to do so

have been successful and that reflection has been beneficial to both preservice and inservice teachers.

Successful programs. Spalding and Wilson (2002) explored strategies for helping preservice teachers to improve their reflection by means of reflective journals. The authors conducted four case studies with preservice teachers in an alternative certification program. They found that by helping students identify reflective writing juxtaposed with descriptive writing, discussing Valli's typology for reflection, allowing for some peer sharing of journals, and offering feedback, the basic instructional strategy of assigning weekly journals was effective in promoting reflection among the novice teachers.

The Stichting Pleiding Leraren (SOL) program used logbooks, or reflective journals, as a helping process in educating preservice teachers (Korthagen, 1985). The program also utilized a practicum that involved role-plays and discussions used to help students develop reflection. The program was evaluated by means of a questionnaire and interviews with participants approaching graduation from the program. Analysis of the questionnaire revealed that more than half of the students felt the program helped them to become more reflective teachers. However, this analysis also revealed that more than half of the teachers felt the program insufficiently prepared them for handling problems in their profession, in particular, discipline and motivation. The participants felt there was a disconnect between theory and practice.

Benefits of reflection. In addition to some success at helping preservice teachers to be more reflective, some researchers have found benefits to helping their preservice teachers to reflect. In a more recent study, Korthagen (1991) analyzed 10 years of data

from SOL and found that reflective student teachers considered it important for their students to learn through investigation and structuring and had strong feelings of personal security and self-efficacy.

Clarke (1995) sought to extend the work of Schön by applying his model to preservice teacher practicum settings. By means of case studies that included video analysis, Clarke asserts that in his study what was important was that as "students framed and reframed problems ... they were engaged in *purposeful inquiry leading to the resolution of a problem or the management of a dilemma"* (p. 247, italics original). In their study, Baird, Fensham, Gunstone, and White (1991) explored the conceptions of both preservice and inservice science teachers in relation to a preservice program based on a constructivist rationale. They found that reflection was important for individual teacher development and that collaboration was important for fostering reflection.

Critiques of Teacher Education Programs Based on Reflection

Since the reflective turn in education, several teacher education programs have been based on the idea of helping preservice teachers to develop their reflective practice. To better understand reflective teacher education, Valli edited a book *Reflective Teacher Education* designed to answer two questions: "How ought we define and practice reflective Teaching? What issues are central to designing programs of reflective teacher education" (Valli, 1992, p. x). This book has been a noteworthy contribution to the literature on reflection in teacher education. Stanley (1998) referred to this work as "a comprehensive study" that "identified seven major universities in the U.S. that teach reflection as a cornerstone of their teacher education programs" (p. 584). Hatton and Smith refer to this work as a "most valuable critique of reflection in teacher education" (p.

40

43). In critiquing the seven education programs included in the book Calderhead (1992) addressed concerns with reflective teacher education programs. In particular, he noted that "student teachers approach preservice training with different knowledge and perspective, [thus] they may progress towards reflective teaching in different ways" (p. 142). Calderhead argues that individual differences must be taken into account when helping students learn to reflect. One of the goals of the current study is to understand the attitudinal differences among preservice teachers in the physics LA program and to determine if this is a predictor for the level of reflection that is evident in their writing. Calderhead also concluded that reflective teacher education programs should consider whether it is possible for preservice teachers to reflect or if this is something to be expected of teachers with 10 or more years of experience. He also questioned whether or not students would be able to reach higher levels of reflection—critical reflection being the highest level. The current study addressed these two concerns by identifying the level of reflection evident in the physics LAs writing using the rubric based on Hatton and Smith' (1995) "Criteria for Determining the Type of Reflection Evident in Writing." This phase of the study also addressed another one of Calderhead's concerns: whether or not all students can learn to reflect. In the second phase of the study, our analysis will reveal what percentage of the physics LAs' writing assignments gave evidence of reflection.

In summary, the literature on reflection in teacher education reveals that there are issues with reflection in teacher education, benefits to including reflection in teacher education programs, and concerns regarding reflective teacher education programs. Reflection may be used to entrap teachers and blame them for the current issues in

education—although this is not the intended use of reflection in teacher education. Moreover, some have found it difficult to teach preservice teachers to be reflective. Others do not believe that preservice teachers are capable of being reflective. On the other hand, some programs have found success in helping preservice teachers to be reflective. In addition, results of research on reflective teaching indicate that reflective practice is beneficial because it increased self-efficacy and positive affect among teachers, perceptual changes among students, helped preservice teachers to address problems and engage in inquiry, and contributed to individual teacher development. Although helping preservice teachers to develop reflective practice is an explicit goal in the Learning

Learning Assistant Programs

The use of undergraduates as learning assistants in science courses is not new. In 1996, Groccia and Miller reported on the use of undergraduate learning assistants in an introductory biology course at Worcester Polytechnic Institute (WPI). An introductory materials science course at WPI also made use of undergraduate peer learning assistants (Demetry & Groccia, 1997). However, this was not done with the purpose of recruiting and preparing the learning assistants for careers in science teaching. In the Colorado LA program "the target population of the program is the LAs themselves" (Otero, Pollock, & Finkelstein, 2010, p. 1219). The Colorado LA Model is designed to address the "national challenges in science education" by improving science and mathematics education at the collegiate level, recruiting future science and mathematics teachers, engaging science faculty in the preparation of future teachers, and transforming the cultures of science departments to value and utilize the findings of education research (Otero et al., 2010).

Benefits of LA Programs

The original LA program was developed at the University of Colorado Boulder in 2003 (Otero, Finkelstein, McCray, & Pollock, 2006). This program has since been emulated nationally (Gray, 2008; Otero et al., 2010). Most research on the LA program has been conducted at the UCB. This is because LA program s at other institutions are less than five years old. Research on the LA program at Colorado indicate that the initiation of the program at UCB has increased the number of science majors entering education programs, resulted in greater learning gains for students enrolled in the courses using learning assistants (LAs), and impacted faculty by increasing their attention to student learning, use of collaborative student work, and use of students to transform their courses (Otero et al., 2010). Researchers at Florida International University (FIU) found that implementation of the Colorado LA program and use of open source tutorials resulted in greater student conceptual understanding in the introductory physics courses as determined by learning gains on an instrument designed to assess student conceptual understanding of forces (Goertzen, Brewe, Kramer, Wells, & Jones, 2011; Wells et al., 2009). Research at UCB also indicates that LAs themselves have stronger content knowledge after participation in the program and attitudinal gains demonstrating that their views about learning science became more expertlike (Otero et al., 2010).

Inservice Teacher Practices

There has also been research on the affects of the LA program on inservice teacher practices. Gray and Otero (2009) investigated former LAs' views on cooperative learning by interviewing beginning, middle, and high school teachers who served as undergraduate LAs and comparing them with a group of matched nonLA teachers. They

found that LAs discussed the value of argumentation, building a learning community, and coaching their own students in assisting other students in the process of learning" (p. 152). In 2010, Gray, Webb, and Otero utilized observations of LA and nonLA inservice teachers to assess classroom practices. They found that the LAs tended to teach in a way that was "more aligned with the national standards and research on teaching" (p. 159). In 2012, Barr, Ross, and Otero used artifacts to compare inservice teachers—LAs and non LAs—classroom performance. They found that LAs scored higher in a number of categories. Statistically significant differences were found in collaborative grouping, mathematical/scientific discourse community, and explanation/justification categories. Gray, Webb, and Otero (2011) conducted another study on LA and nonLA inservice teachers practices utilizing both observations and interviews and found that "LAs tend to use more reformed teaching practices than their fellow beginning teachers" and that LAs "tend to focus on using assessments to inform students or their instruction" (p. 3). These studies focused on LAs teaching practices as inservice teachers; there has also been research on LAs teaching practice as preservice teachers.

Preservice Teacher Practices

As a part of the Colorado LA Model, LAs enroll in a weekly seminar course on science and mathematics education (Otero, Pollock, Finkelstein, 2010). As a part of this course, LAs "reflect on their teaching practices, evaluate the transformation of courses, share experiences across STEM disciplines, and investigate relevant educational literature" (p. 1219). One mechanism by which this is accomplished is LA submission of written reflective assignments on teaching experiences and course readings. In 2008, Gray and Otero analyzed the written reflections on teaching experiences to assess UCB LAs views

on teaching and learning in regard to the use of questions. They found that LAs tend to use questions to help students arrive at the right answer and that LA use of questions may taper off toward the end of the semester. Crenshaw, Wells, Kramer, and Brewe (2010) used analysis of FIU LAs' written reflections to determine LA use of pedagogical concepts and strategies. They found that most strategies discussed in the course persisted throughout the semester and that two in particular—differentiated instruction and cooperative learning—were present before they were introduced as a part of instruction. Cochran, Brewe, Kramer, and Brookes (2012) analyzed the written reflections of LAs of various disciplines participating in the LA program at FIU using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" and found that LA's writing assignments gave evidence that they were engaging in reflection. In a follow up study, Cochran, Brookes, Brewe, and Kramer (2012) interviewed four physics LAs and found that they were engaging in reflective practices that helped them to recognize the need to make changes in their teaching.

In summary, research has shown several benefits of implementing the Colorado LA Model in science courses, including: increased conceptual understanding by students in LA supported classes, increased recruitment of preservice science and math teachers, increases in positive attitudes toward education reform in science departments, and improved conceptual understanding by the LAs themselves. Results of research have also been positive in regard to the LA program's affects on LAs teaching practices while serving as preservice teachers and as inservice teachers in regard to both views and practices. However, there is an apparent gap in the literature. According to Otero, Pollock, and Finkelstein (2010), participation in the LA program —including the math

and science education theory course—is a part of the reflective practice necessary for teachers to "try out and revise pedagogical techniques by implementing them with real students" (p. 1219). Although helping LAs to develop reflective practice is an explicit goal of the LA programs, to date there has been little research assessing this. The current study seeks to contribute to the body of literature on LA programs by identifying typologies among physics LAs in regard to their views on reflective teaching, expertise in teaching, and their teaching experience in the LA programs. Moreover results of this study determined whether or not there wass evidence that LAs were engaging in reflection and investigated if there is a relationship between their level of reflection and their views on reflection and the teaching experiences they are provided.

Summary

This chapter included a summary of the theoretical framework for this study, a review of the literature on expertise, a discussion of the two models of reflection used as conceptual framework for this study and their limitations, and a consideration of issues and successes included in the literature on reflection in teacher education and consideration of a critique of reflective teacher education programs. The final section was a review of the literature on LA programs. The aims of the current study were to: a) contribute to the body of literature on LA programs by determining the typologies of physics LAs in the LA program at FIU, b) determine if physics LAs, although preservice teachers, are engaging in reflection as evidenced through their writing, and c) explore the relationship between level of reflection evident in writing and views on reflective teaching, expertise in teaching, and teaching experience. In the next chapter the methods used in the study are discussed.

CHAPTER THREE

METHODS

This chapter describes the methods and procedures employed in the mixed-methods study. The first three sections of this chapter include the purpose of the study, the research questions to be addressed, and related hypotheses where appropriate. The fourth section discusses the research approach used in the study. This section discusses the researcher's decision to conduct a mixed method study and lists the methodologies used in the study. The fifth section provides information on the participants of the study and the sampling procedures. Next, is a section on interviews, the method of data collection used in the first phase of the study. The sixth section discusses Q methodology—the framework used in phase two of the study. This section describes the procedures to be used, the plan for analysis, and the justification for using Q methodology in this study. The seventh section covers phase three of the study: determining the level of reflection evident in writing. This section details the procedures of the third phase and includes considerations regarding the reliability and validity of the instrument used. Section eight discusses ordinal logistic regression and justifies its use as a statistical test for analysis of data and addressing the fourth research question. The final section is a summary of the chapter.

Purpose

The Colorado Learning Assistant Model (CLAM) has been implemented in at least five universities nationally (Otero, Pollock, & Finklestien, 2010) and emulated at an additional 28 institutions (Finklestein, 2012) through the creation of learning assistant programs. One of the underlying goals of these programs is to help prospective science

and mathematics teachers to develop as reflective practitioners. There is little research on

the implementation of the Colorado LA Model at institutions other than the University of

Colorado-Boulder and there is limited research on the development of reflective practice

in prospective teachers participating in programs based on the Colorado LA Model. The

purpose of this study was to contribute to the current body of literature by investigating

the prospective physics teachers' perspectives on reflective teaching practice,

development of expertise in teaching, and their teaching experience in the Learning

Assistant Program at Florida International University (FIU).

Research Questions

The following research questions will be addressed in this study:

1. What are physics LAs' views on reflective teaching, development of expertise
   in teaching, and their teaching experience in the LA program at FIU?

2. What typologies exist among physics LAs participating in the LA program at
   FIU in regard to reflection on teaching, development of expertise in teaching,
   and their experience in the LA program at FIU?

3. Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence
   for Different Types of Reflective Writing," what percentage of writing
   assignments submitted by participants will be characterized as having
   evidence of reflection?

4. Do factors determined by physics LAs' typologies predict the level of
   reflection evident in writing?

Hypotheses

It is advantageous to include hypotheses to research questions when appropriate. According to Calabrese (2006) hypotheses are exact and indicate the measurement and analysis necessary to address them. The research hypotheses for this study are listed below.

1. (For Research Question # 3) Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" at least 66% of the writings submitted by Physics LAs will be characterized as having evidence of reflection.

3. (For Research Question # 4) Analysis of ordinal logistic regression models will indicate that factors determined by the physics LAs' typologies are predictors of level of reflection evident in writing.

Research questions one and two are exploratory in nature and require no hypotheses. The stated hypothesis for research question three is based on a study by Cochran, Brewe, Kramer, and Brookes (2012). The results of that study indicated that 66% of assignments submitted by LAs at FIU analyzed using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" had evidence of reflection. The stated hypothesis for research question four is rooted in theory. As discussed in Chapter 2, the models of reflection by both Dewey and Schon—the conceptual frameworks for this study—assert that experience and attitude toward experience are important factors in reflection. Furthermore, the literature indicates that views or attitude are important indicators of action. This hypothesis will be tested using ordinal logistic regression.

Research Approach

This study employed a mixed method research design. According to Newman, Newman, and Newman (2010), "the research design has to consider and reflect the purpose of the research" and a mixed methods research project "must have questions that are an outgrowth of the purpose and require both qualitative and quantitative procedures to more fully understand the phenomena under investigation" (pp. 195-196). Research question one was concerned with the views of Physics LAs at FIU regarding reflective teaching, development of expertise in teaching, and their teaching experiences in the LA program at FIU. According to Merriam (2002), in qualitative research "researchers *strive to understand the meaning* people have constructed about their world and their experiences; that is, how do people make sense of their experience?" (pp. 4, 5; italics original). Thus, because I was concerned with the LAs own perspectives and the meaning they make in regard to the topics, this question was addressed using a qualitative approach: interviews. However, I also looked to quantify those views. Question two asks about the typologies among the physics LAs. Thus, answering question two required both a qualitative and a quantitative methodology. As a result, Q methodology—a qualitative quantitative hybrid (Davis & Michelle, 2011; Ramlo & Newman, 2011) was used to answer the first research question. A quantitative methodology was used to answer question three, which asks for a percentage. More importantly, I was not interested in understanding or making meaning of the participants' experiences in this question. Thus, a qualitative methodology was not necessary. Question four is assessing the fit of factors as predictors for an outcome variable: level of reflection. Thus, a statistical test is appropriate in answering this question. Ordinal

logistic regression was the chosen method of testing the research hypotheses for question four.

This research study was conducted in three phases. The first phase consisted of semi-structured interviews. The second phase utilized the framework of Q methodology. In the third phase of the study, participants were given videos of LA interatctions with groups of students to watch. They were then asked to reflect on those teaching experiences as if they were their own.

Participants and Sampling

For all phases of the study a purposeful sample was used. Merriam (2002) wrote that "qualitative research inquiry seeks to understand the meaning of a phenomenon from the perspectives of the participants, it is important to select a sample from which the most can be learned" (p. 12). The sampling strategy used was criterion sampling. Creswell (2007) asserts that "criterion sampling works well when all individuals studied represent people who have experienced the phenomenon" (p. 128). Thus, the researcher chose to use the criterion sampling technique to increase the likelihood that the participants experienced the phenomena—opportunities to engage in reflective teaching and participation in the LA program at FIU. All former and present physics LAs at FIU that have served in the LA program for at least one semester and taken the LA seminar were invited to participate in the study. Email addresses for current and former physics LAs were obtained from the coordinator, director, and pre-lab instructor for the LA program. Sample invitations are included in the Appendix A. All interested respondents were invited to participate in all phases of the study. Participation in any one phase of the study did not necessitate participation in any other phase of the study.

Semi-Structured Interviews

In phase one of the study, I conducted semi-structured interviews. According to Rubin and Rubin (2005) interviews are necessary when the researcher anticipates that answers to questions will not be brief and may require follow-up questions. Because I wanted to understand the views of the physics LAs in this phase of the study, I used interviews, rather than surveys or questionnaires. The interviews conducted were considered semi-structured because I made use of pre-determined questions that had a specific focus. The interview protocol is included in the Appendix B and consists mostly of main questions. According to Rubin and Rubin (2005) "main questions get a conversation going on a subject and ensure that the overall subject is covered" (p. 13). However, interviewees were asked specific questions that arose from our discussion. Because interviews were my only source of data collection in phase one of the study, I utilized excerpts from the interviews that provide enough detail to paint a picture in the mind of readers to increase the likelihood of having rich, thick descriptions. Because I could not make generalizations from the results of this phase of the study, it was important that enough contextual detail and descriptions were included to help readers to determine if the results of the study are transferable (Merriam, 2002; Newman, Newman, & Newman, 2010; Creswell, 2007). Rubin and Rubin suggest that rich, thick descriptions are "rooted in the interviewees first-hand experiences and from the material that researchers gather and synthesize" (p. 13). Thus, I included the excerpts from the interviews in my analysis. Furthermore, I used open coding to identify themes in regard to the physics LAs' perspectives on my topic of interest. Interviews were conducted in

the interview room of the Physics Education Research Group at FIU. All interested

participants were interviewed; twelve interviews were conducted.

Q Methodology

Q methodology is a procedure for measuring subjectivity objectively (Brown,

1993). Newman and Ramlo (2010), indicate that Q methodology "is a measure of

subjectivity that represent an individual's feelings, opinions, perspectives, or preferences

… [that] allows participants to provide their perspectives by sorting items, typically

statements related to the topic, into a sorting grid determined by the researcher" (p. 508).

This procedure was developed by William Stephenson and described in his 1935 letter to

Nature (Stephenson, 1935). As stated by Stephenson (1936) using this methodology "we

can determine types of person" (p. 356). In this study the Q methodology framework was

used to answer research question two: What typologies exist among physics LAs

participating in the LA program at FIU in regard to reflection on teaching, development

of expertise in teaching, and their experience in the LA program at FIU?

Q methodology was an appropriate methodology for answering research question

two. As stated by Newman, Howley, and Ramlo (2011), it is "designed to facilitate the

evaluator in identifying typologies based upon the unique profiles that emerge from the

data" (2011, p. 1). As discussed in the section on research approach, the response to

research question two should be both qualitative and quantitative in nature. Q

methodology is generally considered a mixed methodology or a qualitative quantitative

hybrid (Davis & Michelle, 2011; Ramlo & Newman, 2011; Ramlo, 2011).

Q methodology has advantages over qualitative methodologies that made it more suitable for Phase 2 of this study. For example, Davis and Michelle (2011) note that, Q methodology allows for insight on participant "subjectivities in a much richer and more holistic way than conventional surveys, while providing clearer structure, better replicability and a more rigorous analytical framework than purely qualitative approaches such as individual interviews, focus groups or ethnographic observations" (p. 561). Q methodology also allows for the consideration of the views of several participants in a much shorter time frame than what would be required by interviews (Ramlo, McConnell, Duan, & Moore 2008). Furthermore, Q methodology is more likely to establish a variety of views including those that may be otherwise marginalized (Brown, 1993; Ramlo, 2008a). Finally, Q methodology allows for a rich method of determining predictor variables to address research question 4. According to Newman et al. (2011), profiles are beneficial in that they consist of "a number of variables, their rank order, and their weighted relationships, [which] will allow one to more accurately identify and predict outcomes, because the profiles are more descriptive and potentially provide more relevant information then [sic] individual variables can" (p. 11)

Procedures

There are four main procedures in Q methodology: development of the concourse, the Q sort, correlation, and factor analysis (Newman, Howley, & Ramlo, 2008). The concourse is a group of items that can potentially be sorted by the participants of the study. From the concourse a selection of items called the Q sample is given to the participants to sort. A correlation and a subsequent factor analysis are then performed.

Concourse development. There are several ways to develop a concourse (Brown, 1993; Ramlo, 2008a). In this study, the interviews from phase one were one method for developing the concourse. Interviews are a typical method used in concourse development (Brown, 1993; Davis & Michelle, 2011). The other source for developing the concourse was developed from reflective writing assignments submitted by physics LAs at FIU in their LA Seminar course (Cochran, et al., 2013). This work was completed as a part of a pilot study and is not otherwise a part of this study. In the LA Seminar, a science education and theory course taken by LAs from various disciplines, LAs write weekly reflections on their teaching experiences. LAs are simply asked to reflect on their teaching in about a page. Use of essays, contributions from respondents, writings, and published materials are also common sources of concourse development in Q methodology (Brown, 1993; Davis & Michelle, 2011; Newman et al., 2011). It is also common to develop a concourse from multiple sources in an individual study. In her study on physics students' perspectives on learning and knowledge of physics within an introductory physics course, Ramlo (2008a) used a concourse developed from a popular Likert-scale survey, communications with students, and a literature review. Furthermore, Davis and Michelle (2011) exhort that the "key is to capture a wide diversity of possible statements regarding relevant aspects of the issue under investigation, and usually this entails collecting many statements" (p. 566). Thus, codes from both the interviews and the writing assignments were used to generate statements for the concourse. The statements used for the Q sort in this study will come from the developed concourse.

Q sample. In Q methodology, the Q sample is the sample of items drawn from the concourse and given to the participants for sorting. Although the number of

participants is not always a consideration in Q methodology, the number of items included in the Q sample is always of importance. As noted by Davis and Michelle (2011), "because respondents must compare each item with all items, and the number of possible pairwise comparisons is vast, the Q sample usually does not exceed fifty or sixty items" (p. 567). According to Newman and Ramlo (2010), the Q sample typically "consists of 30 to 60 items selected as representative of the concourse" (p. 509). Accordingly, a sample of 50 statements from the concourse was used in the Q sort.

Q sort. To begin with, statements from the concourse that are chosen to be a part of the Q sample are numbered randomly. The statements will then be typed onto cards to allow for sorting (Brown, 1993). During the Q sort, participants will rank the items based on their agreement or disagreement with the items (Brown, 1993). The participants will first be asked to place the cards in three groups: agree, disagree, and neutral (Brown, 1993; Davis & Michelle, 2011; Ramlo, 2008a). Then the participants will be asked to place the cards "into a normalized distribution such as a grid … " (Ramlo, 2008a, p. 179). A picture of the final grid was taken and I recorded the placement of the cards.

Interviews. Interviews regarding the Q sort were also conducted. Newman and Ramlo (2010) indicate that interviews may take place "during the sorting process" or participants "may be asked to make written comments regarding their sorting selections in order to better inform the researcher's interpretation of the results" (p. 509). Brown (1993) suggests that the Q sort "be followed where possible with an interview so that the Q sorter can elaborate his or her point of view" (p. 106). In this study, short interviews followed the sorting procedure when possible.

Analysis

Analyses of Q sorts include correlation, factor analysis, calculation of factor scores, and interpretation of factors (Newman & Ramlo, 2010; Ramlo, 2008a; Ramlo, 2008b). The PQ Method software program was used to assist in the analysis. This software package is free, recommended, and used in numerous studies employing Q methodology (Davis & Michelle, 2011; Newman & Ramlo, 2010; Ramlo, 2008a; Ramlo, 2008b).

Correlation matrix. The first step is calculating the correlation matrix. The correlation is calculated by forming the ratio of the sum of squares for two sorters combined to the sum of the squared differences and then subtracting this from 1.00. This is done for all of the sorters to form a correlation matrix with all of the sorters listed on the row and the column. Although formulation of the correlation matrix is necessary, it is not generally the point of interest in Q methodology. As stated by Brown (1993) "the correlation matrix is simply a necessary way station and a condition through which the data must pass on the way to revealing their factor structure" (p. 110).

Factor extraction. The correlation matrix is then used to determine the factors. Factors are based on Q sorts that are highly correlated with one another. There are two common factor extraction methods allowed for in the PQ Method software program: principal components and Centroid (Newman & Ramlo, 2010). Centroid extraction is the recommend factor extraction method (Newman & Ramlo, 2010; Ramlo, 2008a; Ramlo, 2008b). In the principal component method, 1s are placed in the diagonal along the correlation matrix. This means that each sorter is perfectly correlated with him or herself. However, it is unlikely that a participant would sort the items exactly the same each time

they sort if they were given the opportunity to sort just a few days later (Newman &

Ramlo, 2010). Thus, many researchers do not choose to use principal components.

Nonetheless, I was interested in the participants' sort of the items at the time of the study.

Thus, principal components was a suitable factor extraction method for the study.

Factor rotation. Factor extraction was followed by rotation. Hand rotation is the

recommended method in Q methodology because it allows for the researcher to make

decisions in rotation based on theory (Newman & Ramlo, 2010; Ramlo, 2008a; Ramlo,

2008b). The Centroid extraction method allows for hand rotation (Newman & Ramlo,

2010). However, hand rotation is the most subjective rotation method. In this study, I

chose to use Varimax rotation. Varimax rotation maximizes the amount of variance in

each factor and makes it easier to interpret the factors. After factor extraction, factor

scores, or correlation coefficients, are generated. Factor scores tell how highly the sorter

is correlated with the factor (Ramlo, 2008a). Sorters whose ratings are highly correlated

with a factor are selected, or flagged (Newman & Ramlo, 2010; Ramlo 2008a).

Factor interpretation. The final step in the analysis is factor interpretation.

Using the flagged sorters, a variety of tables, and sorter comments during the post-sort

interview, the typologies of the physics LAs will be determined. Tables to be used in the

interpretation include: a table containing the top and bottom *most agree with* and *most*

disagree with statements, a table of distinguishing factors which lists the statements that

make a factor statistically different from other factors at the .05 level, and a table of

consensus listing the statements that fall under all factors. The interpretation of the

results is qualitative in nature and the quality of the interpretation depends on the

expertise and intuition of the researcher in interpreting the viewpoints that are determined based on the factor analysis and the interviews (Davis & Michelle, 2011).

Reliability and validity. The goal of Q methodology in this study was to determine the typologies of the physics LAs at FIU based on their views regarding reflective teaching, development of expertise, and their teaching experience in the LA program at the time of the study. Although, reliability was not a major concern for this phase of the study, "factors determined in Q are grounded in concrete behavior and are typically reliable and replicable" (Ramlo et al., 2008, p. 220). Validity is also not a major concern for this phase of the study. The sorting of the items is based on the participants' interpretations. Thus, when using Q validity is not a concern (Ramlo, 2008a; Ramlo, 2011). According to Ramlo (2011) because

> the sorting process involves interpretation of the items by the sorts and each are judged relative to the others based upon this interpretation, validity is not a consideration within Q methodology studies. In other words, no external criterion for a person's point of view exists and, therefore, the issue of validity of Q sorts does not apply. (p. 32)

Nonetheless, as was mentioned above, short interviews were conducted following the Q sorts—when possible—to reveal how participants interpreted the statements.

This section described the Q methodology phase of the study. The rationale for use of Q methodology in the study was discussed first. Then, the procedures of conducting a study using Q methodology were described in detail including: concourse development, selection of the Q sample, the Q sort, and interviews. Next, the analysis used in this phase of the study was addressed. This section included the correlation

59

matrix, factor extraction, factor rotation, and interpretation of factors. Finally, reliability and validity were considered.

Determining Level of Reflection

In the third phase of this study the level of reflection evident in the writing of the physics LAs in the LA program at FIU was determined using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing." After completing the Q sort and follow-up interviews, participants were asked to view a recorded video of an LAs from another institution assisting a group of students in completing a physics lab. The participants were then asked to write about the teaching experience as if it were their own. Next, the participants were asked to view a different video recording of another student LA assisting a group of students in completing a physics lab. Students were instructed to write about a page and to consider the task to be similar to the reflective writing assignments they were assigned in the LA Seminar course. I analyzed all of the submissions.

Instrumentation

Writing assignments submitted were analyzed using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing." Hatton and Smith relied on the works of Dewey, Schön, and Van Manen to develop a rubric to determine what kinds of reflection are evident in student writing. The rubric consists of four levels: descriptive writing, descriptive reflection, dialogic reflection, and critical reflection. The rubric being used is a part of a larger framework for characterizing reflection. The rubric for the three levels considered to be reflection fall under the reflection-on-action section of the framework. The first level, descriptive

writing, is writing that has no evidence of reflection at all. It is simply descriptions of actions or observations. Descriptive reflection would be writing that includes decisions or justifications for actions and observations. Dialogic reflection is a consideration of multiple, competing, or alternative justifications and reasoning. This level demonstrates deeper reflection than descriptive reflection and often includes weighing the alternative justifications against each other. Finally, the critical level of reflection includes a consideration of the broader contexts, such as historical, political, and social contexts that inform the experiences. This rubric has been used by previous researchers to analyze the reflective writing assignments of preservice teachers (Cochran, Brewe, Kramer, & Brookes, 2012; Hatton & Smith, 1995; Yayli, 2009). It was also used in an action research study by Johns and Henwood (2008) to analyze the work of MBA and MEd students. Orland-Barak and Yinon (2007) used this rubric to analyze the portfolios of preservice teachers.

Reliability

Reliability estimates were not calculated because I was the only person using the instrument to analyze the writing assignments. Furthermore, the model of reflection in the conceptual framework (Schon, 1983) indicates that people reflect differently based on the events on which they are reflecting. Thus, it was not expected that participants would reach the same level of reflection for each writing assignment.

Validity

To determine the validity of the instrument, a group of judges will be formed to determine expert judge validity. Newman, Newman, and Newman (2010) describe expert judge validity as being "similar to face validity except that it is the perceptions of

61

expert judges who report the test is measuring what it claims to be measuring" (p. 206). Newman et al. go on to indicate that this "includes interjudge agreement and is as trustworthy as the expertise of the judges" (p. 206). There were four expert judges used to assess the face and content validity of this instrument. The first expert is a veteran high school teacher who has been reflecting on his teaching for more than seven years. The second is a veteran high school teacher who has been reflecting on her teaching for more than ten years. The third and fourth judges are both former high school teacher and current teacher educators. Both of these judges assign and assess preservice teacher reflections. This expert judge panel was asked to review the instrumentation and to determine if it actually measures the types of reflection evident in writing. Furthermore, the panel spoke to the discrimination between types of reflection listed in the criteria. Modifications to the criteria were made based on the recommendations of the expert panel.

This section described the third phase of the research study: determining the level of reflection evident in written submissions from the Physics LAs at FIU using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing." The procedure for obtaining and analyzing the reflective writing assignments was described reliability was discussed, and legitimization techniques for determining the validity of the instrument were described. The final section of this chapter will discuss how ordinal logistic regression and the results of the second and third phases of this study will be used to answer research question four.

Ordinal Logistic Regression

Ordinal logistic regression was used to address the fourth research question. Research question four asks: Do factors determined by physics LAs' typologies predict the level of reflection evident in writing? In research question four the outcome variable is level of reflection evident in writing using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing." The possible levels determined by Hatton and Smith's criteria are: descriptive writing, descriptive reflection, dialogic reflection, and critical reflection. These categories are ordinal and, thus, ordinal logistic regression is an appropriate statistical test to use in answering research question four. According to Long (1997), when the outcome variable is ordinal "prudent researchers should use models specifically designed for ordinal variables" (p. 115). Use of regression models to control variables and predict outcomes after a Q methodology study was recommended by Newman and Ramlo (2010). Comparison of the model without any predictors was compared to the model with typologies from Phase two to determine if any of the typologies were predictors for level of reflection evident in writing.

Ordinal Logistic Regression Model

There are three commonly used ordinal logistic regression models: cumulative odds, continuation ratio, and adjacent categories (O'Connell, 2006).   In this study the cumulative odds model in ascending order was used. This "model is used to predict the odds of being at or *below* a particular category" (O'Connell, 2006, p. 31). This model is appropriate in this study because the four levels of reflection determined by the rubric

based on Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" build on each other. For example, the bottom level is descriptive writing, which indicates no reflection at all. This level consists of details concerning an event and would be considered category 0. The next level is descriptive reflection. This level includes details, but also considers justifications for the events described. Thus, a written assignment categorized as descriptive reflection will also include descriptive writing. In like manner, dialogic reflection—category 2—considers multiple justifications for events and often weighs them against each other. Thus, an assignment categorized as dialogic reflection will likely meet the requirements of the levels below it. The final level, category 3, would be critical reflection. At this level, the student is weighing multiple justifications, but is considering the broader structures when doing so. Thus, again, this level builds on the previous levels. In the cumulative odds model, the probabilities considered would be the odds of being in (a) category 0 versus all above, (b) categories 0 and 1 combined versus all above, and (c) categories 0, 1, and 2 combined versus category 3.

Interpreting the Model

A number of statistical packages are available for running ordinal logistic regression models (OLRM). I chose to use SPSS to test the ORLM. The first test considered when interpreting the results from SPSS was the difference between the two log-likelihoods provided in the model-fitting information. The significance value of the difference between the two log-likelihoods tells determines whether to reject the null hypothesis that the model without predictors is as good as the model with the predictors. Thus, this is an overall test to determine if the predictors—which are the factors

determined by the factor analysis—were good predictors of the outcome variable, level of reflection evident in writing. I then looked at the test of parallelism. When using ordinal logistic regression one assumes that the relationship between the predictor variables and the logits are the same for all logits. In this case the null hypothesis states that the location parameters are the same across response categories. If the significance value for the −2 Log likelihood for the test of parallelism was below .05 I would have considered running the data as a multinomial regression. If the significance value was equal to or above .05 I would have failed to reject the null hypothesis and continue on to the next test. I would then use the parameter estimates for the model to determine if the predictor variables are related to the level of reflection in writing. For this test, we will assume that predictor variables with a significance level below .05 are related to the level of reflection evident in writing. To measure the strength of this association, I would have used an R^2-like statistic. To do this, SPSS provided three pseudo R^2 values: Cox and Snell, Nagelkerke, and McFadden. Although the pseudo R^2 values only provide a rough index of whether the model fits, a small R^2 value would suggest that other predictor variables in addition to the ones that come out of the factor analysis may be helpful in understanding the level of reflection evident in the LAs' writing.

Summary

In this chapter the purpose of the study, the research questions to be addressed, and the related hypotheses were discussed. The research approach chosen to addresses the research questions in the study was described. The participants and the sampling procedures were described and justified in this chapter. The methodology for answering the research questions was divided into three phases: (a) semi-structured interviews, (b)

Q methodology, and (c) determining the level of reflection evident in writing. In this

chapter, the data collection and analysis procedures for all phases of the study were

discussed. The statistical test based on the results of the second and third phases of the

study that was used to answer research question 4 was discussed. In Chapter 4, the

results of Phase 1 of the study will be presented. In Chapter 5, the results of Phase Two

of the study will be presented. In Chapter 6 the results of Phase 3 of the study will be

presented. Chapter 7 will discuss the significance of the results of this study.

CHAPTER FOUR

PHASE ONE FIDINGS

This chapter includes the results of phase one of this study. The goal of the first phase of this study was to address Research Question 1: What are physics Learning Assistants' (LAs) views on reflective teaching, development of expertise in teaching, and their teaching experience in the LA program at Florida International University? This question was addressed through the analysis of semi-structured interviews with physics LAs. The first section of this chapter provides information on the participants. The second section includes a description of how the interviews were analyzed. In the third section, the findings are presented. The fourth section is a summary of the chapter.

Participant Information

Semi-structured interviews were conducted with 12 students who participated in the physics LA program using an interview protocol as a guide [See Appendix B]. Six of the participants were former physics LAs; and 6 participants were present physics LAs. Each participant in the study participated in the physics LA program for at least one year. Three of the participants were preservice teachers and the other nine were prospective teachers. There were 4 female participants and 8 male participants. One of the participants was Black/African American, 6 were Hispanic, and 5 were White. Seven of the participants were physics majors, 2 were chemistry majors, 2 were computer science or engineering majors, and 1 participant was pre-med. To provide a measure of confidentiality, the following code names will be used for the participants of the study:

Alexandria, Chelsea, Dominick, Eduardo, Gregory, Ian, Leonardo, Noel, Ophelia, Roberto, Sergio, and Ursulina..

Analysis

The interviews with the twelve participants were transcribed and then coded. Although this is not a grounded theory study, I chose to use a grounded theory approach to analyzing the interview data in this phase of the study. The purpose of this phase of the study was to understand the physics LAs' perspectives. Thus, to avoid bringing my own bias or perspective into the results, I modified coding techniques often used in grounded theory for use in this study. The first phase of coding consisted of line-by-line, open coding (Charmaz, 2006). For this, each sentence was coded for keywords or topics discussed in the sentence. Codes relevant to the broad topics were kept and codes from excerpts not related to the topic of the study were ignored. For example, Noel discussed thinking of analogies he could used to help students to learn magnetism. His motivation for thinking of these analogies outside of class time was related to his reflection on his teaching. Thus, codes from the discussion of the analogies themselves were ignored, but the portion related to his reflection on his teaching was coded under the category of reflection on teaching outside of class. These codes were then collapsed into categories. This resulted in some overlapping. For example, Eduardo talked about reflecting on past experiences as a means for developing expertise. This code would fit under the category of experience for gaining expertise, as well as, the category of reflection for gaining expertise. However, the decision was made to include it under the category of experience because Eduardo was focusing on experience and included reflection as a way to make the experience meaningful. When overlapping occurred in other instances, similar

68

decisions were made as to where to place the code based on my opinion of the main focus of the excerpt. The second phase of coding was selective coding (Charmaz, 2006). Selective coding was conducted by returning to the transcripts and looking for additional statements that would fit into any of the categories created in phase one coding. The categories were then collapsed again into emergent themes. Finally, the emergent themes were collapsed into the three topics of interest in this study: expertise in teaching, reflection on teaching, and the teaching experience in the LA program. Data will be presented according to the emergent themes that were placed under each topic of interest in this study. In the presentation of these findings, selected categories that illustrate the emergent themes found will be included.

Findings

The results of this analysis will be divided into three sections according to our topics of interest: expertise in teaching, reflection on teaching, and the teaching experience in the LA program. In this section, major findings of each subsection will be discussed first. Next, themes that emerged from the analysis will be presented with the excerpts from participant interviews illustrating these themes.

Expertise in Teaching

Analysis of the interviews revealed physics LAs' perspectives on expertise in teaching. To begin with, all physics LAs' declared that content knowledge and pedagogical knowledge are necessary qualifications for expert teachers. Participants also differentiated between expertise in content and expertise in teaching, or expertise in pedagogy. Moreover, three different perspectives were revealed in regard to the importance placed on content knowledge and pedagogical knowledge. There were those

who felt that content knowledge and pedagogical knowledge are equally as important, those who felt content knowledge, or expertise in the content, is more important, and those who felt that expertise in pedagogy, or teaching is most important.

There were also varying perspectives in relation to how one becomes an expert teacher. Some held the perspective that there are things that one can do to become better at teaching, but that some of the characteristics necessary to become an expert teacher are natural and cannot be learned. Other participants described activities that can help one to develop expertise in teaching. These activities included: collaboration with other teachers, being cognizant of research on education, taking education courses, and experience.

Experience, as a major category, made up the final emergent theme. All participants felt that experience is necessary to develop expertise in teaching. However, analysis of the interviews revealed varying perspectives as to what kind of experience is beneficial for developing expertise in teaching.

Content knowledge and pedagogical knowledge. Analysis of the interviews revealed varying perspectives in relation to the role of content knowledge and pedagogical knowledge in expertise in teaching. In response to being asked to describe an expert teacher, many participants responded similarly to Ophelia who said, "I don't know if you meant expert teacher or expert in his field." Participants also differentiated between content [or field] knowledge and pedagogical knowledge, or knowledge of teaching. For example, Ophelia went on to say that "you can be really good at knowing your subject, but really bad teaching it." Similarly, Sergio said:

I think even though you can be knowledgeable about your subject, … if you

don't have an idea of what your students' background are, you know what they

come in knowing, then there's no way that you're going to get them from where

they are to somewhere closer to where you are in your knowledge …

While differentiating between expertise in content and expertise in teaching, Eduardo

showed that he takes expertise in the content to be a quality that all teachers possess. He

said, "Teachers are not stupid, they're experts in their field, obviously, but as far as

expert in teaching that's a whole different concept." Noel indicated that there is a

difference in the difficulty in attaining the two. He said:

Expertise in teaching I think is a lot harder than content area. Content area stuff is

just you versus a book. A book can't really fight back … You could be there

forever and you'll eventually get it. … But expertise in teaching is something you

have to pick up while you're with somebody. You have to be responsible for

somebody else's knowledge and that's intimidating if you don't have that cause

then you messed them up.

The idea that content knowledge and pedagogical knowledge are different and, yet, are

both important to teaching seemed to be shared among all the participants.

Although each participant mentioned content knowledge and pedagogical

knowledge, perspectives regarding the importance of the two when compared to each

other varied. One of the perspectives that emerged is that an expert teacher must be both

an expert in content and an expert in pedagogy. Ophelia is an example of one of the

participants that held this perspective on expertise in teaching. In describing a teacher

that she believed to be an expert teacher, Ophelia said, "So, I think he's both. I think he

knows his stuff and he knows how to convey it to others." She went on to emphasize the importance of expertise in content and its relation to pedagogy by saying, "If you don't truly understand it [the topic you teach] then you cannot put it in different ways and not everybody understands your way." She emphasized the importance of pedagogy when she said:

> … you gotta know your subject, but you need to be an effective communicator. If you cannot put things in terms that others will understand it, then you're not doing your job because the information is not getting to them. So, in order to be effective you need to not only know your material, you need to be a good communicator and know how to translate the idea.

Ursulina explicitly stated that she believes that expertise in content and expertise in pedagogy—what she refers to as expertise in people—are equally as important.

In contrast to the perspective that both expertise in content and expertise in pedagogy are equally important, there were participants who believed that expertise in pedagogy is more important. For example, Gregory said, "I've had teachers that knew the material and were experts in the material. And I've had teachers that may not have known the material as well, but were experts at teaching it." In his description of an instructor that he considered to be an expert teacher, Gregory said:

> [Instructor A], for instance, is not necessarily an expert in [advanced physics topic], but he is very good at teaching the material. So, when I have [advanced physics course] lab with [Instructor A] I end up learning more than in my lecture class purely because how he puts it across, how he interacts with students, and how he gets you to—point A to point B.

For Gregory, and other participants with this perspective, expertise in content is not necessary to be an expert teacher. Participants with this perspective do not seem to be indicating that content knowledge is not of importance. Gregory said:

> … you expect the teacher and you want the teacher to be knowledgeable of the subject matter. Maybe perhaps not the … end all, be all resource, encyclopedic knowledge of the material, but, you know, know it well enough to be able to be a reference.

This quote illustrates that Gregory thinks that content knowledge is important, but as the previous excerpts show he does not give it the same importance as pedagogical knowledge, or expertise in teaching.

Still others demonstrated a perspective that placed much more emphasis on content knowledge, or expertise in content. Ian said:

> So, like I said first and foremost to me to have an expertise in teaching, you need to have expertise in the material you're teaching. You can't explain something; you can't help somebody learn something that you're not really sure about yourself. So, you need to have a solid grasp of the material. I think that's first and foremost of being an expert teacher.

Again, participants with this perspective don't seem to be refuting the need for pedagogical knowledge, or expertise in teaching. They simply believe that it is of more importance than content knowledge. This was evident in the case of Ian. He said, "So, obviously professors have PhDs, but … we're seeing this material maybe for the first time and they need to be able to convey that information to you at that level."

He also spoke of the importance of having "experience in teaching" to be an expert teacher.

In this section, physics LAs' perspectives on content knowledge and pedagogical knowledge were considered. Included excerpts form the interviews illustrated that physics LAs' differentiate between content knowledge and pedagogical knowledge and agree that possession of both is a necessary qualification for teaching. However, when it comes to the importance of these two, more specifically, having expertise in content knowledge or in pedagogy, their perspectives varied.

Development of expertise in teaching. Physics LAs held varying perspectives when it came to to how and if someone can develop expertise in teaching. For example, some of the LAs believed that some are probably not capable of ever becoming an expert teacher because they lack the necessary natural abilities or personality that an expert teacher must possess. For example, Ophelia said:

I want to say it's natural. I think you need a lot of patience also. So, automatically if you're an impatient person, you are probably not a good teacher. Yeah, it's just—it's an ability that I don't think you can gain. People can train you. You can try, but really good teachers are just natural.

When discussing reflection as a tool for improving teaching, she again reveals her belief that not everyone can become an expert teacher. She said, "Some professors may improve, but some people just don't have it. I don't think so." Roberto, as well, believed that some people have a natural talent important for expertise in teaching and that some teachers will probably never attain expertise in teaching. He said:

74

I don't think everybody can get there. I know a lot of teachers and everyone has different techniques and styles, but I've just seen so few … [expert teachers] I don't know if that's because … they have this talent you can't really just learn by theory, but just a few of them get there.

Although Alexandria does not declare that it may be impossible for some to become expert teachers, she too believes that expert teachers possess an ability that is natural. She said, "… maybe other things [make one an expert teacher]; maybe there's just that love, that something you're born with that you're automatically a good teacher …" Other participants did not speak to the natural ability of expert teachers, but to how expertise in teaching can be obtained.

According to the perspectives of other participants; expertise in teaching is not automatic and there are things that anyone can do to improve their teaching. Many stated the fact that expertise in teaching is something that develops over time. Leonardo, specifically stated that "it can't be automatic." He then went on to discuss several things that a teacher could do to progress toward expertise in teaching. One of the things that he—as well as other participants—believed helps someone to develop expertise in teaching is taking education courses. In describing an expert teacher, Leonardo said:

… the fact that he had a degree in education made a big—I think it made a big deal because he had a lot more experience … with teaching it rather than just knowing the material. I mean a lot of professors know the material, but I think they have a lot of trouble actually getting their students to understand why something is the way it is, but I think the fact that he had a degree in education really helped.

Alexandria also mentioned the importance of taking classes in developing expertise. She said, "from the classes they talk about different topics … in classes like these they break it down how you learn, the different types of learning, the different ways that you can promote learning, and all of these things." Chelsea also spoke about developing expertise from the things learned in school. She mentioned taking seminar courses. She even went on to mention that these seminar courses needed to be interactive. She said:

> It should be more like a hands-on thing and practicing and maybe having test subjects that you can practice a class on or something. … I don't know how it is, but how I interpret it to be is: they give you a topic and you have to teach students a certain way and see …

Several other participants also mentioned taking education courses as a means for developing expertise in physics.

Participants also mentioned the importance of collaborating with other teachers as a means for developing expertise. While describing how someone becomes an expert teacher, Roberto said, "having other teachers talking about how to teach. … Maybe actually talk about teaching techniques and learning that with other experts." Similarly, Leonardo said, "I guess interaction with other people who are in the same field as them. You have your own ideas, but if you collaborate with other people, I'm sure it has an impact on how you learn or how you see or view things." Ian also described this process, but as happening unconsciously. He said:

> It can happen … unconsciously. … Let's say you're a physics instructor and you don't really know about [reformed physics courses], but your peers know about it and they can sort of tell you … so you're not actively seeking these sort of

methodologies, but they're active around you and you can sort of pick up some things from there …

Participants also discussed education research as a means for developing as an expert teacher. Alexandria spoke of the teacher "doing some research" themselves while Ian spoke of learning from the results of education research conducted by others. He said:

> … there's a lot being done in physics education or just education in general and they find certain aspects of teaching that will benefit instructors … all an instructor has to do is be aware of those and try to incorporate those sort of aspects into their methods to improve as instructors to be more expert-like … maybe you could be proactive in learning more about the education research that's going on because maybe your peers and yourself … you don't have the evidence to support other aspects that are effective that education groups are doing research on.

Although few participants were explicit as to how education research helps one to develop expertise in teaching, they did mention it as one way to obtain expertise in teaching.

In this section, physics LAs' perspectives on the development of expertise in teaching were discussed. Some participants revealed their belief that some people will never be able to obtain expertise in teaching and that there are certain natural abilities that expert teachers have that cannot be taught. Other participants focused on the fact that expertise in teaching can be taught and spoke to various methods for developing expertise

in teaching, including: taking education courses, collaborating with peers or colleagues, and utilizing the results of education research.

Experience: A necessary component for expertise in teaching. Experience is a term that each participants related to expertise in teaching. Some mentioned it as a characteristic of an expert teacher. For example in describing an expert teacher, Roberto said, "You need to be experienced." While others claimed that experience is what helps someone to develop expertise in teaching. Many used experience in this way. However, the kinds of experience they felt were necessary for developing expertise varied.

Sergio talked about previous experience with the topic taught as both a student and an instructor. When discussing how one develops expertise in teaching he said:

> I think it's mostly experience because I remember when I started LAing, what experience I would use about what questions students would ask was the experience from when I took physics … And if you're teaching for years and years and years, you already—it already becomes second nature … the experience is the biggest contributing factor.

Ian also spoke about the need for experience in teaching, but he believes that it is experience teaching a variety of topics that helps one to develop expertise in teaching. He said:

> In terms of experience if you put yourself in a bunch of different situations. So, for example, if you're a professor that only teaches one subject to a certain level of students and that's what you always do then maybe you won't have the same experience as a professor who teachers at multiple levels or different subjects and

so that's one way where you can gain that sort of experience by putting yourself in different positions.

Chelsea, like Sergio above, talked about experience as a student, rather than as an instructor. She said that one can develop expertise in teaching, more specifically, knowing how to engage students as coming from experience. She wrote, "I think knowing how to engage is from experience either being a student and realizing, "Okay, this is how I can do it and then by their education."

Some participants mentioned the need for experience with diverse groups of students. Ursulina speaks about teaching ethnically diverse groups of students. She wrote:

No, it can't be the experience alone. I think it also has to do with the location. [Professor 1 described as an expert] has taught in more than one country because he's from [country named] and then he's here and I believe his wife is [ethnicity named]. I think he did teach in [country of wife's origin] at one point too. So, he gets to see the different sort of perspectives and viewpoints from different cultures. And as far as I know [Professor 2 described as an expert] is from [location named] and he's taught in different states too and so has [Professor 3 described as an expert]. He's also from [location named], here, and he's from one of the White people states.

Ursulina explained that teaching in different locations leads to teaching diverse groups of students, which she believes is necessary for developing expertise in teaching. Leonardo also spoke to teaching diverse groups of students or "different types of students," but not

in terms of ethnicity, nationality, or culture. He spoke of the need to teach students with diverse academic backgrounds, or students at different levels of understanding.

Leonardo also speaks about the importance of interacting with these students from different backgrounds when it comes to developing expertise from experience. He said, "You can have five years, but if nobody interacts with you then it doesn't really make you an expert because you have no experience with the students." Gregory said that it is not the experience alone, but the ability to learn from your experience. He said:

> There are some people that no matter how many times they burn themselves will continue to burn themselves. Not perhaps that dramatic of an example, but still they will continue to do the same thing. You see that they're the people … like your girlfriend that's always going, "Why do I always attract these loser guys."
> Okay. It's because they from experience didn't learn.

Eduardo also spoke to the need to learn from previous experiences, but he focuses on learning from experiences by means of reflection. He said, "I think kind of reflecting on those experiences … reflecting on those experiences and seeing, again, how you can do better …"

In addition to the reflecting on teaching experiences, Eduardo also spoke to the need for experience in industry or in the field. In describing a teacher he considered to be an expert, he said, "He used to work in consulting and so he gave very applied examples about how to use this ... " Alexandria also spoke of "on the job experience."

In this section, experience as a means for developing expertise in teaching was discussed. Included excerpts in this section revealed a variety of perspectives on what kind of experience is necessary to develop expertise in teaching. Participants indicated

that experience being an instructor and teaching and experience as a student are important. Some participants indicated the need to teach a variety of topics, whereas others, emphasized the need for teaching a variety of students, including culturally and academically diverse students. Some participants emphasized that teaching experience—or teaching alone is not necessarily teaching experience that will lead to the development of expertise in teaching. Interacting with students, learning from experiences, and reflecting on experiences were mentioned as necessary for gaining the kind of experience that will lead to expertise in teaching.

Reflection on Teaching

To begin with, all participants mentioned that they have engaged in reflection on their teaching and shared examples of this. Through analysis of these participants' perspectives on reflection themes were revealed in regard to why they reflect on their teaching and how they reflect on their teaching. In regard to why they reflect on their teaching, participants indicated that their reflection is usually sparked by a frustration due to a phenomenon occurring in the class. However, an overarching motivation for reflecting on their teaching is a need to improve in their teaching. Participants indicated that they believe that reflecting on one's teaching is a means for improving their teaching. That being the case, they consider reflecting on one's teaching to be something that all teachers should do. However, they also revealed that they reflect less on their teaching now than they did as new LAs. In regard to how they reflect, LAs indicated that they found reflection through writing to be beneficial, but not their preferred method of reflection. They indicated a preference toward peer reflection because they valued the feedback from others as a part of their reflection.

Why LAs reflect. During the interviews all LAs indicated that they reflect on their teaching. Some participants indicated that they reflect on their teaching often. For example, Gregory said that he reflected "all the time." He went on to say, "I probably shouldn't admit that, but all the time." Most LAs indicated that reflection on their teaching most often takes place while they are still in the classroom. For example, Leonardo explained that he often reflected on his teaching while still in the classroom because something went wrong and it bothered him. When asked if he reflected on a particular incident after class, he said "Not after I left. It was immediately after that it kind of bothered me and I went back and I asked a different question and kind of got them on track, but not after. … I immediately went back like after five minutes and asked them something else. I felt bad about it." Reflecting immediately while in the classroom because of something going wrong or just not according to plan was mentioned by most participants.

Some participants described the reflection on their teaching as arising from frustration with things not going according to plan. Noel said:

> I think the best reflection I have is how frustrated I am when I leave. …If I'm really, really frustrated I'm like, … "What can I do to stop this frustration because it's going to give me a heart attack. … where are some areas where I can make up analogies where people just know? How can I relate it to things that people are really, really familiar with? Or how can I relate it to things that are really obvious?" And I'll just sit there and I'll think up ideas.

Similarly, Gregory indicated that he reflects on how he could make things better, how to improve something, or figure out a problem in the classroom because he cannot let it go.

He said, "I kept trying to figure out why the hell it didn't work." In these scenarios and the majority of the scenarios described participants indicated reflecting when something went wrong. Noel said of his reflection, "Usually when I'm wrong, I think back and I'm like, 'Man!'" Participants indicated that reflecting on their teaching when these types of situations occur is motivated by their desire to improve at teaching.

Reflecting to improve as teachers. For many of the participants reflecting on one's teaching for the purpose of improving their teaching is natural. Ursulina said:

I think that process, for anybody who has any interest in their students, is a very natural process … you don't have to think about it very much. It just comes up on its own for you to want to change.

Ian also spoke to the idea that reflection is necessary to improve on one's teaching. He said that:

…if you don't think about what you're doing you can't ever improve on it. So, if you go about doing things the same way and you never think about, "Well, why am I doing it this way or what other ways can I do it better." Then you'll never improve and you sort of stay stagnant.

Chelsea gave an explanation for why one stays stagnant if they do not reflect on their teaching. She said:

If you don't think about the student and if you're not thinking about them afterwards it's hard to just, "Okay, I'm going to change the next time. When I get there I'll think of something different." So, yeah, reflecting is important if you want to change as a teacher. If you want to be better and improve yourself, you

have to think about what worked and what didn't work and then try and change

that.

For all of the participants of this study, reflection on past teaching experiences was for

the future. According to the perspective of the participants, one reflects on their past

teaching experiences to determine what changes or decisions to make in the future,

motivated by the desire to improve as teachers. Because participants believed that

reflection on teaching is necessary to improve in teaching, they considered reflection to

be their responsibility. Participants' perspective on reflection being a responsibility or

mandatory for LAs and teachers alike will be discussed in the next section.

   Reflecting on teaching a responsibility for teachers. For Noel he has a sense of

responsibility to reflect on his teaching and making changes so that his students will

understand what he is trying to teach. He said, "It's my job. I'm supposed to help them

understand. It's my title, you know: Learning Assistant. I have to help them understand."

When explaining why he reflects with others, Ian said:

> I think that's the goal right? If you're teaching someone you want to teach them
>
> in the most effective manner possible and so that's—I think—that's the
>
> responsibility as a teacher to make sure you're teaching someone in the most
>
> effective way.

Although many of the scenarios of reflecting on teaching shared by participants were

related to reflecting on teaching strategies, some discussed a need to reflect on other

aspects of teaching. For example, Gregory mentioned that he reflected on the way he

interacted with students because he:

had a tendency to at least sound—not actually be— … an intellectual snob … I

have a tendency to do that kind of thing to either actually be or come off as

completely intellectually superior, you know and I may not necessarily be. …

But it is something that I have to watch in my interactions with other people …

Whether participants described reflecting on their teaching strategies or reflecting on

other aspects of their teaching, they all described it as mandatory to their teaching.

Eduardo explained that this was the key factor to being a better teacher. He said:

Just being an LA doesn't make you a great teacher. It's like those reflections …

if you're teaching, great, okay, you feel like you did a good job. But you don't

really know because you don't really ponder, "how did the students understand

these concepts, did they look confused, what questions did they have, how can I

do better in all this," and those are a lot of things that we went over with those

reflections. I think those reflections were really important initially because you're

just starting to teach, you don't really know how to analyze yourself. How do you

decide if you're doing a good job?

Here Eduardo referred to the reflections from the LA Seminar and revealed his belief that

reflection is a part of self-evaluation and assessing one's self as a teacher. This sheds

light on participants' perspective on why teachers must engage in reflection. Although

participants expressed the need for teachers to engage in reflection, they also indicated a

decrease in their reflection over time.

A decrease in reflection. Many participants indicated that they engage in

reflection less often now than they did when they were initially teaching as an LA.

Alexandria said this when speaking about peer reflection. She said, "In the past yes, but

recently no." When asked why she stopped engaging in peer reflection, she indicated that it was because she did not see her fellow LAs as much anymore. Eduardo, on the other hand, explained that he stopped reflecting because he became comfortable with teaching; although he regretted this. He said:

> And then later on as I kind of got used to it I think that was the bad thing, I started getting used to it and I was really good and I started not really paying attention as much to the smaller details about how I'm talking to the students, how much I'm walking around, how much I'm paying attention to the conversations that are happening, and ways that I could intervene and kind of make a better influence for all those different groups. So, I guess I got kind of a little comfortable and just started not paying as much attention as I used to when I first started. … I think it was a disservice to the students.

Sergio also spoke to reflecting more when he first started teaching. When discussing reflection he said:

> I would … mostly when I started off because eventually it becomes something that's automatic. … I just remember at least when I first started off, I would teach two lab sections a week and the first lab section I would spot where my weaknesses were where my strengths were and I would use that for the second lab section and for other sections ahead of time in the other semesters.

Although participants mentioned reflecting less on their teaching over time, in a general sense, when asked follow up questions, many indicated that it was the reflecting on their teaching strategies that was happening less often. For example when speaking specifically about reflecting on teaching strategies, Dominick said:

I've been LAing for technically three semesters. Spring, and now fall, and then

summer. When I first started I feel like I [reflected on my teaching strategies] a

little bit more. In the first semester that I LAed I was learning them pretty much

as we went through the LA Seminar.

No follow up questions were asked regarding why LAs reflected less over time

considering they felt reflection to be a part of a teacher's responsibility and a means for

improving in teaching over time.

In this section, LAs' perspectives on reflection were investigated through analysis

of their discussion on why they engage in reflection. All participants indicated that they

engage in reflection and explained that it was motivated by a sense to improve as teachers.

Although they reflected on the teaching strategies they used in the classroom less often

over time, they indicated that reflection on teaching experiences is a responsibility of

teachers, particularly if they want to progress in their teaching. In the next section, LAs'

perspectives on different methods of reflecting will be discussed.

Different mediums for engaging in reflection. Participants revealed that they

engage in personal reflection in the classroom. However, this was not the only way in

which they reflect on their teaching. Participants revealed their perspectives on personal

reflection through writing and peer reflection. Although participants found reflection

through writing to be beneficial, they indicated that they no longer engaged in reflection

through writing once it was no longer a requirement for a course. Perspectives shared by

the participants indicate that this may be due to the formulaic method in which they had

to write their reflections for the LA Seminar course. Furthermore, participants expressed

a preference for engaging in peer reflection over personal reflection. Participants'

perspectives on reflecting through writing and engaging in peer reflection will be discussed in this section.

   Written reflections. Some participants indicated that writing reflections on their teaching experiences was beneficial for them. Roberto described why written reflections on teaching experiences was beneficial to him. He said:

> Writing it down makes it a little more official in some way instead of just thinking in your head and start getting distracted. Writing it down kind of makes you focus your thoughts and organize them a little better than you would just as random thoughts in your head.

Although participants indicated that writing reflections was beneficial, the majority of them indicated that they do not personally write reflections on their teaching experiences. Ian said, "writing is not common. I don't write about teaching, but at the same time I don't write about any other aspect of my life." Noel said, "I don't write reflections. I don't do any—I just kind of walk away and think to myself." This comment by Noel illustrates his preference to engage in personal reflection over written reflection. Other participants indicated their preference to engage in peer reflection over personal reflection through writing. Specifically speaking to the reflections written in the LA Seminar, Leonardo said:

> I felt like writing about it and turning it in and not getting any feedback was not helpful for me at all, but I felt like talking about it with other LAs or other professors or other colleagues … is relevant. I feel like it's good for me because I'm getting natural feedback depending on how I present it and I'm getting something that means something to me because I'm asking them for a reason.

Another reason LAs did not seem to engage in reflection through writing though they considered it to be beneficial, is because they associated it with a routine or formulaic type reflection they submitted as a course requirement for the LA Seminar. For example, when describing the way he reflects now, Eduardo initially stated that he doesn't engage in reflection through writing, but then differentiates between the reflection through writing that he did in the LA Seminar course and the way that he reflections through writing now. When asked if he reflects on his teaching experiences through writing he said:

> No, not at all actually. It's more kind of like … it's more every week when I finish my reviews I kind of write down things that worked and didn't work. So, it wasn't like a full reflection on how the review went and everything like that …

Other participants spoke to this formulaic-type written reflection. Noel said:

> Everybody should reflect on something, but I don't think it has to be written. I don't think it has to be the same formula every time. It doesn't have to be what did you do well, what didn't you do well.

Although participants did not seem to care for engaging in reflection through writing, engaging in peer reflection seemed to be very important to them.

Peer reflection. Several participants indicated that they engage in peer reflection while discussing their teaching with fellow LAs. Ian, a former LA said, "Yeah, I talked about it with other LAs because a lot of my friends were also LAs and they're still LAs. So, I still [talk about teaching with them] even though I'm not an LA anymore …" Eduardo, also a former LA said:

… back then I used to talk about it with the other LAs. Kind of like if we ever got

frustrated that usually happened. We'd just go to the corner and talk about it and

see what we could do about this one student who was being troublesome … So, it

was very much like informal when I was an LA.

When explaining why he engages in peer reflection, Ian said:

… if you care about what you're doing, you're doing the best job possible. And

in doing that you have to see what other people are doing, right? That applies to

any aspect of life. So, if I want to be a good teacher, not only do I have to think

about what I'm doing, but I have to see what other people are doing and see how

my situation compares to theirs and if I can incorporate what they're doing into

what I'm doing.

So, again, Ian spoke to a sense of duty or responsibility that causes him to reflect, but in

this case he is saying that peer reflection as a specific form of reflection is mandatory as

well. Leonardo explained how he engages in peer reflection. He said:

So, the main thing is that when I tell them the situation I wouldn't tell them my

point about it—my perspective on it. I would just tell them straight up so that

they could react appropriately without any bias or anything in the way. … I don't

want to tell them how I feel so that they could just agree with me or disagree with

me just to disagree … but I wanted to get their natural reaction to it.

He went on to explain why he believes this kind of reflection was beneficial to him. He

said:

… it kind of teaches me about whether I did the right thing or not or how I could

approach it differently or what I could have done better because they obviously

90

aren't going to tell me, "Oh, you did great." The people I'm asking, I'm asking

for a reason. They'll give me feedback that's relevant.

Leonardo went on to discuss his preference for peer reflection over personal reflection.

Roberto felt similarly to Leonardo. He said:

It is helpful to think about what you did and what went right and what didn't work,

but I guess I would prefer having someone else to go back and forth to because I

have my point of view in thinking back personally. So, I'm not going to have

another input. It's just going to be my input on what I did and what I think. It's

more beneficial to have someone else, but even though I think personally it does

give you some benefit, just not as much as you get having someone else have an

opinion about what you did.

Although LAs discussed personal reflection on their teaching as happening most often, it

seems that they found peer reflection to be more beneficial to them because of the

feedback they received from others.

In this section, participants' views on reflection were determined by means of a

discussion of why and how they engage in reflection. The excerpts from the interviews

included in this section revealed that physics LAs engage in personal reflection in the

classroom as a response to phenomenon occurring in the classroom. Moreover,

motivated by a desire to improve on their teaching, LAs considered reflecting on their

teaching to be a part of their responsibility as teachers. Nonetheless, participants

revealed a recognition that they reflected on their teaching strategies less over time.

Participants also shared their perspectives on various ways to reflect. They found

reflection through writing beneficial, but did not engage in it when it was not required.

Furthermore, they found peer reflection to be more beneficial than any forms of personal reflection because they had the added value of a different perspective and feedback from someone else.

Teaching Experience in the LA Program

An investigation of physics LAs' perspectives on teaching in the LA program revealed that they found the teaching experience to be very beneficial, especially to them as prospective and preservice teachers. They considered the teaching experience provided a sort of practice for them in the future. They also found it rewarding to be able to help other students through the teaching experience. These two findings will be discussed in this section.

Valuable Teaching Experience. Overall comments on the teaching experience provided by the LA program, were positive. All of the LAs indicated that they enjoyed the experience and that they found it to be valuable teaching experience. Noel said, "Overall, I think it's a good experience. I'm glad I did it." Alexandria indicated that the teaching experience in the LA program strengthened her desire to teach. Dominick said, "It made me know that I could become a teacher if I wanted to." Comparing the teaching experience in the LA program to other aspects of the LA program, Chelsea said that it was the "most important" part of the program.

In particular, participants spoke to the teaching experience in the LA program as practice for teaching in the future and a unique opportunity. Speaking of the benefit of the teaching experience to himself personally, Gregory said:

It is worth its weight in gold. It's worth its weight in gold to me as a prospective teacher. … There are certain things that only can be learned by being thrown to

the wolves. … Being thrust upon students and learning what works and what doesn't, you know.

Speaking of the benefit of the program to LAs in general, Gregory emphasized the uniqueness of the opportunity. He said, "There are certain times when you have to learn by experience, you know. And then there are certain times when you can be taught. But as an LA, you get access to something that you would normally have to finish college [to receive]…" He goes on to mention that most people don't get access to a class to teach until they are doing student teaching or for some not until after they are in the field teaching as a part of their job. Roberto shares similar sentiments in considering the LA teaching experience to be an opportunity that many do not have. He feels this is especially true in his case because he did not major in education. He said, "I got a whole new insight into teaching, which I didn't know. I don't know how else I would have gotten this experience without a program like this since my main career is not education."

Several participants spoke to why they consider this experience to be important for prospective and preservice teachers. The most common perspective was that it prepared them for teaching. Noel spoke of the experience as preparing him before actually teaching. He said, "It gets my feet wet, …I don't like to do things without knowing how to do it first. … So, the more experience I get teaching in some way the better off I'll be …" Similarly, Ian said:

> The teaching experience, … I think being an LA prepared me to be a TA. And I think being a TA will prepare me in some regards for being a teacher … I think all that comes from the LA program. It all starts as being an LA.

Eduardo spoke of the experience as practice for teaching. He said:

So, that whole experience really just shows you how, it's kind of like an outlet for

you to practice different types of teaching and seeing what, works what doesn't.

And later if you're going to be a teacher or a professor, looking back on that and

maybe applying some of the things that worked and didn't work.

Ian spoke, particularly, to why he thinks this is an invaluable experience for those

preparing to be teachers without prior teaching experience. He said:

I would go so far as to say invaluable in the sense that it's a low-pressure

environment. You're with peers; you're not a teacher, you're not getting paid as a

teacher, you're not expected to—… You're not at that level. You're expected to

know the material and to be able to help the students and the students are aware of

that. So, it's a very low pressure environment in that sense and I think that's

important if you're starting off if you want to put your feet into teaching, you

need to sort of be in that environment that the LA program provides to build your

confidence, to gain some experience like I said, and to see whether or not it's

something that you would enjoy. … So, I think that's invaluable.

Similar comments from the participants revealed that they found the teaching experience

in the LA program to be beneficial to them as prospective and preservice teachers.

However, they did believe that more preparation would be necessary before they would

be ready to teach their own class. Noel indicated that he did not feel completely ready to

teach after participating in the physics LA program. However, he went on to say:

I think everybody should do it at the same time … At least if you're going to do

education and you're going to teach people. It's useful. It's fun, but mostly yeah

it's useful. It's good. I think that when I do finally teach, I will at some point say, "Thank God I did something like this before … "

Noel's comment and many similar comments from the participants revealed that they found the teaching experience in the program to be beneficial to them as preservice and prospective teachers. Mainly, it provided them with practice teaching others and an opportunity to learn things that they believed they would use in the future as teachers.

Rewarded by helping others. Many of the participants also indicated feeling a sense of accomplishment from helping students as a part of their teaching experience in the LA program. Noel describes his feelings of accomplishment when helping a particular student's grade to improve. He said:

I'm really proud of what happened with her because I feel like I directly helped a lot of what she did and I feel like I influenced her grade a lot. I don't want to say her knowledge because I don't know a lot about her knowledge, but I do know her grade. … While I don't take credit, I felt really good about myself. I was like, "Alright, I did this too. I helped her get here. Sweet!"

Similarly, Sergio indicated that he felt good when he had evidence that he'd helped a student to be successful. He said:

The best feeling was when I taught someone something and then next week they would come in and then they would still know it. They didn't just learn it for like two seconds, throw it away, and then had a drink at Chilli's. They actually held it in. So, I felt like I did something right.

Dominick described this rewarding sense of accomplishment as a unique experience. He said, "you can go through life without ever teaching anyone anything and you can be a

happy person, but if you … are the cause of that light bulb moment, that is an interesting feeling. … I think everybody should be an LA for at least a day."
Many participants described this rewarding feeling of accomplishment from helping students to learn as a part of the teaching experience in the LA program.

Summary

In this chapter, the results of phase one of the study were presented. The purpose of this phase of the study was to answer research question one: What are physics Learning Assistants' (LAs) views on reflective teaching, development of expertise in teaching, and their teaching experience in the LA program at FIU? By means of analysis of semi-structured interviews, several themes emerged in relation to physics LAs' perspectives on expertise in teaching, reflection on teaching, and the teaching experiences provided by the LA program at FIU. More specifically, participants revealed varying perspectives in regard to the importance of content knowledge and pedagogical knowledge in being an expert teacher, if and how a teacher can develop expertise in teaching, and the role experience plays in developing expertise in teaching. In regard to reflection on teaching, participants revealed that they all engaged in reflection on their teaching, that they believed that reflecting on teaching is a means of improving as a teacher, and that reflecting on teaching is a teacher's responsibility. Participants also revealed that they reflected on their teaching strategies less as they gained more experience in teaching. Participants found engaging in reflection through writing to be beneficial—though they didn't engage in reflection through writing after it was no longer required as a course. They found peer reflection to be especially beneficial to improving as a teacher. In regard to the teaching experience in the LA program, all participants

found it to be beneficial, they found the experience to be a unique opportunity to work with an entire class, they believed it prepared them for teaching in the future—though they believed that more preparation would be needed before they actually teach, and they believed it gave them a sense of accomplishment to help other students during their teaching experiences. In the next chapter, the findings of phase two of the study, the q methodology study, will be presented.

CHAPTER V

PHASE II FINDINGS

The goal of the second phase of this study was to address Research Question 2: What typologies exist among physics Learning Assistants (LAs) participating in the LA program at Florida International University (FIU) in regard to reflection on teaching, development of expertise in teaching, and their experience in the LA program at FIU? This question was addressed through analysis of Q sorts conducted by participants in the second phase of the study. The results and analysis of this phase of the study are presented in this chapter. The first section includes information on the participants in this phase of the study. The second section explains how a three-factor was chosen based on factor eigenvalues, percentage of variance accounted for by each factor, and factor loadings. The third section includes a discussion of the factor interpretation. This third section focuses on the varying perspectives as determined by the factors, or typologies, found in this phase of the study. It also includes comparison of the three factors. The fourth section matches participant teaching plans with associated factors. The chapter concludes with a summary of the findings.

Participant Information

In this phase of the study, 26 participants sorted 50 statements from the Q-sample [See Appendix C] into a quasi-normalized grid [See Appendix D] according to their agreement or disagreement with the statement. Participants' LA status is displayed in Table 1.

Table 1
Participant LA Status

Characteristic	Former LAs	Current LAs
Number (Percentage)	10 (38)	16 (62)

Each participant in this phase of the study participated in the physics LA program for at least one semester. Although the purpose of this study was to understand the perspective of prospective teachers participating in the physics LA program, this phase of the study was conducted at the end of the semester and the majority of participants indicated that they did not want to be K-12 teachers at this time. Participants' teaching plans are displayed in Table 2.

Table 2
Participants' Teaching Plans

Characteristic	Preservice	Prospective	Not Teaching
Number (Percentage)	4 (15)	5 (20)	17 (65)

Note: The majority of participants included in the "Not Teaching" category indicated that they are not interested in becoming a K-12 teacher at the time of data collection for this phase of the study. If participants did not explicitly state their teaching plans, it was collected from their LA rehire applications.

Participants' demographic information is displayed in Table 3 and Table 4.

Table 3
Participants' Demographic Information (Gender)

Characteristic	Female	Male
Number (Percentage)	10 (38)	16 (62)

Note: Participants were not asked for their gender. This information was collected from the LA database.

Table 4
Participants Demographic Information (Race or Ethnicity)

Characteristic	Black	Asian	White	Hispanic
Number (Percentage)	1 (4)	1 (4)	7 (27)	17 (65)

Note: Participants were not asked for their demographic information. It was collected from the LA database.

Table 5 displays participants' major.

Table 5
Participants' Declared Majors

Characteristic	Computer Sci.	Pre-med	Biology	Engineering	Chemistry	Physics	Psychology
Number (Percentage)	1 (4)	2 (8)	4 (15)	4 (15)	1 (4)	13 (50)	1 (4)

For confidentiality, participant information will not be matched to any individual sorters. Code names will be used to refer to any sorters in this phase of the study. If participants participated in phase one of the study, then codes names used in Chapter Four will be used in this chapter as well.

The Q Sample

The 50 statements in the Q Sample consisted of codes that came from LAs' written reflections as a part of the LA Seminar course. These codes were translated into statements and went through 5 rounds of peer review before the final Q sample was chosen. The members of the peer review were all members of the Physics Education Research Group at FIU. Six members were advanced graduate students, one member was a postdoctoral research associate, and one member was a physics professor. During the review process, I presented the codes and several excerpts from the reflections that I believed fit under the code. I also created sample statements that I felt were representative of the codes. Members of the peer review, gave suggestions on additional codes when they felt the codes were not representative of the excerpts from the reflections. They also gave suggestions for editing the statements to be more aligned with the thoughts in the excerpts. This process continued until the final codes and statements were deemed satisfactory by the group. The statements were consistent with

the codes on LAs' perspectives found in the interview data. A table of the Q sample is displayed in Appendix C.

Determination of the Three-Factor Model

The data from the sorts was entered into the PQMethod software program. As a standard, the PQMethod software program provides eight un-rotated factors. Thus, analysis of the un-rotated factors was completed in order to determine the number of factors to rotate and use for the study. Information used to rule out five of the factors will be presented first, then, factor properties for the three chosen factors will be presented separately. Because PQMethod automatically provides eight factors, eight factors were initially considered. However, factor eight had an eigenvalue of less than one. Thus, it was immediately ruled out as a factor. Table 6 shows the eigenvalues for factors four, five, six, seven, and eight. Factor properties for the three selected factors are presented in Table 9. Furthermore, the un-rotated factor solutions showed that factors five, six, and seven did not account for an adequate amount of the total variance. Table 6 shows the percent of the total variance explained by factors four, five, six, seven, and eight. Thus, factors five, six, seven, and eight were not considered. Factor four was not ruled out based on the total variance explained.

Table 6
Un-rotated Eight-Factor Solution

Characteristic	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Eigenvalue	1.4869	1.3308	1.0707	1.0020	0.8498
Percent of Variance Explained	6	5	4	4	3

The next consideration was the factor loadings. Table 7 displays the un-rotated factor matrix, which includes the factor loadings. Factor loadings above .40 were considered.

This is more liberal than the standard .50 (Brown, 1993) in an effort to include a higher

number of loadings in determining the number of factors to rule out. Even with the

liberal designation of .40 for factor loadings, the un-rotated eight-factor solution showed

that factors four, five, six, seven, and eight had less than three significant loadings which

led to eliminating factor four. Thus, a three-factor solution was chosen based on the data.

Table 7
Un-rotated Factor Matrix

Sorts	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
1	**0.6333**	-0.1129	**-0.4148**	0.3441	0.1274	-0.0665	0.1451	-0.0821
2	**0.5851**	-0.3377	-0.1395	0.3574	0.0804	**0.4046**	-0.1882	-0.0656
3	**0.4214**	**-0.4067**	-0.0918	0.1999	-0.1949	0.0019	**0.4892**	-0.2864
4	**0.6150**	0.0230	**0.5178**	-0.1952	0.0093	0.1836	0.1525	0.0333
5	**0.5391**	**0.4805**	-0.0962	-0.1926	-0.0911	-0.3142	0.2122	-0.0762
6	**0.7115**	-0.0437	-0.0387	-0.1540	0.0166	-0.0867	-0.2737	-0.3126
7	**0.6772**	-0.1463	**0.4020**	-0.0997	0.0989	-0.0346	0.2116	0.0234
8	**0.6996**	-0.2194	0.2483	-0.0412	0.0652	-0.2325	-0.1485	0.0032
9	**0.7913**	0.1782	-0.2220	0.1135	0.1040	0.0959	0.1156	0.0995
10	**0.4928**	0.3355	**-0.4739**	-0.1276	-0.0293	-0.1736	0.0541	0.0640
11	**0.5474**	0.3049	**-0.4516**	-0.0103	-0.0143	0.2788	-0.0526	0.0389
12	**0.7071**	-0.0595	-0.1845	-0.0380	**0.4713**	-0.2131	-0.0425	0.0552
13	**0.6249**	0.1904	0.1374	-0.0655	0.3373	0.1862	0.3387	-0.1866
14	**0.6459**	-0.2080	-0.2919	-0.1673	-0.0909	**0.4409**	0.1368	0.2076
15	**0.6750**	0.3737	0.2350	0.0131	0.0589	-0.2051	-0.1539	-0.2374
16	0.3633	**0.6097**	0.2618	0.1451	0.0246	0.3253	-0.2500	0.1698
17	**0.7204**	-0.3816	-0.0036	-0.0240	-0.1041	-0.0455	-0.1807	0.0859
18	**0.6989**	**-0.4304**	-0.1073	0.0693	-0.0998	-0.0888	-0.2083	-0.0822
19	**0.5801**	0.0506	**0.5003**	-0.0361	-0.3499	0.0681	0.0686	0.0004
20	**0.5853**	-0.2158	0.1517	0.1932	-0.2163	-0.2200	-0.0787	**0.5159**
21	**0.4199**	-0.2068	0.3147	0.2569	**0.5432**	-0.1184	0.0987	0.1996
22	**0.6782**	-0.1260	0.1267	-0.0170	**-0.5050**	0.0590	-0.0622	-0.2103
23	**0.5045**	-0.2191	-0.2593	**-0.5502**	0.1116	-0.0391	-0.2744	-0.0406
24	**0.6846**	**0.4514**	0.1472	0.0670	0.0658	0.1361	-0.1595	-0.0898
25	**0.6000**	0.1783	-0.1974	-0.3114	-0.2672	-0.1267	0.2294	0.3092
26	0.3005	0.3359	-0.1236	**0.7004**	-0.2431	-0.2264	-0.0420	-0.0163

Note: Factor loadings over .40 appear in bold.

Principal components analysis and Varimax rotation was performed on the three

chosen factors. For the rotated factors a loading value of > .50, positive or negative, was

considered important (Brown, 1993). The three factors accounted for 20 of 26

participants. The remaining six either loaded significantly on more than one factor (n =

1) or did not load significantly on any factor ($n = 5$). The factor loadings for each sort on

these three rotated factors, with significant loadings greater than .50 is shown in Table 8.

Table 8
Factor Loadings for the Three Rotated Factors

Q Sort	Factor 1	Factor 2	Factor 3
1	**0.6569**	0.3926	0.0150
2	**0.6462**	0.0986	0.2202
3	**0.5652**	-0.0583	0.1692
4	0.1439	0.1680	**0.7732**
5	0.0794	**0.6921**	0.2134
6	0.4950	0.3588	0.3686
7	0.3421	0.1100	**0.7159**
8	0.4710	0.1181	**0.6029**
9	0.4865	**0.6358**	0.2573
10	0.3102	**0.6848**	-0.1219
11	0.3542	**0.6826**	-0.0723
12	**0.5672**	0.3943	0.2459
13	0.2135	0.4332	0.4608
14	**0.6704**	0.2836	0.1256
15	0.0856	**0.5682**	**0.5659**
16	-0.2731	**0.5754**	0.4082
17	**0.6992**	0.0902	0.4095
18	**0.7626**	0.0766	0.3126
19	0.1121	0.1768	**0.7386**
20	0.4394	0.0931	0.4587
21	0.2565	-0.0440	**0.5003**
22	0.4525	0.2207	0.4884
23	**0.5734**	0.1885	0.0734
24	0.0815	**0.6636**	0.4971
25	0.3545	**0.5255**	0.1701
26	0.0323	0.4624	0.0597

Note: Factor loadings over .50 appear in bold.

These three factors had eigenvalues greater than one and explained 54 percent of the total

variance as shown in Table 9. Consideration of the eigenvalues and the percent of

variance explained by these three factors indicate that these three factors are important

and should be included in the factor model.

Table 9
Rotated Three-factor Solution

Characteristic	Factor 1	Factor 2	Factor 3
Eigenvalue	9.6045	2.2619	1.9850
Percent of Variance Explained	20	17	17

Factor Interpretation

Factor interpretation is a subjective process. Interpretation of the factor is

determined by the researcher and "closely guided by the particular configuration of items

in each typical array, along with the qualitative explanations provided by respondents

about their reasons for agreement or disagreement with the items they have chosen to

rank most highly" (Davis & Michelle, 2011, p. 571). In this study, interpretation of the

factor is based on the analysis of the Q sort results and comments made by sorters.

In order to interpret the factors, five features were used: (a) extreme ranking

statements, (b) distinguishing statements, (c) model arrays, (d) Q sort values, and (e)

participant comments. PQMethod automatically normalizes factor scores, which are an

average of the scores given to a statement by defining sorters. These average scores on a

given statement are weighted z-scores. *Extreme rankings* are based on z-scores greater

than one, positive or negative. *Distinguishing statements* are statements that differentiate

one factor from the other two. Distinguishing statements were considered to be

statements with z-score differences of 1 or greater between factors. *Model arrays* are

constructed by placing the statements back into the original Q sort grid based on the z-

scores. The values given to the statements in the model array are the Q sort values.

Participant comments were taken from interviews conducted with selected participants

after the Q sorts were completed. All of these things were taken into account when

interpreting the three factors of the model. The factors were named to reflect the

interpretation. Thus, the descriptions of the factors evolved with additional insights

revealed throughout the analysis (Newman & Ramlo, 2010). In this chapter, the name for

the factor is presented as a description of the sorters based on the views of the sorters

revealed through analysis of the Q sorts and sorters' comments.

Factor One Results

Factor One was representative of eight of the sorters as determined by eight sorts

loading highly, greater than .50, on Factor One. Analysis of the Q data for Factor One

revealed that sorters represented by Factor One felt strongly about what it means to be an

expert teacher, found reflection to be valuable, and felt rewarded while teaching.

This can be determined from the model array for Factor One in Figure 1. The

extreme statements in the model array, statements 36, 44, 22, and 46 were all related to

expertise in teaching. Strong agreement with statement 18 (+3) demonstrates feeling

rewarded while teaching in the LA program. Strong agreement with statement 37 (+3)

reveals that sorters represented by this category value reflection as helping teachers to

improve in their teaching. The name for this factor is Developing Expertise Through

Reflection. LAs associated with this factor felt strongly about expertise in teaching, felt

rewarded while teaching in the LA program, and valued reflection.

Figure 1

Model Array for Factor One

-4	-3	-2	-1	0	+1	+2	+3	+4
46	22	13	4	1	3	20	18	36
	44	23	8	2	5	31	37	
		24	12	6	7	33		
		29	16	11	9	34		
		30	28	14	10	41		
		43	35	15	17	50		
			38	21	19			
			40	27	25			
			47	39	26			
			48	42	32			
				45				
				49				

A consideration of the extreme ranking statements—statements with a z-score greater than one—confirm the chosen name. Table 10 shows the extreme ranking statements with high and low z-scores for Factor One. Of the 15 extreme ranking statements for Factor One, 11 are about expert teachers, two about reflection on teaching; and two about teaching experience in the LA program.

Table 10

Factor One Extreme Ranking Statements with High and Low z-scores

No.	Statement	z-score
36	A teacher can be an expert in their field, but not good at teaching it.	1.701
37	Thinking about what worked in the past and what didn't work in the past helps a teacher to become better over time.	1.566
18	While teaching in the LA program, I felt rewarded when helping students learn.	1.463
31	The teaching experience provided by the LA program opened my eyes to what it is like to be a teacher.	1.285
34	There is no set number of years of teaching experience required to become an expert teacher.	1.114
33	An expert teacher must be motivated to teach.	1.073
41	An expert teacher is approachable.	1.021
24	Certain qualities of an expert teacher are natural and cannot be learned.	-1.207
30	An expert teacher has a natural ability to teach.	-1.424
13	As one gains more experience, the need to think back on one's teaching decreases.	-1.663
29	An expert teacher should be both an expert in their field and an expert in teaching.	-1.672
23	It takes approximately five years of teaching to become an expert teacher.	-1.931
44	An expert teacher should be expert in the subject they teach.	-1.970
22	It takes approximately ten years of teaching to become an expert teacher.	-2.228
46	An expert teacher should be able to answer every question regarding the topic they are teaching.	-2.445

Sorters in this group did not feel as strongly about the need for an expert teacher to be an expert in content or an expert in pedagogy, which is shown by their disagreement with statements 29, 44, and 46. This group seemed to place more value on the qualities of an expert teacher. This can be seen in their agreement with statements 33 and 41.

The emphasis on expertise in teaching for Factor One sorters was confirmed by Roberto (Sorter 18), whose sort loaded highest on Factor One. He said:

> I think about the LA [program] as like creating a teacher, trying to mold a good teacher, an expert teacher as it is in some of the statements. So, I guess I thought of some of the techniques or what represented an expert teacher would be and I gave those more importance than other things that—even though they were helpful, it wasn't best representative of a good teacher.

Roberto agreed with the description that "people represented by this factor felt most strongly about what it means to be an expert teacher." He said, "Yeah that makes sense. I focused more on the idea of what an expert teacher is and becoming a good teacher rather than other ideas about the program."

They also place a high value on reflection on teaching, which is shown by their agreement with statement 37 and their disagreements with statement 13. Roberto also confirmed this in his comments. He said:

> I put it [statement 37] really high. I felt strongly about that one I guess because it seems like the basic way to become a better teacher. Simply to think about what you did that worked or didn't that worked and, then, do it again. If you were going to learn pretty much any practice it seems like the common sense best way to do it. Did that work? Yes. Okay, do it again. Etcetera.

The model array, the extreme ranking statements, and sorter comments agree with the initial interpretation and naming of this factor.

Factor Two Results

Factor Two was representative of seven of the sorters as determined by seven sorts loading greater than .50 on Factor Two. Sort 15 is not included because it loaded on

both Factor Two and Factor Three. Analysis of the Q data for Factor Two revealed that

sorters represented by Factor Two felt strongly about what it means to be an expert

teacher, valued the teaching experience, but did not value writing reflections.

The model array for Factor Two is displayed in Figure 2. The extreme statements

in the model array, statements 36, 33, 22, and 23 were all related to expertise in teaching.

Strong agreement with statement 2 (+3) demonstrates valuing the teaching experience in

the LA program for revealing gaps in their physics knowledge. Strong disagreement with

statement 40 (-3) demonstrates not valuing writing reflections as an aid to improve in

teaching. The name for this factor is Trying Out Teaching. LAs associated with this

factor felt strongly about expertise in teaching, valued the LA teaching experience, but

did not value writing reflections.

Figure 2
Model Array for Factor Two

-4	-3	-2	-1	0	+1	+2	+3	+4
23	22	12	6	1	5	37	2	36
	40	13	11	3	7	41	33	
		16	14	4	9	43		
		35	15	8	10	45		
		42	19	17	18	47		
		46	24	25	20	48		
			27	26	21			
			28	29	38			
			31	30	39			
			34	32	50			
				44				
				49				

Consideration of the extreme ranking statements reveals more about this factor.

Table 11 shows the extreme ranking statements with high and low z-scores for Factor

Two. Of the 12 extreme ranking statements for Factor B, eight of them are related to expertise in teaching. Two of the statements were related to reflection on teaching and two of the statements were related to the teaching experience in the LA program.

Table 11
Factor 2 Extreme Ranking Statements with High and Low z-scores

No.	Statement	z-score
36	A teacher can be an expert in their field, but not good at teaching it.	2.276
2	The teaching experience in the LA program forced me to confront the gaps in my physics knowledge.	2.132
33	An expert teacher must be motivated to teach.	1.656
41	An expert teacher is approachable.	1.640
43	An expert teacher should be an expert in conveying their knowledge to students.	1.581
48	A teacher develops expertise in teaching through experience.	1.227
46	An expert teacher should be able to answer every question regarding the topic they are teaching.	-1.458
13	As one gains more experience, the need to think back on one's teaching decreases.	-1.524
35	As a result of the teaching experience provided by the LA program, I am more likely to become a teacher in the future.	-1.649
22	It takes approximately ten years of teaching to become an expert teacher.	-1.718
40	Writing reflections on my teaching experiences helped me to become a better LA.	-2.009
23	It takes approximately five years of teaching to become an expert teacher.	-2.164

This group felt most strongly about the characteristics or qualities of an expert teacher as shown by their agreement with statements 33, 41, and 43. This group did not feel that writing reflections helped them to become better teachers as evidenced by their disagreement with statement 40. However, they seem to value reflection as shown by their disagreement with statement 13. In regard to teaching experience, this group agreed with statement 2; however, they disagreed with statement 35. Sorters associated with this

factor did not feel the teaching experience in the LA program made them more likely to become a teacher in the future.

When explaining his ranking of statement 40 Brian (Sorter 24), whose sort loaded highly on Factor Two, said:

> …when writing the reflection … there were times when I wrote something down and I realized certain ways about how I taught or tried to teach students, but I felt that a majority of the time, what really helped me out to become a better LA was discussion with other LAs and other professors more than anything. That's where I found … the different things I had to change in order to become a better LA … I learn more when I talk things out.

This comment is consistent with the perspective found in Phase One of the study. LAs interviewed in Phase One indicated that they found more benefit in peer reflection than through writing reflections. Brian went on to say,

> …even though I feel strongly about having good teachers and how important being a teacher is, I don't see myself doing it. I don't feel like that's my calling in life … and being an LA has helped sway that opinion … not that I didn't like it … it' just not what I wanted to do. … I think the LA program, if anything, is to help people discover, "Wow, I really want to teach" or "I don't want to teach." That's good to me because there' some teachers out there that really shouldn't be teaching and then there's others that really should be teaching.

According to comments by sorters associated with Factor Two, they saw the LA program as a chance to determine if they wanted to teach or not. Based on the analysis of Factor Two data and sorter comments this factor is named, "LAs that valued reflection, but did not value writing reflections, felt strongly about expertise in teaching, and valued the LA teaching experience.

Factor Three Results

Factor Three was representative of five of the sorters as determined by five sorts loading, greater than .50 on Factor Three. Sort 15 was not included because it loaded on both Factor Two and Factor Three. Analysis of the Q data for Factor Three revealed that sorters represented by Factor Three felt strongly about their views on reflection, expertise in teaching, and the teaching experience in the LA program.

The model array for Factor Three is displayed in Figure 3. Of the extreme statements in the model array, statements 46 and 22 were related to expertise in teaching, 27 and 18 were on the teaching experience in the LA program, and 9 and 13 were on reflection. Strong agreement with statements 27 and 18 show that this group valued the teaching experience in the LA program. Strong agreement with statement 9 and strong disagreement with statement 13 show that this group valued reflection. The name for this factor is Gaining Valuable Experience. LAs associated with this factor valued the teaching experience and reflection."

Figure 3
Model Array for Factor Three

-4	-3	-2	-1	0	+1	+2	+3	+4
46	13	4	8	1	6	3	9	27
	22	23	16	2	10	7	18	
		24	19	5	11	17		
		28	25	12	33	20		
		30	26	14	35	29		
		50	31	15	36	37		
			32	21	38			
			42	34	41			
			48	39	44			
			49	40	45			
				43				
				47				

Consideration of the extreme ranking statements provide more information about this factor. Table 12 displays the extreme ranking statements with high and low z-scores for Factor Three. Of the eight extreme statements with positive z-scores for Factor Three, six of them are related to the teaching experience in the LA program. Extreme statements with a negative z-score did not include any statements on the teaching experience in the LA program. This is likely due to the fact that no statements included in the Q sample mentioned anything negative regarding the teaching experience in the LA program. Thus, it makes sense that extreme ranking statements with low z-scores would not include statements on the teaching experience in the LA program for Factor Three. Five of the six extreme ranking statements with low z-scores are related to expertise in teaching. This shows that expertise in teaching was a category that sorters across all three factors felt strongly about. A consideration of the varying views on expertise in teaching was considered when distinguishing between factors. Those represented by Factor Three (Gaining Valuable Experience), in particular, did not agree with statements about expert teachers that seemed to be restrictive or indicated that expert teachers had a natural ability to teach.

Table 12

Factor 3 Extreme Statements with High and Low z-scores

No.	Statement	z-score
27	The teaching experience provided by the LA program, was exciting.	1.675
18	While teaching in the LA program, I felt rewarded when helping students learn.	1.598
9	Thinking back on one's teaching is beneficial to being a good teacher.	1.540
17	As a result of the LA program, my teaching skills have improved.	1.462
7	As an LA, I used my experiences from one lab section (or with one group) to help me make decisions about what to do with the next lab section (or the next group).	1.410
3	Thinking about what worked and what didn't work when I was teaching, helped me to become a better LA.	1.204
29	An expert teacher should be both an expert in their field and an expert in teaching.	1.187
20	As a result of the teaching experience provided by the LA program, my knowledge of how to teach has increased.	1.045
24	Certain qualities of an expert teacher are natural and cannot be learned.	-1.502
30	An expert teacher has a natural ability to teach.	-1.563
23	It takes approximately five years of teaching to become an expert teacher.	-1.909
13	As one gains more experience, the need to think back on one's teaching decreases.	-1.972
22	It takes approximately ten years of teaching to become an expert teacher.	-1.972
46	An expert teacher should be able to answer every question regarding the topic they are teaching.	-2.700

This group felt strongly about the benefit of the teaching experience provided in the LA program as shown by their high rankings of statements 27, 18, 17, and 20. This group also felt strongly about the benefits of reflection. This can be seen in their high rankings for statements 9, 7, and 3 and their disagreement with statement 13.

Factor Three (Gaining Valuable Experience) stood out clearly among the other factors because of its high ranking of statements regarding the teaching experience in the LA program. Furthermore, Ian, Sorter 4—whose sort loaded highest on Factor Three— confirmed this. When asked to explain what his "considerations were in moving things around?" He explained that the ones he felt:

> more strongly about … had to do with …my experiences with the LA program. That's why you see in the front half … a good chunk of them are in the upper regions because those are the ones I felt most strongly with. I feel like the LA program benefited me a great deal in terms of teaching. So, those specific statements I think they resonated more with me.

In regard to reflection, Ian also shared that he felt strongly about the benefits of reflection and the importance of it in the LA program. He said, "I ranked ones that dealt with reflection higher because it's something that the LA program emphasized … and it's something that I feel is very important when you're learning something." Ian also confirmed my description of Factor Three (Gaining Valuable Experience) sorters as feeling "most strongly about the teaching experience provided by the LA program" and that "it had a major impact" on them. He said, "That pretty much—[nods his head] I agree with that completely." Based on the analysis of Factor Three (Gaining Valuable Experience) data and sorter comments LAs associated with this factor are described as having felt strongly about the value of the teaching experience in the LA program and expertise in teaching and also valued reflection."

Differences Between Factor One and Factor Two

Following an initial analysis of the three factors, distinguishing statements were used to discriminate between the three factors. Distinguishing statements are statements for which there was a difference in z-score greater than 1 for Factor One (Developing Expertise Through Reflection) and Factor Two (Trying Out Teaching). These statements were used to further explain the two factors. In Table 13, the Q Sort Values for Factor One and Factor Two follow each statement and indicate the differences in the viewpoints of the sorters associated with each of the two factors.

Table 13

Q Sort Values for Differences Between Factor 1 and Factor 2

No.	Statement	Factor 1	Factor 2
31	The teaching experience provided by the LA program opened my eyes to what it is like to be a teacher.	2	-1
34	There is no set number of years of teaching experience required to become an expert teacher.	2	-1
40	Writing reflections on my teaching experiences helped me to become a better LA.	-1	-3
35	As a result of the teaching experience provided by the LA program, I am more likely to become a teacher in the future.	-1	-2
19	The teaching experience provided by the LA program made me more aware of aspects of teaching that go beyond just being in the classroom.	1	-1
6	As a result of the teaching experience provided by the LA program, I have come to like teaching more.	0	-1
42	Taking education courses can help someone to become a better teacher.	0	-2
18	While teaching in the LA program, I felt rewarded when helping students learn.	3	1
47	An expert teacher is confident.	-1	2
48	A teacher develops expertise in teaching through experience.	-1	2
29	An expert teacher should be both an expert in their field and an expert in teaching.	-2	0
30	An expert teacher has a natural ability to teach.	-2	0
2	The teaching experience in the LA program forced me to confront the gaps in my physics knowledge.	-2	0
44	An expert teacher should be expert in the subject they teach.	-3	0
43	An expert teacher should be an expert in conveying their knowledge to students.	-2	2

Teaching Experience in the LA Program

Overall, we see that sorters associated with Factor One (Developing Expertise Through Reflection) ranked statements that had to do with the teaching experience in the LA program higher. This can be seen in the Q sort values for statements 31, 35, 19, 6, and 18. Thus, sorters associated with Factor One valued the teaching experience in the LA program more than those associated with Factor Two.

Sorters associated with Factor Two (Trying Out Teaching) valued the teaching experience in the LA program, but did not feel strongly about its value or impact on them. When describing her participation in the LA program, Chelsea (Sorter 5), whose sort loaded highest on Factor Two said:

> I mean I like it more than tutoring at the learning center, but it's still work. As much as you can like work, I like it. I don't like look forward to going, but I don't mind when I'm there.

Both Chelsea and Brian—discussed in the section on Factor Two—did not seem to be indicating that they did not like the teaching experience in the LA program. However, they did not seem to feel it benefited them as much as sorters associated with Factor One. Moreover, it did not increase their desire to want to be teachers as shown in their disagreement with statement 35. In fact sorter comments associated with Factor Two indicated that the teaching experience in the LA program helped them to realize that they did not want to become teachers. Chelsea, who indicated that she is now certain that she

does not want to become a teacher mentioned "knowing if you want to teach" as a benefit of the LA program. Brian said:

> I guess cause even though I feel strongly about having good teachers and how important being a teacher is I don't see myself doing it. I just don't feel like that's my calling in life. Being an LA has helped sway that opinion not that I didn't like it, I liked it very much it's just not what I wanted to do. … so, I think the LA program is to help people discover "wow I really want to teach" or "I don't want to teach."

We can see a sharp contrast here in the way that sorters associated with Factor One (Developing Expertise Through Reflection) and those associated with Factor Two (Trying Out Teaching) saw the benefit of the LA program as a whole and the teaching experience in the LA program. Roberto (associated with Factor One) mentioned that he saw the LA program as preparing future expert teachers. Chelsea and Brian, on the other hand, seemed to see the LA program as an opportunity for LAs to determine whether or not they want to teach. The negative ranking of statement 35 by both groups indicates that they do not believe that they are more likely to become a teacher as a result of the LA program, but sorters associated with Factor Two felt more strongly about this.

The one distinguishing statement related to the teaching experience in the LA program that was ranked higher by Factor Two (Trying Out Teaching) was statement 2 which expressed valuing the teaching experience for forcing the LA to confront the gaps in their physics knowledge. For these sorters increasing their own physics knowledge is a motivation for becoming an LA. When asked about the benefit of the LA program

Chelsea initially stated, "I think the benefit is learning the material better." Brian also expressed that the teaching experience in the LA program helped him to confront gaps in his physics knowledge "all the time."

As a result of the consideration of these distinguishing statements and sorter comments the description for Factor One (Developing Expertise Through Reflection) will remain the same. LAs associated with this factor felt strongly about expertise in teaching, felt rewarded while teaching in the LA program, and valued reflection. Based on these findings the description for Factor Two (Trying Out Teaching) was changed to indicate that LAs associated with this factor valued reflection, but did not value writing reflections, felt the LA program would help them decide if they want to teach, but as a result of the teaching experience in the LA program were less likely to become teachers, felt strongly about expertise in teaching, and valued the teaching experience in the LA program for helping them to confront gaps in their physics knowledge.

Expertise in Teaching

Physics LAs' whose sorts associated with Factor One (Developing Expertise Through Reflection) and Factor Two (Trying Out Teaching) also differed in their views on expertise. Sorters associated with Factor One disagreed with many of the statements indicating that an expert teacher must be an expert in their subject or pedagogy. This can be seen in their low Q-sort values for statements 29, 2, and 44. For each of these statements the Q sort value for Factor One was -2. When asked about the statements on the extreme left, Roberto said:

… a lot of those were easy for me to discard because they would say things like an expert teacher has to know all the right answers or they have to .. have natural ability to teach or know everything about their subject and that was the opposite of what we were taught as an LA. … You can become a teacher with practice and learning methods, and any experience, and thinking about how you teach and what's working and what's not. That seems important to becoming a good teacher. It's not that the only good teachers are good because they were born that way. That was completely incorrect.

Sorters associated with Factor Two, on the other hand, did not disagree with these statements. This is indicated by the Q sort value of 0, for statements 29, 30, and 44. Regarding statement 30, Sorter B said:

They could [have a natural ability to teach]. I've noticed some people who are just very good at explaining things off the bat. They've never had any teaching experience before, but I've also met plenty more people who are really good at explaining things … and who are just very well talented with words, who were never like that. …

Thus, these were statements for which sorters associated with Factor Two had neutral feelings. Sorters associated with Factor One, on the other hand, strongly disagreed with these statements.

Three additional statements regarding expertise in teaching distinguished Factor One and Factor Two: statements 43, 47, and 48. Although they were not given extreme

rankings, positive or negative, for either factor, sorters associated with Factor Two expressed agreement with these statements while sorters associated Factor One expressed slight disagreement. Statement 43 was ranked negatively because, again, sorters associated with Factor One do not believe that being an expert teacher requires expertise in content or pedagogy. Statement 47 was ranked negatively because sorters associated with Factor One believe that a teacher is still learning and need not always be confident about everything they teach. Finally, statement 48 was ranked negatively because sorters associated with Factor One believe that one develops expertise in teaching through experience when it is coupled with reflection. This was indicated by both sorter comments and ranking of statements regarding reflection. This was also one of the viewpoints that emerged from the data in Phase One of this study.

As a result of the consideration of these distinguishing statements and sorter comments the description for Factor One (Developing Expertise Through Reflection) was changed to indicate that LAs associated with this factor believed expertise in teaching is not natural and does not require expertise in content or pedagogy, but develops over time as a result of reflecting one one's teaching experience and felt rewarded while teaching in the LA program. Based on these findings the description for Factor Two (Trying Out Teaching) was changed to indicate that LAs associated with this factor valued reflection, but did not value writing reflections, felt the LA program would help them decide if they want to teach, but as a result of the teaching experience in the LA program were less likely to become teachers, and valued the teaching experience in the LA program for helping them to confront gaps in their physics knowledge. The only distinguishing

statement for these two factors related to reflection was statement 40 on writing

reflections, which was already considered in the interpretation and naming of Factor Two.

Thus, a consideration of the statements on reflection does not help to further distinguish

between these two factors.

Differences Between Factor One and Factor Three

In Table 14, the Q Sort Values for Factor One (Developing Expertise Through

Reflection) and Factor Three (Gaining Valuable Experience) are shown for the

statements for which the difference in z-score was greater than 1. These statements will

be used to distinguish between Factor One (Developing Expertise Through Reflection)

and Factor Three (Gaining Valuable Experience).

Table 14

Q Sort Values for Differences Between Factor 1 and Factor 3

No.	Statement	Factor 1	Factor 3
31	The teaching experience provided by the LA program opened my eyes to what it is like to be a teacher.	2	-1
50	As a result of the teaching experience provided by the LA program, I have more appreciation for people who teach.	2	-2
36	A teacher can be an expert in their field, but not good at teaching it.	4	1
26	The teaching experience provided by the LA program prepared me for teaching in the future, if I choose to teach.	1	-1
34	There is no set number of years of teaching experience required to become an expert teacher.	2	0
19	The teaching experience provided by the LA program made me more aware of aspects of teaching that go beyond just being in the classroom.	1	-1
25	A teacher becomes an expert by teaching students from a variety of different backgrounds.	1	-1
32	As a result of the teaching experience in the LA program, I learned from the students I taught.	1	-1
35	As a result of the teaching experience provided by the LA program, I am more likely to become a teacher in the future.	-1	1
43	An expert teacher should be an expert in conveying their knowledge to students.	-2	0
27	The teaching experience provided by the LA program, was exciting.	0	4
44	An expert teacher should be expert in the subject they teach.	-3	1
29	An expert teacher should be both an expert in their field and an expert in teaching.	-2	2

Teaching Experience in the LA Program

Overall, we see that sorters from both factors ranked statements regarding the benefit of the teaching experience high overall. As discussed in the section on Factor Three, sorters associated with this factor placed a high value on the teaching experience as shown by the number of extreme statements with positive values that were related to the teaching experience in the LA program. However, Table 14 shows higher Q Sort Values for Factor One than Factor Three. In particular, statements 31, 50, 26, 19, and 32 were ranked higher by sorters associated with Factor One. In discussing his sort of these statements, Ian (associated with Factor Three) said:

> … some of these ones about people who teach, I did rank them kind of low and that's because in the LA program, all you do is you sort of help students and I took it as a way of if you were to go to a school and teach. There's a lot more to it than just being able to help students. There's lesson planning and things like that, that the LA program doesn't focus on at all. So, I think I had that mindset when I put those teaching ones to the lower end.

Although sorters associated with Factor Three felt strongly about the impact of the teaching experience on them, when it came to the teaching experience preparing them for teaching or making them aware of what it was like to be an actual K-12 teacher, they did not agree that it did this. Thus, statements 31, 50, 26, 19, and 32 were ranked lower by sorters associated with Factor Three. Agreement with statement 35 shows that sorters associated with Factor Three are more likely to become teachers as a result of the teaching experience in the LA program.

Based on these findings, the description for Factor One (Developing Expertise Through Reflection) did not changed, but the description for Factor Three (Gaining Valuable Experience) changed to indicate that LAs associated with this factor valued the teaching experience in the LA program because it had an impact on them and increased the likelihood that they will become teachers, but felt it did not completely prepare them to enter the field of teaching, valued reflection, and felt strongly about expertise in teaching."

Expertise in Teaching

Another difference between sorters associated with Factor One (Developing Expertise Through Reflection) and Factor Three (Gaining Valuable Experience) is in relation to their feelings on expertise in teaching. As mentioned earlier, sorters associated with Factor One (Developing Expertise Through Reflection) disagreed with the idea that teachers need to be an expert in their subject or an expert in teaching. Roberto mentioned that as a teacher you learn as you teach. He said that "sometimes you learn from your students." Sorters associated with Factor Three, on the other hand, felt that an expert teacher must be an expert in both content and pedagogy. For example, Ian said:

> I ranked higher that an expert should be an expert in the subject that they teach
> and that an expert should be both an expert in their field and an expert in teaching.
> … I think you need to have both. Not just an expert in teaching, but an expert in
> the field. It's extremely important to me. That's why I ranked those highly. I

have all three of those statements on the higher end. In my experience, it's

extremely important.

This perspective that both expertise in content and expertise in pedagogy are important to

being an expert teacher is in line with the perspective on expertise in teaching discussed

in the results of Phase One of the study. However, Roberto—and the sorters associated

with Factor One —seem to be revealing another perspective. There are some physics

LAs that feel that one does not need to be an expert in content or pedagogy. This view

was not evident in the data from Phase One of the study. For these sorters teachers can

be expert teachers because of the qualities they possess and still continue to learn and

develop their expertise in content and pedagogy while teaching.

Based on these findings the description of Factor One (Developing Expertise

Through Reflection) remained the same. However, the description for Factor Three

(Gaining Valuable Experience) was changed to indicate that LAs associated with this

factor valued the teaching experience in the LA program because it had and impact on

them and increased the likelihood that they will become teachers, but felt it did not

completely prepare them to enter the field of teaching, valued reflection, and felt that

expertise in teaching requires both expertise in content and expertise in pedagogy."

There are no statements on reflection that distinguish Factor One from Factor Three, thus,

no additional insight on views on reflection help to further the interpretation of these

factors.

Differences Between Factor Two and Factor Three

Much of the information regarding the interpretation of Factor Two (Trying Out Teaching) and Factor Three (Gaining Valuable Experience) has been teased out in the previous sections. A consideration of the distinguishing statements for Factor Two (Trying Out Teaching) and Factor Three (Gaining Valuable Experience) confirmed the findings from the previous sections. Table 15 follows the format of Tables 13 and 14.

Table 15

Q Sort Values for Differences Between Factor 2 and Factor 3

No.	Statement	Factor 2	Factor 3
30	An expert teacher has a natural ability to teach.	0	-2
36	A teacher can be an expert in their field, but not good at teaching it.	4	1
2	The teaching experience in the LA program forced me to confront the gaps in my physics knowledge.	3	0
48	A teacher develops expertise in teaching through experience.	2	-1
43	An expert teacher should be an expert in conveying their knowledge to students.	2	0
46	An expert teacher should be able to answer every question regarding the topic they are teaching.	-2	-4
50	As a result of the teaching experience provided by the LA program, I have more appreciation for people who teach.	1	-2
41	An expert teacher is approachable.	2	1
3	Thinking about what worked and what didn't work when I was teaching, helped me to become a better LA.	0	2
18	While teaching in the LA program, I felt rewarded when helping students learn.	1	3
17	As a result of the LA program, my teaching skills have improved.	0	2
29	An expert teacher should be both an expert in their field and an expert in teaching.	0	2
6	As a result of the teaching experience provided by the LA program, I have come to like teaching more.	-1	1
40	Writing reflections on my teaching experiences helped me to become a better LA.	-3	0
27	The teaching experience provided by the LA program, was exciting.	-1	4
35	As a result of the teaching experience provided by the LA program, I am more likely to become a teacher in the future.	-2	1

As was mentioned before, sorters associated with Factor Three (Gaining Valuable Experience) valued the teaching experience in the LA program, but did not feel it prepared them to teach. Sorters associated with Factor Two felt the LA program gave them more appreciation for teachers and helped them to confront gaps in their physics knowledge (statement 50 and statement 2). Sorters associated with Factor Three felt more strongly about the benefit of the LA program to them as prospective teachers than sorters associated with Factor Two (Trying Out Teaching). Thus, they ranked statements 4, 6, 17, and 18 higher than sorters associated with Factor Two.

Although their ranking of statements indicate a difference in their views on expertise, sorter comments reveal that sorters associated with Factor Two (Trying Out Teaching), feel similarly to sorters associated with Factor Three in regard to expertise in teaching. Sorters associated with both Factor Two and Factor Three held views on expertise in teaching that were contrary to sorters associated with Factor One. The difference is the weight of the ranking of these statements. In Factor Two they are ranked neutral (0) and in Factor Three they are positively ranked (+2). Thus, no new insights came from the analysis of statements related to expertise in teaching that distinguished Factor Two from Factor Three. Likewise, no new statements regarding reflection offered insights on the factors. Thus, the descriptions of Factor Two and Factor Three were not changed.

Participant Teaching Plan Matched to Profiles

In this section, participant teaching plan is matched to the factors in Table 16.

Table 16 also matches participant LA status to the associated factors. Only the 20 sorters

whose sorts loaded significantly—greater than .50 (Brown, 1993)— on one factor are

considered as being associated with that factor. Thus, only those 20 are included in Table

16.

Table 16					
Teaching Plan and LA Status for Sorters Associated with Factors (sort loaded > .05)					
	Preservice	Prospective	Not Teaching	Former LA	Current LA
Factor One	2 (25%)	2 (25%)	4 (50%)	3 (38%)	5 (62%)
Factor Two	0	0	7 (100%)	3 (43%)	4 (57%)
Factor Three	0	2 (40%)	3 (60%)	2 (40%)	3 (60%)

Because of the small sample size in this phase of the study, no conclusions can be

drawn about participant teaching plan and factors for which they were associated.

Similarly, because of the research design of this phase of the study, no conclusions can be

drawn regarding why sorters of any particular group associated with particular factors.

However, it is interesting that Factor Two consists solely of participants who indicated

that they are no longer interested in teaching and all of the preservice teachers are

associated with Factor One. The prospective physics teachers were split between Factor

One and Factor Three.

Summary

In this chapter the results of phase two of the study, the Q methodology study, were

presented. Findings based on these results answered the second research question: What

typologies exist among physics LAs participating in the LA program at FIU in regard to

reflection on teaching, development of expertise in teaching, and their experience in the LA program at FIU? Results of the Q study revealed three typologies among physics LAs' regarding their perspectives on expertise in teaching, reflection on teaching, and their experience in the LA program at FIU. LAs associated with Factor One (Developing Expertise Through Reflection) believed expertise in teaching is not natural and does not require expertise in content or pedagogy, but develops over time as a result of reflecting on one's teaching experience and felt rewarded while teaching in the LA program. LAs associated with Factor Two (Trying Out Teaching) valued reflection, but did not value writing reflections, felt the LA program would help them decide if they want to teach, but as a result of the teaching experience in the LA program were less likely to become teachers, and valued the teaching experience in the LA program for helping them to confront gaps in their physics knowledge. LAs associated with Factor Three (Gaining Valuable Experience) valued the teaching experience in the LA program because it had and impact on them and increased the likelihood that they will become teachers, but felt it did not completely prepare them to enter the field of teaching, valued reflection, and felt that expertise in teaching requires both expertise in content and expertise in pedagogy."

CHAPTER VI

PHASE III FINDINGS

In this chapter the results of Phase Three of the study are presented. The goal of the third phase of this study was to address Research Questions 3 and 4. Research Question 3 was: Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing," what percentage of writing assignments submitted by participants will be characterized as having evidence of reflection? The hypothesis for Research Question 3 was: Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" at least 66% of the writing assignments submitted by physics LAs will be characterized as having evidence of reflection. Research Question 4 was addressed using the data from both Phase Two and Phase Three of the study. Research Question 4 was: Do factors determined by physics LAs' typologies predict the level of reflection evident in their writing assignments? The results of this analysis are included in this chapter as well. The hypothesis associated with Research Question 4 was: Analysis of ordinal logistic regression models will indicate that factors determined by the physics LAs' typologies are predictors of level of reflection evident in writing.

The first section of this chapter explains how data was collected in Phase Three of this study. The second section includes Phase Three findings. In the third section, Research Question 3 was addressed. The fourth section of this chapter includes the analysis of the ordinal logistic regression used to answer Research Question 4. This chapter concludes with a summary.

Phase Three

To answer Research Question 3, the rubric based on Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing" was used to assess written reflections for 24 participants. All participants included in Phase Three of this study participated in Phase Two of the study as well. Participant information for this study will not be included in this chapter so as not to identify the two participants who chose not to participate in the third phase of the study. The participant information is similar to that provided in phase two of the study.

During this phase of the study, participants were asked to watch two videos of physics LAs at a different institution assisting students during completion of an Open Source Tutorial (Elby et al., 2013) similar to what is used at FIU. Students submitted a writing assignment for both videos. For the writing assignment, participants were asked to "write reflections on the videos as if they were your own teaching experiences you were thinking about." Thus, many participants wrote the assignments in first person. Participants were given two videos to watch to increase the likelihood that they would find something of interest to reflect on in their writing.

In the first video clip, a group of three students are working on a tutorial that involves depth. Initially, the students are trying to decide if surface pressure is included in depth. The LA comes to the table, sits down, and listens to the group. A group member asks the LA about the definition of depth. The LA responds and the group begins making claims regarding the problem they are working on. The LA restates a claim made by one of the group members and asks if everyone agrees. The video clip

ends at that point. In the second video clip, a group of four students are working on a

kinematics tutorial. The group is determining the velocity and acceleration of a cart on a

track. The group reaches a consensus and waves over the LA. The LA looks at the

groups' graph and then asks if they agree with the shape of the graph. Group members

indicate that they agree. The LA mentions that it's an interesting question and walks

away. The video clip ends with one of the group members asking if another LA is

available.

Assessing Level of Reflection

The rubric based on Hatton and Smith's (1995) "Criteria for the Recognition of

Evidence for Different Types of Reflective Writing" allows for four levels, three of

which indicate reflection: descriptive writing, descriptive reflection, dialogic reflection,

and critical reflection. Writing assignments at the descriptive writing level are

considered to have no evidence of reflection. Writing assignments at the other three

levels give evidence of varying levels of reflection. In the next sections, these levels will

be explained and excerpts from participants' writings will be used to illustrate the levels.

Descriptive Writing

In descriptive writing, only details and descriptions are provided without clear

explanations or reasons to accompany the descriptions. As an example, one participant

submitted the following writing assignment on the first video:

> The first video clip consisted of a familiar scenario in which physics students
>
> were discussing a concept in physics. (1) As with most physics concepts, it

required careful thought and discussion. (2) The students did not necessarily agree on the interpretation of the concept and there were varying degrees of knowledge of the subject within the group. (3) The LA seemed to do a good job of moving the discussion along without providing the group members with specific answers but put forth an element of direction. (4)

This writing assignment included observations, descriptions, and belief statements, but no evidence of reflection. In sentence one, he described the setting of the video. In the second sentence, he gave his thoughts on the concept being covered. Although he considered the physics concept being discussed as "requiring careful thought and discussion," he gave no clear indication as to why that was the case. He began the sentence with "as with most physics concepts". Thus, it is clear that he believed that it made sense for the concept to require careful thought and discussion, yet, there is still no evidence as to why this one would require thought and discussion where as the few others concepts that would fall outside of the "most physics concepts" would not. In the third sentence he wrote that "there were varying degrees of knowledge of the subject within the group." However, he did not offer any explanation for this finding. It is likely that he had a reason for feeling that way. However, in reflection reasons for belief and findings are made explicit. It is possible that he thought about this and reflected personally, but simply did not include it in his writing. In the fourth sentence, he evaluated the performance of the LA in the video by writing that the LA "seemed to do a good job." However, no explanation was given as to why the LA seemed to do a good job. Although brief, this writing assignment included observations, beliefs, and an evaluation. However, there was no explanation or reasoning included as a reflection on these things.

Thus, this assignment was coded as descriptive writing. This does not mean that the participant did not reflect on the video; it indicates that no reflection is evident in the writing assignment.

If it is unclear through the writing whether or not a participant reflected on the video, the reflection was considered to be descriptive writing. For example, the language used in the following assignment submitted by another participant, suggests that the participant may have considered reasons for the descriptions and details he provided, but there is no evidence in the writing.

> I approached a group of students that were having a debate about the definition of depth. (1) One seemed to think that depth and height were interchangeable terms while the other two were unsure so I explained to them how both height and depth were measurements of distance and thus how they could be used similarly. (2) From there the students continued to discuss about how the area of something could affect the force at which something shoots out. (3) I took their thoughts and collected them in a cohesive conclusion and repeated it back to them. (4) One of them seemed to [be] uncomfortable with the conclusion I collected from the group's discussion so I asked her what she thought was different. (5) She explained why she thought what she thought going through her reasons why that would be the case. (6) Careful not to add to [sic] my input to their deductions, I let the students finish the experiment. (7)

This participant provided the details of what happened in the classroom. His writing included a number of observations, but no level of reflection was evident in the writing.

For example, in sentence two he described what the students seemed to think. In that same sentence he wrote, "so, I explained to them how both height and depth were measurements of distance and thus how they could be used similarly." It is possible that the beginning of the sentence—where he described what they were thinking—is his reasoning for explaining as he stated in the second part of the sentence. However, this may not be the case. Thus, it is unclear as to whether he is providing explanations for his action or not. For an assignment to be marked as having some level of reflection, according to the rubric, there needs to be evidence of an explanation for actions or behaviors observed. We find a similar kind of incident in the fifth sentence. He wrote, "One of them seemed to [be] uncomfortable with the conclusion I collected from the group's discussion so I asked her what she thought was different." The use of the word "so" implies that he may be giving an explanation for the actions taken by the LA in the video. However, it is unclear that reflection is taking place here. There are no instances in this writing assignment, where reflection is evident through explanations or reasons. Thus, this assignment was coded as descriptive writing.

Descriptive Reflection

In descriptive reflection, reasons and explanations accompany the descriptions provided in the writing assignment. As an example, one participant submitted the following writing assignment on the first video:

> The LA in this first video serves as a guide to the students, not as a source of knowledge, unless the discussion becomes about such a basic concept such as "what is defined as height". (1) In order to guide the students, he follows their

train of thought, encourages everybody to have an input, and asks further questions to make sure the students stay on topic and reach the understanding the exercise is trying to achieve. (3) His method seems effective, for the three students seem engaged and try to reason things out with valid points. (4) I particularly liked the fact [that] he encouraged them to disagree with one another, if that was the case, because whether a student is right or not, confronting other points of view is always helpful for the learning process; it makes you think about other approaches or arguments and why they would be correct or not. (5)

This participant included explanations and reasons for the descriptions she gave. For example, she described the behavior of the LA in the video in sentence three. She also gave an explanation for his conduct in sentence three where she wrote, "in order to guide the students." After she described the LAs' method as effective in sentence four, she gave a reason for why she believed it was effective. In the fourth sentence, she wrote, "for the three students seem engaged and try to reason things out with valid points." Finally, she gave an explanation for her belief that confronting other viewpoints is helpful in sentence five where she wrote, "it [confronting other viewpoints] makes you think about other approaches or arguments and why they would be correct or not." Because her writing included explanations and reasons for her beliefs and descriptions, it was coded as descriptive reflection. It was not coded as dialogic reflection, however, because there was no evidence that she was considering multiple explanations or reasons. Furthermore, there is no evidence of deep reflection here. She simply justified her statements with reasons.

Dialogic Reflection

In dialogic reflection, the writing includes explanations and reasons, but it is at a deeper level. It often includes weighing different explanations, reasons, or decisions against each other. As an example, one participant submitted the following writing assignment on the second video:

Today I had an interesting experience with a group drawing a velocity graph for a car as it slides up a ramp and slides back down. (1) Sometimes I feel like approaching a group gives them a loophole to thinking about the questions thoroughly because they figure they can just ask me if it's right and I'll have to answer. (2) Sometimes I try just to ask them to explain what they've drawn and try to get the group to think individually and come up with alternate options to argue but sometimes its obvious when I ask if the rest of the group agrees that I think its wrong. (3) I try to make it a habit to ask if everyone agrees all the time so its not as obvious but today caught me, I basically told them it was wrong and left them to think about it. (4) I realize now that maybe a better approach would have been to ask the group to define the velocity at each point but also to try to think about how the position is changing. (5) Sometimes I'm torn between not leaving until I get an answer I like and over-guiding the students and the opposite, which is to let them figure out what [is] wrong on their own. (6) Maybe its good I didn't force them to think my way but rather indicated that they needed to do more thinking. (7) I think there might have been a better way to help them figure out they were wrong in the first place, though. (8)

140

This participant is weighing two different decisions: to stay with the group and help them figure out that their answer is wrong or to let them figure out their error on their own. In sentence two he indicated that his belief that approaching a group will lead to him having to give them the answer. In sentence three he provided a strategy for overcoming the need to provide the answer when he approaches a group. However, in the third sentence he also acknowledged why this may not always work. In the fourth sentence, he explained a strategy for overcoming the problem associated with asking students to reach consensus. Although the participant provided explanations made for the decisions made by the actual LA in the video, he still provided an alternative response in sentence six. This shows that he empathized with the decisions made by the LA in the video and, yet, he was still aware of alternative methods of response. In sentences seven and eight he provided a rationale for the LA in the video leaving the students on their own and gave an explanation for why this may be a good technique. In sentence nine he acknowledged that there was still probably a better way for the LA to assist the group initially, but does not explain how. This writing assignment is considered to be dialogic reflection because the participant is reflecting on the decisions made by the LA in the video and weighing alternative explanations and strategies for assisting this group. He empathized with the decisions made by the LA in the video, but also provided alternatives actions the LA could have taken. In the end, he still has not determined the best method for helping the students in the video to realize that their answer was wrong, but he acknowledged that there probably was a better way. This writing assignment gave evidence of a higher level of reflection, because the participant is thinking more deeply about what happened in the video. He did not simply give an explanation for each

observation, but he took it a step further by considering alternative actions and consequences for those actions.

Critical Reflection

No writing assignments submitted in this section gave evidence of critical reflection. Thus, no excerpt from this study is available to illustrate the critical reflection level. In critical reflection, there is evidence of thinking outside of one's own classroom and considering the broader issues in education (i.e., historical, social, and political factors). This is the highest level of reflection on the rubric and few preservice teachers demonstrate evidence of this level of reflection through their writing (Cochran, Brewe, Kramer, & Brookes, 2012; Hatton & Smith, 1995).

Results for the assessments of the writing assignments are provided in Table 17. The descriptive writing category made up the second largest category of writing assignments with 19 percent of assignments being coded as descriptive writing. This is consistent with the results found in Cochran et al. (2012). The majority of the responses to the writing assignments in this study were at the level of descriptive reflection. This is consistent with the results of the previous study on the level of reflection evident in LAs' writing assignments as well (Cochran et al., 2012). Very few writing assignments, 21%, gave evidence of reflection at the dialogic level. This is consistent with results from previous studies as well (Cochran et al., 2012; Hatton & Smith, 1995). None of the assignments submitted gave evidence of critical reflection. Cochran et al, found that 66% of the writing assignments gave evidence of reflection.

Table 17

Level of Reflection Evident in Participants' Writing Assignments

Characteristic	Descriptive Writing	Descriptive Reflection	Dialogic Reflection	Critical Reflection
Number (percentage)	9 (19)	29 (60)	10 (21)	0 (0)

Note: Each participant submitted two writing assignments. Thus, the total number of writings = 48.

Research Question Three

Research Question Three was: Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing," what percentage of writing assignments submitted by participants will be characterized as having evidence of reflection? The hypothesis, based on the Cochran et al. (2012) study was that at least 66% of the writing assignments submitted by physics LAs would be characterized as having evidence of reflection. Although the percentage of writing assignments coded as descriptive writing, descriptive reflection, and dialogic reflection categories was similar to that of the Cochran et al. (2012), study, 81% of the writing assignments submitted in Phase Three of this study gave evidence of reflection. To date, no other studies on LAs views on reflection could be found. Thus, no conclusions can be made regarding the total percentage of writing assignments coded as giving evidence of reflection being inconsistent with that found in the Cochran et al. (2012) study. The difference in the number of writing assignments having evidence of reflection may be due to some natural variance in the percentage of assignments that give evidence of reflection or it could be a significant difference. Nonetheless, this study has contributed to the literature on LAs reflection. In this study we found that the majority of writing assignments were at the descriptive reflection level and that none of the writing assignments were at the critical

reflection level. Also, half of the participants submitted one writing assignment that was at a higher level than the other. According to Schon (1983), reflection is dependent on the context and situation on which one is reflecting.

<center>**Research Question Four**</center>

Data from both Phases Two and Phase Three of the study were used to address Research Question Four: Do factors determined by physics LAs' typologies predict the level of reflection evident in their writing? The hypothesis for Research Question Four was: Analysis of ordinal logistic regression models will indicate that factors determined by the physics LAs' typologies are predictors of level of reflection evident in writing.

For this research question, the outcome variable is level of reflection evident in writing. Level of reflection was determined by the highest level of reflection evident in either of the two writing assignments submitted by participants. Again, this is because the scenario on which one is reflecting may play a role in the level of reflection evident in the writing (Cochran et al., 2012; Schon, 1983). Thus, two videos were shown in an endeavor to increase the likelihood that participants would reflect at higher levels.

The predictor variables are the typologies found in Phase Two of this study. Results of Phase Two of this study revealed three typologies among physics LAs regarding their perspectives on expertise in teaching, reflection on teaching, and their experience in the LA program at FIU. LAs associated with Factor One were "LAs who believed expertise in teaching is not natural and does not require expertise in content or pedagogy, but develops over time as a result of reflecting on one's teaching experience and felt rewarded while teaching in the LA program." LAs associated with Factor Two were

<center>144</center>

"LAs that valued reflection, but did not value writing reflections, felt the LA program would help them decide if they want to teach, but as a result of the teaching experience in the LA program were less likely to become teachers, and valued the teaching experience in the LA program for helping them to confront gaps in their physics knowledge." LAs associated with Factor Three were "LAs that valued the teaching experience in the LA program because it had and impact on them and increased the likelihood that they will become teachers, but felt it did not completely prepare them to enter the field of teaching, valued reflection, and felt that expertise in teaching requires both expertise in content and expertise in pedagogy."

Data for the 24 participants were entered into the SPSS software package. Then, ordinal logistic regression was run. The first consideration in analysis was the difference between the two log-likelihoods provided in the Model Fitting Table. The results of this analysis is displayed in Table 18. The significance value of the difference between the two log-likelihoods tells us whether to reject the null hypothesis that the model without predictors is as good as the model with the predictors. However, based on our p-value of .423 we fail to reject the null hypothesis and conclude that the model with the predictors does not provide any more information than the model without the predictor variables.

Table 18
Model Fitting Test

Characteristic	-2 Log Likelihood	Chi-Square	df	Significance
Intercept Only	19.634			
Final	16.831	2.803	3	.423

We next considered the "Test of Parallel Lines". The null hypothesis for this test states that the location parameters are the same across categories. The results for this test are included in Table 19. In this case, because our significance value is .074, we fail to reject the null hypothesis and determine that the data did not need to be run as a multinomial regression.

Table 19
Test of Parallel Lines

Characteristic	-2 Log Likelihood	Chi-Square	df	Significance
Null Hypothesis	16.831			
General	9.889	6.942	3	.074

Finally, the significance values for the individual variables was considered in the table of parameter estimates. The results from this analysis are displayed in Table 20. Table 20 shows that none of the predictor variables are significant as evidenced by a significance value > .05 and, thus, we cannot conclude that they are predictors of the level of reflection evident in writing.

Table 20
Parameter Estimates

Characteristic	Wald	df	Significance
Factor One	1.273	1	.259
Factor Two	2.263	1	.132
Factor Three	.448	1	.503

Based on the analysis of the ordinal logistic regression model, we conclude that the typologies from Phase Two of the study are not predictors for the level of reflection evident in the writing assignments submitted in Phase Three of the study.

There are three possible explanations for these findings. The most likely explanation is that the sample size was not large enough for the statistical test used to have the power needed to detect an effect. In logistical regression, the recommended sample size is at least 30 people for each predictor variable. In this study, there were three typologies that served as predictor variables and, thus, a sample size of 90 participants would be reasonable to detect a medium sized effect. There were only 24 participants that participated in both Phase Two and Phase Three of the study. Thus, even if there was a relationship between the typologies among the physics LAs and the level of reflection evident in their writing, it is not likely that it would have been found.

Another likely reason for not finding a predictor model that fit the data is that there may not have been enough variance in the level of reflection at which the participants wrote. Participants were asked to write two separate reflective writing assignments on two different videos to increase the likelihood that at least one of the videos would spark reflection for the participants. Each participant that wrote an assignment assessed to be at the descriptive writing level for one of the videos wrote an assignment assessed to be at a higher level for the other video. Furthermore, none of the writing assignments gave evidence of critical reflection. Thus, there were only two levels of the outcome variable in our data. Thus, it is likely that even if there was a relationship between the typologies among the physics LAs and the level of reflection evident in their writing, due to the lack of variability in the level of reflection evident in the writing of the participants, it is not likely that it would have been found.

Finally, it is possible that none of the typologies among the physics LAs were found to be predictors of the level of reflection evident in the writing assignments of the LAs because there is no relationship between the typologies among the physics LAs and the level of reflection evident in their writing assignments. However, considering the small sample size and the lack of variation in the highest level of reflection evident in the writing assignments for each individual participant, further investigation would be required to determine the validity of this finding.

Summary

In this chapter the findings in Phase 3 of the study were discussed and Research Questions Three and Four were addressed. I found that 19% of the assignments submitted were at the descriptive writing level, 60% were at the descriptive reflection level, and 21% were at the dialogic level. None of the writing assignment submitted gave evidence of critical reflection. In response to Research Question Three, we found that 81% of the writing assignments submitted gave evidence of reflection. Although the findings of Phase Three of the study do not match the data in the Cochran et al. (2012) study on the assessment of level of reflection evident in the writing assignments of LAs, the findings do provide some insight into the level of reflection evident in the writing assignments of LAs. To begin with, I found that the majority of LAs—though preservice and prospective teachers—are able to engage in reflection as evident in their writing. Furthermore, we found that the majority of the writing assignments submitted by LAs gave evidence of reflection. Furthermore, the majority of assignments submitted are coded as descriptive reflection. Finally, the findings of this study show that, although

148

participants were reflecting on the teaching experiences of someone else, the percentage of assignments coded at the various levels of reflection were similar to the findings when LAs were reflecting on their own personal teaching experiences (Cochran, et al., 2012). Thus, having LAs reflect on videos is a viable option for promoting and helping LAs to engage in reflection.

Factors determined by physics LAs' typologies were not found to be predictors for the level of reflection evident in their writing. However, further investigation would shed more light on these results. In particular, a larger sample size would be necessary to increase the power of this statistical test, given that three predictor variables were found in Phase Two of the study. Also, a greater variance in the reflection levels assessed by the writing would shed more light on the outcome variable. In this study, the highest levels of reflection evident in the participants' writing assignments only accounted for two levels of the rubric.

CHAPTER VII

DISCUSSION AND RECOMMENDATIONS

Research on Learning Assistants (LAs) as prospective and preservice teachers in LA programs is limited. This is especially true in regard to their reflective practice. There is also limited research on the implementation of the LA program at ethnically diverse universities. The purpose of this study was to contribute to the body of literature by investigating physics LAs' views on reflective teaching, the development of expertise in teaching, and their teaching experience in the LA Program at FIU and to determine if typologies found among the LAs are predictors of the level of reflection evident in their writing. This purpose was to be accomplished by addressing four research questions:

1. What are physics LAs' views on reflective teaching, development of expertise in teaching, and their teaching experience in the LA PROGRAM at FIU?

2. What typologies exist among physics LAs participating in the LA PROGRAM at FIU in regard to reflection on teaching, development of expertise in teaching, and their experience in the LA PROGRAM at FIU?

3. Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence for Different Types of Reflective Writing," what percentage of writing assignments submitted by participants will be characterized as having evidence of reflection?

4. Do factors determined by physics LAs' typologies predict the level of reflection evident in writing?

The conceptual framework guiding the study consisted of two models on reflection, the theory on expertise, and the LA program model. Dewey's model of reflection motivated why reflection should be taught. Donald Schön's model of reflective practice highlighted the importance of practitioners being reflective in their practice. A general theory of expertise explained why reflection is an important skill for preservice teachers. Finally, the Colorado Learning Assistant Model aims to help prospective science teachers to develop as reflective practitioners.

The four research questions were addressed through a mixed-methods research study. This chapter includes a summary of the findings in each phase of the study, implications and significance of the study, identification of the limitations and delimitations of the study, and recommendations for future research. The first three sections cover the first three phases of the study. Then, the response to Research Question Four, which utilizeD data from Phase Two and Phase Three of the study will be covered separately. A summary of the findings and the significance of the results of answering Research Question Four will be considered. The final section of this chapter will be concluding remarks.

Phase One of the Study

The first research question was: What are physics Learning Assistants' (LAs) views on reflective teaching, development of expertise in teaching, and their teaching experience in the LA program at Florida International University? This question was addressed through the first phase of the study. In this phase of the study, semi-structured interviews were conducted with former and current physics LAs.

Summary of Findings

Analysis of the semi-structured interviews revealed LAs' perspectives in regard to expertise in teaching, reflection on teaching, and the teaching experience in the LA program. The results of this phase of the study indicated that the participating LAs believed that pedagogical knowledge and content knowledge are important aspects of being an expert teacher. However, their perspectives varied as to the importance of expertise in teaching and expertise in content for teachers when compared to each other.

Some LAs believe that some natural ability is required to become an expert teacher and that some teachers do not have the ability to become expert teachers. Other LAs revealed their belief that teachers develop toward expertise in teaching by taking education courses, collaborating with colleagues, and utilizing education research. LAs indicated that teaching experience is an important part of gaining expertise in teaching. Perspectives varied as to the kind of experience necessary to develop expertise in teaching.

LAs all agreed that reflection on teaching is important because it helps one to improve their teaching. LAs considered reflecting on one's teaching a part of the responsibility of teachers. Although LAs considered reflective writing to be beneficial, they revealed a preference toward peer reflection because of the peer feedback and different perspective it offers. Finally, the LAs found the teaching experience in the LA program to be beneficial practice in teaching for prospective and preservice teachers and a rewarding opportunity to help others. The purpose of the first phase of the study was to determine LAs perspectives on expertise in teaching, reflection on teaching, and the teaching experience in the LA program. By means of the semi-structured interviews

conducted in Phase One of this study, the LAs perspectives on these topics were determined.

Implications of the Study

LAs' indicated that the importance of content knowledge and pedagogical knowledge in teaching. Through their explicit discussion of content knowledge and pedagogical knowledge and their hinting at tools for gaining pedagogical content knowledge, LAs revealed that their views on expertise in teaching are moving toward an understanding of pedagogical content knowledge. As stated by Otero, Pollock, and Finkelstein (2010) one of the goals of the LA program model is to help LAs to develop pedagogical content knowledge. Although pedagogical content knowledge is explicitly addressed in the teacher preparation program, through the LA Seminar and Modeling Physics workshops (Wells, Hestenes, & Swackhamer, 1995), the term is not explicitly taught. Results of Phase One of the study may indicate that in addition to helping LAs to develop pedagogical content knowledge, faculty and staff in the LA program may need to help LAs to realize the importance of developing expertise in pedagogical content knowledge rather than pedagogical knowledge or content knowledge individually. Shulman described pedagogical content knowledge as the blending of content and pedagogy into an understanding of how particular content is organized and presented for instruction (Shulman, 1986, 1987). It is expertise in this kind of knowledge that has been found to be effective for teaching (Garet et al., 2001).

Participants' perspectives varied in regard to whether or not someone can develop expertise in teaching and if expert teachers have some natural abilities. The perspective that people are born with pre-determined abilities required for developing expertise in

teaching, can potentially be a hindrance for prospective physics teachers to remain in the LA program. This is also a potential problem for preservice teachers as they enter the field. Thus, physics LAs need to understand that one can hone his or her teaching skills over time and that—as in any other discipline or career choice—expertise is gained through several years of deliberate practice (Ericcson, 1991). To help LAs to realize that one can improve in their teaching, it may be beneficial to have LAs engage in self-evaluation while participating in the program so that they can evaluate their own progress as they begin to hone their teaching skills.

LAs perspectives on the kind of experience necessary to develop expertise in teaching varied as well. Although LAs seemed to have a good understanding of how various types of teaching experience can contribute to their developing expertise in teaching, it may be beneficial to help them focus on how one can learn from and improve in their teaching skills, regardless of the kind of teaching experience they have by engaging in a deliberate practice, reflective practice on their teaching. According to Schon (1993), it is reflection on practice that helps a practitioner to become better over time.

LAs found reflection to be beneficial and necessary for teachers to improve in their teaching. However, they mentioned reflecting less on their teaching strategies in the LA program as they gained more experience teaching. They also indicated that they no longer engaged in reflection through writing after the LA Seminar course, but continued to reflect with their peers. Thus, it may be beneficial to help LAs to have more formal peer reflection after the seminar course; with a focus on things that are not just teaching

strategies. Moreover, peer reflection and other forms of reflection can be included in the curricular materials for the LA Seminar course.

Limitations of Phase One of the Study

Every study has limitations and three limitations have been identified in phase one of this study. Only 12 participants were interviewed in phase one of this study. Of course, interviewing more participants would have likely contributed more information in regard to the perspectives of physics LAs on our topics of interest. However, interviewing 12 participants allowed me to go into more depth in my analysis of the twelve interviews conducted without requiring an extended length of time.

The study was limited by volunteers who participated in the study. A recruitment email was sent out to 87 former and present physics LAs for whom contact information was available. However, within a 2-month period only twelve people responded. All twelve people were interviewed. All 12 of these people were aware of the topic of this interview. It is likely that these 12 people of the 87 people recruited chose to participate in this study because they already had strong feelings about the topics to be discussed.

Finally, there is a possible researcher bias. All twelve of the participants interviewed in this phase of the study knew me, the researcher, before volunteering to participate in the study. Ten of the 12 participants interviewed were former students of mine. It is possible that they chose to participate in this study because of their relationship with me. Furthermore, it is possible that they responded to the interview questions in accord with what they thought my expectations were for this study.

Delimitations of Phase One of the Study

This phase of the study was delimited to physics LAs in the LA program at FIU for whom current contact information was available. Although there was a recorded 109 people who were physics LAs that had completed at least one semester as LAs and had taken the LA Seminar at the time of this phase of the study, contact information for only 87 was available. Thus, the results of Phase One of this study represent the views of only those who participated in this phase of the study.

Suggestions for Future Research

Based on the results from phase one of this study, suggestions for future research have been determined. To begin with, this research was limited to physics LAs at FIU. However, the LA program has been extended to several other disciplines, including: chemistry, mathematics, engineering, biology, earth science, and astronomy. LAs from other disciplines were not included in this study because teaching experiences for LAs vary drastically across the disciplines. With teaching experience being such an important aspect of this study, it seemed more efficient to focus on a group of LAs who have the same kind of teaching experience. However, future research on LAs' perspectives on expertise in teaching, teaching experience in the LA program, and reflection on teaching needs to be conducted with LAs in different disciplines as well. Also, LAs views on pedagogical content knowledge seemed to be an important part of their views on expertise in teaching. Open coding was used in Phase One of the study to decrease the likelihood of me bringing my own bias to the analysis of the data. However, reanalyzing the data through the lens of pedagogical content knowledge may provide an alternative understanding of LAs views on reflection. Finally, LAs indicated that experience is an

important part of becoming an expert teacher, but varied in their beliefs on what kind of experience is necessary to help one to become an expert teacher. Further investigation into LAs' views on the kinds of experiences they will believe will prepare them as teachers is needed

Phase Two of the Study

Research Question Two was: What typologies exist among physics LAs participating in the LA PROGRAM at FIU in regard to reflection on teaching, development of expertise in teaching, and their experience in the LA program at FIU? This question was addressed in the second phase of the study by means of Q methodology. A three-factor model emerged from the data collected in phase two of the study that represented three typologies among physics LAs who participated in the study.

Summary of the Findings

LAs associated with Factor One were "LAs who believed expertise in teaching is not natural and does not require expertise in content or pedagogy, but develops over time as a result of reflecting on one's teaching experience and felt rewarded while teaching in the LA program." LAs associated with Factor Two were "LAs that valued reflection, but did not value writing reflections, felt the LA program would help them decide if they want to teach, but as a result of the teaching experience in the LA program were less likely to become teachers, and valued the teaching experience in the LA program for helping them to confront gaps in their physics knowledge." LAs associated with Factor Three were "LAs that valued the teaching experience in the LA program because it had an impact on them and increased the likelihood that they will become teachers, but felt it did not

completely prepare them to enter the field of teaching, valued reflection, and felt that expertise in teaching requires both expertise in content and expertise in pedagogy."

Implications of Phase Two of the Study

The literature review revealed that research on physics LAs was limited. This study provided a beginning to understanding the views held by physics LAs in regard to expertise in teaching, reflection on teaching, and the teaching experience in the LA program. Understanding the views of the physics LAs at FIU has helped to determine the alignment of physics LAs' views with current LA program goals and expectations. As a component of the teacher preparation program at FIU, the LA program has a specific design and focus. It may be beneficial for program administrators to be explicit with potential participants in regard to the goals of the program and what is expected from participants. Typologies revealed that LAs' ideas on the purpose of the program were important to their thoughts on program components. Also, further investigation of the LAs' views on the purpose of the LA program is needed.

Limitations of Phase Two of the study

A limitation of this phase of the study is that the results of the Q study are not generalizable to the general population. The perspectives found in this phase of the study only represent the perspectives of the participants and do not represent a percentage of the sample or the general population. However, the Q concourse used in this study will be made available to other LA programs. Thus, researchers can conduct Q studies at other institutions to determine typologies that exist among LAs at those institutions in

regard to expertise in teaching, reflection on teaching, and the teaching experience in the LA program.

Delimitations of Phase Two of the Study

This phase of the study was delimited to physics LAs in the LA program at FIU for which current contact information was available. Although there was a recorded 122 physics LAs that had completed at least one semester LAing and had taken the LA Seminar at the time of this phase of the study, contact information for only 101 was available. Furthermore, two potential participants indicated a desire to participate in the study, but were located in other states. These potential participants also found that it would be difficult to complete the Q sort via other means.

Suggestions for Future Research

A variety of additional unanswered questions arose while conducting this study and analyzing the results of this phase of the study. To begin with, would similar typologies be discovered if this study were conducted at multiple institutions with LA programs? Because the results of this phase of the study are not generalizable to the general population, no conclusions can be drawn regarding typologies that may exist among physics LAs at other institutions. Thus, future research could include conducting studies using the Q concourse developed in this study at other institutions.

Second, sorters associated with Factor Two revealed an interesting perspective on the LA program. They did not feel as strongly about the value of the teaching experience in the LA program and they indicated that it did not make them more likely to become teachers in the future. Furthermore, each of the sorters associated with Factor

Two indicated that they did not plan to become K-12 teachers. The perspective of students that particularly fit this typology needs to be investigated further. What were their perspectives before participating in the program? What were their motivations for participating in the physics LA program? Did the physics LA program meet their expectations? How do they feel the physics LA program could be improved? Additional research studies addressing these questions would be valuable to understanding the LA experience.

Finally, the Q concourse used in this phase of the study focused on three topics. Although this design allowed for a surface understanding of LAs' views in regard to expertise in teaching, reflection on teaching, and the teaching experience in the LA program, a Q concourse focused on just one of the topics may allow for a more nuanced an in-depth look at physics LAs' views on the topic chosen. In particular, LAs associated with all three factors held strong views in regard to expertise in teaching. A future Q study should be conducted to further tease out LAs' views on expertise in teaching.

Phase Three of the Study

Research Question Three was: Using Hatton and Smith's (1995) "Criteria for the Recognition of Evidence of Reflection in Writing" what percentage of writing submitted by physics LAs will be characterized as having evidence of reflection. This research question was addressed in phase three of the study. Participants' watched two videos of LAs at other institutions assisting students in completing a lab assignment. Participants then submitted writing assignments on the videos. Data collected in Phase Two and Phase Three of the study was used to address Research Question Four: Do factors

determined by physics LAs' typologies predict the level of reflection evident in their writing?

Summary of the Findings

Participants' writing assignments indicated that they can reflect on teaching experiences of others as evident in their written assignments. Of the writing assignments submitted, 81% were characterized as having evidence of reflection. Of the writing assignments submitted 19% were characterized as descriptive writing, 60% were characterized as descriptive reflection, 21% were characterized as dialogic reflection, and none of them were characterized as critical reflection. All 23 participants in this phase of the study submitted at least one writing assignment at the descriptive reflection level or higher. Ordinal logistic regression revealed that using a model with typologies among physics LAs as a predictor was no different than using a random model to predict level of reflection evident in writing. Moreover, none of the typologies were determined to be predictors of evidence of reflection in writing.

Implications of Phase Three of the Study

Participants writing assignments revealed evidence of reflection on the teaching experiences they viewed via video. Thus, writing assignments is an efficient method for analyzing the reflection of prospective and preservice teachers. However, for many participants level of reflection evident in their writing was different for the two different videos. This may indicate that they engage in reflection differently depending on what they are reflecting on or that the reflection evident in their writing is not always

indicative of the highest level of reflection that they engage in while thinking about teaching experiences. Thus, writing assignments submitted by prospective and preservice teachers should not be used as the sole means of assessing their level of reflection or their feelings on reflection. Therefore, when assessing the writing of prospective and preservice teachers educators need to be aware that there are possibly many factors determining the level of reflection that is evident in their writing. The percentage of writing assignments coded for the four levels of reflection was similar to that found in the Cochran et al. (2012) study. Also, the lack of assignments coded as critical reflection indicates that LAs made need explicit instructions on how to engage in critical thinking and several opportunities to practice critical reflection. This is in harmony with Yayli's (2009) suggestions.

Limitations of Phase Three of the Study

Again, the results of this phase of the study are limited to participants in this study and cannot be generalized to the population.

Delimitations of Phase Three of the Study

As with phase two of the study, this phase of the study was delimited to physics LAs in the LA program at FIU for which current contact information was available. Although there was a recorded 122 people who were physics LAs that had completed at least one semester as LAs and had taken the LA Seminar at the time of this phase of the study, contact information for only 101 was available.

Suggestions for Future Research

This study contributed to the literature on assessing the level of reflection evident in the writing of LAs. Although the results found in this study were similar to those found in the Cochran et al. (2012) study, more research should be conducted on assessing the level of reflection evident in the writing of LAs. This will help researchers to gauge the expected variance in the level of reflection evident in their writing and provide insight on how to help LAs to engage in deeper reflection on their teaching, even critical reflection. Both this study and the Cochran et al. study were conducted at the same institution. Thus, future research should include the assessment of the level of writing of LAs at other institutions.

Research Question Four

Research Question Four was: Do factors determined by physics LAs' typologies predict the level of reflection evident in writing? Research Question 4 was answered using the data from Phase Two and Phase Three of the study. Only 24 participants participated in both Phase Two and Phase Three of the study. Using the SPSS software, data from Phase Two and Phase Three of the study were used to create a model to predict the level of reflection evident in the writing of the physics LAs using the typologies determined in Phase Two of the study as predictor variables.

Summary of the Findings

The original logistic regression model with the predictor variables was not found to be a better predictor of the level of reflection evidence in the writing of the physics

LAs than the model with the predictor variables. Thus, LAs perspectives on expertise in teaching, reflection on teaching, and the teaching experience in the LA program were not determined to be predictors for the level of reflection evident in their writing. Understanding these results requires a consideration of the limitations of Phase Two and Phase Three of the study. Due to the number of participants in Phase Two and Phase Three of the study, even if one of the variables was a predictor for the level of reflection evident in writing it is not likely that it would have been detected. Moreover, given the lack of variance in the highest level of reflection evident in the writing submitted by the participants in Phase Three of the study, it is also unlikely that any significant relationship would have been detected.

Significance of the Study

Given the limitations of Phase Two and Phase Three of the study, a definitive answer on why the perspectives determined in Phase Three of the study were not found to be predictors for the level of reflection evident in the writing of the LAs is not possible. This study has still provided a viable methodology for answering this question. In order to reach the suggested 90 participants for Phases Two and Three of the study, approximately 450 LAs will need to have gone through the LA program. Given the current rate of approximately 12 new physics LAs per semester, it would take 13 years to reach an adequate number of participants to satisfy the suggested sample size for this study if 20 percent of the participants indicate willingness to participate in the study.

Concluding Remarks

The purpose of this study was to understand physics LAs' views on reflection on teaching, expertise in teaching, and teaching experience in the LA program and to determine if these views were predictors for the level of reflection evident in the writing of these physics LAs. In this study, I was able to determine views of physics LAs in the LA program at FIU. Phase Two and Phase Three of the study allowed LAs to share their viewpoints and feelings in regard to teaching. In Phase One of the study, LAs revealed their viewpoints on the topics of interest. Likewise, in Phase Two of the study, physics LAs were able to share their viewpoints by means of their sorting of statements in the Q sort and during follow-up interviews. Phase Two of this study also revealed typologies among the Physics LAs based on their views on expertise in teaching, reflection on teaching, and the teaching experience in the LA program. Although typologies among physics LAs were not found to be predictors of the level of reflection evident in their writing, it was found that physics LAs are able to reflect on teaching experiences and that it is evident in their writing the majority of the time. I hope that this work is just a beginning into the investigation of the viewpoints of physics LAs. What is more, I hope that the findings of this study will be used to help faculty and staff to better understand the views of physics LAs and that they might help the physics LAs to better understand the purpose of the LA program and to take advantage of the opportunities available to them through the LA program.

REFERENCES

About FIU (2011). About Florida International University. Retrieved from
http://cmshared.fiu.edu/fiu-edu/_assets/files/pdf/rankings-facts/about-fiu.pdf

Ajzen, I., & Fishbein, M. (1972). Attitude and normative beliefs as factors influencing behavior intentions. *Journal of Personality and Social Psychology, 21*(1), 1-9.

Baird, J.R., Fensham, P.J., Gunstone, R.F., & White, R.T. (1991). *The importance of reflection in improving science teaching and learning.* National Association for Research in Science Teaching. New York, NY: John Wiley and Sons.

Barr, S.A., Ross, M., J., & Otero, V. (2012). Using artifact methodology to compare learning assistants' and colleagues' classroom practices. *AIP Conference Proceedings, 1413*, 119-122.

Barnett, B.G. (1995). Developing reflection and expertise: Can mentors make the difference? *Journal of Educational Administration, 33*(5), 45-59.

Bereiter, C. & Scardamalia, M. (1986). Educational relevance of the study of expertise. *Interchange, 17*(2), 10-19.

Brown, S. R. (1993). A primer on Q methodology. *Operant Subjectivity*, *16*, 91-138.

Bryan, W.L., & Harter, N. (1899). Studies of the telegraphic language: The acquisition of a hierarchy of habits. *Psychological Review, 6*, 345-375.

Boshuizen, H.P.A. (2009). Teaching for expertise: Problem-based methods in medicine and other professional domains. In K.A. Ericsson (Ed.), *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments* (pp. 379-404). New York, NY: Cambridge University Press.

Calabrese, R.L. (2006). *The elements of an effective dissertation & thesis: A step-by-step guide to getting it right the first time.* Lanham, MD: Rowman & Littlefield Education.

Calderhead, J. (1992). The role of reflection in learning to teach. In L. Valli (Ed.), *Reflective teacher education: Cases and critiques* (pp. 139-146). Albany, NY: State University of New York.

Carlton, S. M. (2010). Listening to teachers: Teachers' perceptions of reflective practices in a metropolitan school district (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (UMI No. 3301452)

Carson, L., & Fisher, K. (2006). Raising the bar on criticality: Students' critical reflection

in an internship program. *Journal of Management Education*, *30*, 700–723.

Charness, N., Tuffiash, M., Krampe, R., Reingold, E., & Vasyukova, E. (2005). The role of deliberate practice in chess expertise. *Applied Cognitive Psychology, 19*, 151-165.

Chase, W.G., & Simon, H.A. (1973). *The mind's eye in chess*. In W. G. Chase, (Ed.), *Visual information processing*, (pp. 215–281). New York, NY: Academic Press..

Clarke, A. (1995). Professional development in practicum settings: Reflective practice under scrutiny. *Teaching & Teacher Education*, *11*(3), 243-261.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2010). Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects. *Journal of Human Resources, 45*, 655-681.

Cochran, G.L., Brewe, E., Kramer, L.H., & Brookes, D.T., (2012, March). *Assessing the reflective practice of prospective teachers through written reflections*. Paper presented at the 2012 National Association for Research in Science Annual International Conference, Indianapolis, IN.

Cochran, G.L., Brookes, D.T., Brewe, E., & Kramer, L.H. (2012, January). *Physics learning assistants' perspectives on development of reflective teaching practice*. Presented at the winter meeting of the American Association of Physics Teachers, Ontario, CA.

Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology & Committee on Science, Engineering, and Public Policy. (2007). *Rising above the gathering storm: Energizing and employing America for a bright economic future*. Washington, DC: The National Academies Press.

Cornford, I. R. (2002). Reflective teaching: Empirical research findings and some implications for teacher education. *Journal of Vocational Education & Training, 54*, 219-236.

Court, D. (1988). Reflection in action: Some definitional problems. In P. Grimmett and G. Erikson (Eds.), *Reflection in teacher education* (pp. 143-146). New York, NY: Teachers College Press.

Creme, P. (2005). Should student learning journals be assessed? *Assessment & Evaluation in Higher Education*, *30*, 287-296.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. (2nd ed.). Thousand Oaks, CA: Sage.

Darling-Hammond, L., Holtzman, D. J., Gatlin, S. J., & Heilig, J. V. H. (2005). Does teacher preparation matter? Evidence about teacher certification, Teach for America, and teacher effectiveness. *Education Policy Analysis Archives, 13*(42), 1-51.

Davis, C., & Michelle, C. (2011). Q Methodology in audience research: Bridging the qualitative/quantitative "divide'? *Journal of Audience & Reception Studies, 8*, 559-593).

Demetry, C. & Groccia, J. (1997). A comparative assessment of students' experiences in two instructional formats of an introductory materials science course. *Journal of Engineering Education,86*, 203-210.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process.* Chicago, IL: Henry Regnery.

Dyment, J. E., & O'Connell, T. S. (2010). The quality of reflection in student journals: A review of limiting and enabling factors. *Innovations in Higher Education*, *35*, 233-244.

Elbaz, F. (1988). Critical reflection on teaching: Insights form Freire. *Journal of Education for Teaching 14*, 171-181.

Eraut, M. (1994). *Developing professional knowledge and competence.* Bristol, PA: The Falmer Press.

Ericsson, K.A. (2009). Enhancing the development of professional performance: Implications from the study of deliberate practice. In K.A. Ericsson (Ed.), *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments* (pp. 405-431). New York, NY: Cambridge University Press.

Ericsson, K.A., Krampe, R. Th., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363-406.

Ericsson, K.A., Prietula, M.J., & Cokely, E.T. (2007). The making of an expert [Special issue]. *Harvard Business Review on Managing for the Long Term,* 1-9.

Ericsson, K.A. & Smith, J. (1991). Prospects and limits of the empirical study of expertise: An introduction. In K.A. Ericsson and Jacqui Smith (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 1-38). New York, NY: Cambridge University Press.

Finkelstein, N.D. (2012, February), *Using data to make the case for sustained reform,* Workshop presented at the 2012 Physics Teacher Education Coalition, Ontario, CA.

Goertzen, R. M., Brewe, E., Kramer, L. H., Wells, L., & Jones, D. (2011). Moving toward change: Institutionalizing reform through implementation of the learning assistant model and open source tutorials. *Physical Review Special Topics--Physics Education Research, 7*(2), p. 1-9.

Gore, J. M. (1987). Reflecting on reflective teaching. *Journal of Teacher Education*, *3*, 33–39.

Gore, J. M. & Zeichner, K. M. (1991). Action research and reflective teaching in preservice teacher education: A case study from the United States. *Teaching and Teacher Education, 7*, 119-136.

Gray, K.E., & Otero, V.K. (2008). Analysis of learning assistants' views of teaching and learning. *Physics Education Research Conference Proceedings, 1064*, 123-126.

Gray, K.E., & Otero, V.K. (2009). Analysis of former learning assistants' views on cooperative learning. *Physics Education Research Conference Proceedings, 1179*, 149-152.

Gray, K. E., Webb, D. C., & Otero, V.K. (2010). Are learning assistants better k-12 science teachers? *Physics Education Research Conference Proceedings, 1289*, 157-160).

Gray, K.E., Webb, D.C., & Otero, V.K. (2011). Effects of the learning assistant experience on inservice teachers' practices. *Physics Education Research Conference Proceedings, 1413*, 199-202.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18,* 59-82.

Harris, I.B. (1989). A critique of Schon's views on teacher education. *Journal of Curriculum and Supervision, 5*, 13-18.

Harris, D. N., & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics, 95*, 798-812.

Hatton, N., & Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teaching and Teacher Education*, *11*, 33-49.

Hayes, J.R. (1981). *The complete problem solver.* Philadelphia, PA: Franklin Institute.

Hodges, N.J., Kerr, T., Starkes, J.L., Weird, P.L., & Nananidou, A. (2004). Predicting performance times from deliberate practice hours for triathletes and swimmers: What, when, and where is practice important? *Journal of Experimental Psychology: Applied, 10*, 219-237.

Johns, J., & Henwood, J. (2009). Building reflective practitioners on business programmes: An action research study. *Journal of hospitality, leisure sport, & tourism, 8,* 21-36.

Kirby, P.C., & Teddlie, C. (1989). Development of the reflective teaching instrument. *Journal of Research and Development in Education, 22*, 45-51.

Klug, J.H. (2010). Teacher reflective practice in Jesuit high schools (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (3404323).

Korthagen, F. A. J. (1985). Reflective teaching and preservice teacher education in the Netherlands. *Journal of Teacher Education*, *36*, 11-15.

Korthagen, F.A.J. (1991, April). Characteristics of reflective practitioners: Towards an operationalization of the concept of reflection. Paper presented at the American Educational Research Association, Chicago, IL. Abstract retrieved from http://eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED334183&ERICExtSearch_SearchType_0=no&accno=ED334183

Larkin, J., McDermott, J., Simon, D.P., & Simon, H.A. (1980). Expert and novice performance in solving problems. *Science, 208*, 1335-1342.

Lauder, W. (1994). Beyond reflection: Practical wisdom and the practical syllogism. *Nurse Education Today 14*, 91-98.

Long, J.S. (1997). *Regression models for categorical and limited dependent variables.* Thousand Oaks, CA: Sage.

Lyons, N. (2010). Approaches to portfolio assessment of complex evidence of reflection and reflective practice. In N. Lyons (Ed.), *Handbook of reflection and reflective inquiry* (pp. 475-490). New York: NY: Springer.

Madsen, A.J. (2005). *Where is the "self" in teacher self-assessment? An examination of teachers' reflection and assessment practices in relation to their teaching practices.* (Unpublished doctoral dissertation). Iowa State University, U.S.

McKeny, T.S. (2006). A case-study analysis of the critical features within field experiences that effect the reflective development of preservice secondary mathematics teachers (Doctoral dissertation). Retrieved from ProQuest Dissertations

& Theses database. (UMI No. 3238196)

McNamara, D. (1990). Research on teachers' thinking: Its contribution to educating student teachers to think critically. *Journal of Education for Teaching, 16*, 147-160).

Merriam, S. B. (2002). Introduction to qualitative research. In S. B. Merriam (Ed.), *Qualitative research in practice: Examples for discussion and analysis* (pp.3-17). New York: NY: John Wiley & Sons.

Mills, R. (2008). Valli's typology of reflection and the analysis of preservice teachers' reflective journals. *Australian Journal of Teacher Education, 33*, 55-65.

Moon, J. A. (2006). *Learning journals: A handbook for reflective practice and professional development* (2nd ed.). London, England: Routledge.

Moon, J.A. (2008). *Reflection in learning & professional development: Theory and practice*. New York, NY: RoutledgeFalmer.

Neild, R. C., Farley-Ripple, E. N., & Byrnes, V. (2009). The effect of teacher certification on middle grades achievement in an urban district. *Educational Policy, 23*, 732-760.

Newman, I., Howley, A., & Ramlo, S. (April, 2011). *Research on mixed methods approach to addressing generalization and transferability in evaluations in rural contexts: The use of Q factor analysis as potential tool for evaluating rural education programs.* Paper presented at the American Educational Research Association, New Orleans, LA.

Newman, I., Newman, D., & Newman, C. (2010). Writing research articles using mixed methods: Methodological considerations to help you get published. In T. S. Rocco (Ed.), *The handbook of scholarly writing and publishing* (pp. 191-211). San Francisco, CA: Jossey-Bass.

Newman, I., & Ramlo, S. (2010). Using Q methodology and Q factor analysis to facilitate mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social & behavioral research* (2nd ed.). New York, NY: McGraw-Hill.

No Child Left Behind Act of 2001, 20, U.S.C. § 1001 (2004).

O'Connell, A.A. (2006). *Logistic regression models for ordinal response variables.* Thousand Oaks, CA: Sage.

Olson, J. K., & Finson, K. D. (2009). Developmental perspectives on reflective practices of elementary science education students. *Journal of Elementary Science Education,*

21, 43-52.

Orland-Barak, L., & Yinon, H. (2007). When theory meets practice: What student teachers learn from guided reflection on their classroom discourse. *Teaching and teacher education,* 23, 957-969.

Otero, V., Finkelstein, N., McCray, R., & Pollock, S. (2006). Who is responsible for preparing science teachers? *Science*, *313*, 445-446.

Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado learning assistant model. *American Journal of Physics*. *78*, 1218-1224.

Patel, V.L., Groen, G.J., & Arocha, J.F. (1990). Medical expertise as a function of task difficulty. *Memory & Cognition*, *18*, 394-406.

Raeford, C. R. (2010). Reflective practice: The teacher in the mirror (Doctoral dissertation). Retrieved form ProQuest Dissertations & Theses database. (3412395).

Ramlo, S. (2008a). Determining the various perspectives and consensus within a classroom using Q methodology. *Physics Education Research Conference Proceedings*, *1064*, 179-182.

Ramlo, S. (2008b). Student perspectives on learning physics and their relationship with learning force and motion concepts: A study using Q methodology. *Human Subjectivity, 2*, 73-90.

Ramlo, S. (2011). Facilitating a faculty learning community: Determining consensus using Q methodology. *Mid-Western Educational Researcher, 24*, 30-36.

Ramlo, S.E., McConnell, D., Duan, Z., & Moore, F.B. (2008). Evaluating an inquiry-based bioinformatic course using Q Methodology. *Journal of Science Education in Technology, 17*, 219-225.

Ramlo, S.E., & Newman, I. (2011). Q Methodology and its position in the mixed-methods continuum. *Operant Subjectivity: The International Journal of Q Methodology 34*, 172-191.

Rubin, H.J., & Rubin. I.S. (2005). *Qualitative interviewing: The art of hearing data* (2nd ed.). Thousand Oaks, CA: Sage.

Sabella, M.S. (2002). Implementing *Tutorials in Introductory Physics* at an inner-city university in Chicago. *Physics Education Research Conference Proceedings, 79-82.*

Sawtelle, V., Brewe, E., & Kramer, L. (2009). Validation study of the Colorado Learning

Attitudes about Science Survey at a Hispanic-serving institution. *Physical Review Special Topics - Physics Education Research*, *5*(2).

Scardamalia, M. & Bereiter, C. (1991). Literate expertise. In K.A. Ericsson and Jacqui Smith (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 172-198). New York, NY: Cambridge University Press.

Schön, D. A. (1987). *Educating the reflective practitioner*. San Francisco, CA: JosseyBass.

Spalding, E., & Wilson, A. (2002). Demystifying reflection: A study of pedagogical strategies that encourage reflective journal writing. *Teachers College Record, 104*, 1393-1421.

Sloboda, J.A. (2000). Individual differences in music performance. *Trends in Cognitive Science, 4*, 397-403.

Smyth, J. (1992). Teachers' work and the politics of reflection. A*merican Educational Research Journal*, *29*, 267-300.

Sparks-Langer, G.M. & Colton, A.B. (1991) Synthesis of research on teachers' reflective thinking. *Educational Leadership 48*, 37-44.

Sparks-Langer, G., Simmons, J.M., Pasch, M., Colton, A., & Starko, A. (1990). Reflective pedagogical thinking: How can we promote it and measure it? *Journal of Teacher Education*, *41*, 23-32.

Spellings, M. (2007, July 23). [Key Policy Letters Signed by the Education Secretary or Deputy Secretary]. U.S. Department of Education Archives.

Stanley, C. (1998). A framework for teacher reflectivity. *TESOL Quarterly, 32*, 584-591.

Stephenson, W. (1935). Technique of factor analysis. *Nature, 136,* 297.

Stephenson, W. (1936). Introduction to inverted factor analysis, with some applications to studies in Orexis, *Journal of Educational Psychology*, *27*, 353-367.

Stewart, K.E. (2010). The role of reflection: Preschool teachers' use of reflective thinking to translate higher education learning into practice (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (3403411).

U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. (2010). *ESEA Blueprint for reform.* Washington, DC: Education Publications Center.

Valli, L. (1992). *Reflective teacher education: Case and critiques*. Albany, NY: State

University of New York.

Valli, L. (1997). Listening to other voices: A description of teacher reflection in the United States. *Peabody Journal of Education*, *72*, 67-88..

Well, M., Hestenes, D., & Swackhamer, G., (1995). A modeling method for high school physics instruction, *63*, 606-619.

Wells, L., Valenzuela, R., Brewe, E., Kramer, L., O'Brien, G., Zamalloa, E. (2008). *Physics Education Research Conference Proceedings, 1064*, 227-230.

Yayli, D. (2009). Reflective practices of preservice teachers in a listening skill course in an ELT department. *Procedia Social and Behavioral Sciences, 1*, 1820-1824.

Zeichner, K. & Liston, D. (1987). Teaching student teachers to reflect. *Harvard Educational Review*, *57*, 23-48.

Zeichner, K., & Liu, K. Y. (2010). A critical analysis of reflection as a goal for teacher education. In N. Lyons (Ed.), *Handbook of reflection and reflective inquiry* (pp. 67-84). New York: NY: Springer.

APPENDICES

Appendix A

Sample Email Invites

Sample Email Invitation

Hi Everyone,

I am writing to recruit volunteers for my dissertation study on Physics LAs' perspectives on the underlying themes of the LA program. I have completed the first phase of my study and am now on phases 2 & 3. If you are interested in participating in either one or both **PLEASE** let me know. I will work with any schedule.

Phase 2: In phase 2, you will be asked to sort 50 statements according to how much you agree with them into a grid. These are not content questions they are opinion statements. So, there is no wrong or right answer. This was pilot tested with chemistry LAs and took each of them **less than 20 minutes** to complete. One of them also commented that "it was kind of fun."

Phase 3: In phase 3, you will be asked to watch two 3-minute clips of physics LAs at other universities and write a reflection (a paragraph or so) on what you saw. In the pilot study, this took **less than 30 minutes.**

Completing phases 2 & 3 together should **be about an hour.** I can't pay anyone for participating in the study, but **I can buy you lunch** and will do so for anyone participating in both phases.

I need at least 60 volunteers for phases 2 & 3 to complete the study. So, if you know of any other physics LAs (completed at least 1 semester) whose contact information I may not have, please, feel free to pass it on.

My IRB approved cover letter is attached. My major advisor is Dr. Eric Brewe. If you have any concerns regarding this study you can contact him at eric.brewe@fiu.edu.

If you have any questions for me or you want more information, please, let me know.

Thanks!

Geraldine

Appendix B

Interview Protocol

Interview Protocol

1. Have you had a teacher that you consider to be an expert teacher?
   a. If yes, how do you think he/she came to be a expert teacher?
      i. Is there a certain amount of time one must teach to become an expert teacher?
      ii. Is there something one must do to become an expert teacher?
         1. If yes, what must they do?
         2. If no, what makes on teacher better than another teacher?
         3. If not mentioned, is being a good teacher something someone is born with?
   b. If no, ideally how would you describe an expert teacher? How do you think a teacher could come to be an expert teacher? Then questions i. and ii.
2. Have you ever thought back on a teaching experience and wished you'd done something differently? Or have you ever thought back on a teaching experience and decided that you wanted to do what you did from then on?
   a. If yes
      i. Tell me about that.
      ii. Why do you think you thought about that teaching experience after it happened?
      iii. What is the purpose of that process? Is that beneficial?
      iv. How do you feel about that process?
   b. If no
      i. Do you think about your teaching after you have left the class at all?
      ii. Tell me about that.
      iii. If no, why not?
3. What is the purpose of the LA Program?
   a. Why does FIU have an LA program?
   b. What do you think about the teaching assignments in the LA program?
   c. Has teaching in the LA program impacted you?
      i. If yes, how so?
      ii. If no, why do you think that is the case?

Appendix C

Q Sample

Statement 1: The teaching experience provided by the LA program gave me the opportunity to implement the things I learned about teaching.

Statement 2: The teaching experience in the LA program forced me to confront the gaps in my physics knowledge.

Statement 3: Thinking about what worked and what didn't work when I was teaching, helped me to become a better LA.

Statement 4: As an LA, the teaching experiences I thought back on were usually the teaching experiences where I wished that I had explained something differently.

Statement 5: As an LA, I thought about how I could have explained things better.

Statement 6: As a result of the teaching experience provided by the LA program, I have come to like teaching more.

Statement 7: As an LA, I used my experiences from one lab section (or with one group) to help me make decisions about what to do with the next lab section (or the next group).

Statement 8: As a new LA, I thought back on my teaching more often than I did after LAing for some time.

Statement 9: Thinking back on one's teaching is beneficial to being a good teacher.

Statement 10: As an LA, I noticed that I made changes in the way that I taught.

Statement 11: As an LA, I thought about my teaching while I was in the classroom.

Statement 12: As an LA, I discussed my teaching with other LAs.

Statement 13: As one gains more experience, the need to think back on one's teaching decreases.

Statement 14: As an LA, I would think about my teaching at random times and places.

Statement 15: As an LA, I would think about my teaching after class when I was alone.

Statement 16: As an LA, I discuss my teaching with my friends.

Statement 17: As a result of the LA program, my teaching skills have improved.

Statement 18: While teaching in the LA program, I felt rewarded when helping students learn.

Statement 19: The teaching experience provided by the LA program made me more aware of aspects of teaching that go beyond just being in the classroom.

Statement 20: As a result of the teaching experience provided by the LA program, my knowledge of how to teach has increased.

Statement 21: The teaching experience provided by the LA program has provided me with skills that I can use in my future career.

Statement 22: It takes approximately ten years of teaching to become an expert teacher.

Statement 23: It takes approximately five years of teaching to become an expert teacher.

Statement 24: Certain qualities of an expert teacher are natural and cannot be learned.

Statement 25: A teacher becomes an expert by teaching students from a variety of different backgrounds.

Statement 26: The teaching experience provided by the LA program prepared me for teaching in the future, if I choose to teach.

Statement 27: The teaching experience provided by the LA program, was exciting.

Statement 28: The teaching experience provided by the LA program helped me to find solutions to problems that are faced in teaching.

Statement 29: An expert teacher should be both an expert in their field and an expert in teaching.

Statement 30: An expert teacher has a natural ability to teach.

Statement 31: The teaching experience provided by the LA program opened my eyes to what it is like to be a teacher.

Statement 32: As a result of the teaching experience in the LA program, I learned from the students I taught.

Statement 33: An expert teacher must be motivated to teach.

Statement 34: There is no set number of years of teaching experience required to become an expert teacher.

Statement 35: As a result of the teaching experience provided by the LA program, I am more likely to become a teacher in the future.

Statement 36: A teacher can be an expert in their field, but not good at teaching it.

Statement 37: Thinking about what worked in the past and what didn't work in the past helps a teacher to become better over time.

Statement 38: As a result of the teaching experience provided by the LA program, I gained confidence in my ability to teach.

Statement 39: Collaborating with other teachers helps a teacher to become an expert teacher.

Statement 40: Writing reflections on my teaching experiences helped me to become a better LA.

Statement 41: An expert teacher is approachable.

Statement 42: Taking education courses can help someone to become a better teacher.

Statement 43: An expert teacher should be an expert in conveying their knowledge to students.

Statement 44: An expert teacher should be expert in the subject they teach.

Statement 45: As a result of the teaching experience provided by the LA program, my knowledge of physics has increased.

Statement 46: An expert teacher should be able to answer every question regarding the topic they are teaching.
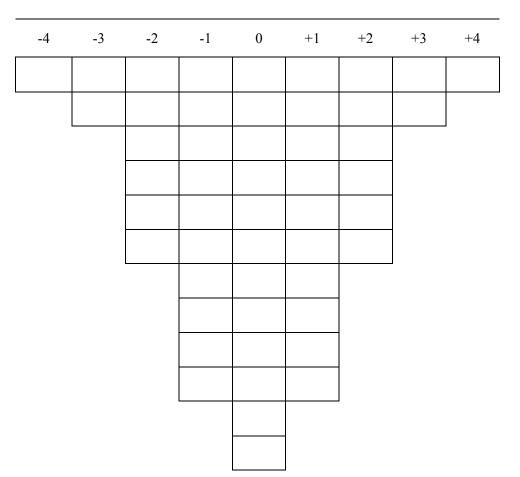
Statement 47: An expert teacher is confident.

Statement 48: A teacher develops expertise in teaching through experience.

Statement 49: As a result of the teaching experience provided by the LA program, I realized that teaching is more complicated than I thought.

Statement 50: As a result of the teaching experience provided by the LA program, I have more appreciation for people who teach.

Appendix D
Q Grid

Q Grid

-4	-3	-2	-1	0	+1	+2	+3	+4

VITA

GERALDINE L. COCHRAN

PROFESSIONAL PREPARATION

Chicago State University	Physics	B.S. 2004
Chicago State University	Mathematics	B.S. 2004
Chicago State University	Secondary School Physics	M.A.T. 2009
Florida International University	Science Education	Ed.S. 2013

Illinois Secondary Teaching Certification   2009

ACADEMIC/PROFESSIONAL APPOINTMENTS

Rochester Institute of Technology	Coordinator of CASTLE	2013-present
Florida International University	LA Program Administrator	2010-2013
North Carolina State University	Program Specialist	2009-2010
Chicago Public School Systems	Teacher	2007-2009
North Carolina State University	Instructor	2005-2007

RECENT PUBLICATIONS

1. Coble, K. M., Camarillo, C. T., Trouille, C. T., Bailey, J. B., **Cochran, G. L**, Nickerson, M. D., & Cominsky, L. R. (2013). Investigating student ideas about cosmology I: Distances and structure. *AER, 12*(1).
2. **Cochran, G.L.,** Brookes, D.T., & Wells, L. (Accepted 2013). *Physics Learning Assistants' Views on Expert Teaching: Toward and Understanding of PCK*, *American Institute of Physics Conference Proceedings*.
3. **Cochran, G.L.,** & Brookes, D.T. (2013). *Prospective teachers serving as physics learning assistants' perspectives on reflective practice.* Peer-reviewed paper presented at the South Florida Education Research Conference, Miami, FL.
4. Trouille, L.E., Coble, K., Cochran, G.L., Bailey, J.M.,, Camarillo, C., Nickerson, M.D., & Cominsky, L.R. (2013). Investigating student ideas about cosmology III: Big Bang theory, expansion, age, and history of the universe. *AER, 12*(1).
5. Trouille, L.E., Coble, K., Bailey, J.M., Cochran, G.L. ,Camarillo, C., Nickerson, M.D., & Cominsky, L.R. (2013). Investigating student ideas on cosmology II: Composition of the universe. *AER, 12*(1).
6. **Cochran, G. L.**, Brewe, E., Kramer, L. H., Brookes, D. T. (2012). *Assessing the reflective practice of prospective teachers through written reflections*. Paper presented at the meeting of the National Association of Research in Science Teaching, Indianapolis, IN.
7. **Cochran, G.L.,** Brookes, D.T., Kramer, L.H., & Brewe, E. (2012). A framework for assessing learning assistants' reflective writing assignments, *American Institute of Physics Conference Proceedings, 1513, 15-18.*
8. Bailey, J. M., Coble, K. M., **Cochran, G. L.,** Larrieu, D., Sanchez, R., & Cominsky, L. R. (2012). A Multi-institutional investigation of students' preinstructional ideas about cosmology. *AER, 1* (1).
9. Coble, K., **Cochran, G.**, Hayes, V., Larrieu, D., Sanchez, R., McLin, K., & Cominsky, L. (2010). Using the big ideas in cosmology to teach college students, *BAAS, 41*, 828.

INVITED PRESENTATIONS
1. **Cochran, G. L.**, Brookes, D. T., Kramer, L. H., & Brewe, E. (2013, April). Investigating prospective science teachers' views on teaching, reflection, and expertise. Invited session at the 2013 Meeting of the National Association for Research in Science Teaching, San Juan, Puerto Rico.
2. **Cochran, G. L.**, Brookes, D. T., Kramer, L. H., & Brewe, E., (2012, August). "A framework for assessing learning assistants' reflective writing assignments." Invited Session at the 2012 Physics Education Research Conference, Philadelphia, PA.
3. **Cochran, G. L.**, Musoba, G., Pineda, F., & Robertson, D. (2012, March). "Where international meets intercultural." Invited Panel Session at the 2012 Diversity Week at Florida International University, Miami, FL.
4. **Cochran, G. L.**, Gonzalez, V., Incera, V., Muhoro, P., Rockward, W., & Sunda-Meya, A. (2012, February). "Cultural perspectives on teacher education." Invited Panel Session at the 2012 Physics Teacher Education Coalition Conference: New Paradigms for Physics Teacher Education, Ontario, CA.
5. **Cochran, G. L.**, Coble, K. A., & Bailey, J. (2010, July) Addressing students needs in understanding cosmology. Invited talk at NASA's 2010 Education and Public Outreach Workshop, Sonoma, CA.

COURSES TAUGHT

Science and Math: Educational Theory and Practice	Florida International University
College Physics I Lab (Mechanics)	North Carolina State University
Physics for Engineers and Scientists I Lab (Mechanics)	North Carolina State University
Kinematics & Dynamics for Inservice Teachers (SMI)	University of Washington
Physics I with Calculus	Chicago State University
General Physics I (Algebra-based)	Chicago State University

Secondary School Teaching Experience

Honors Physics	Homewood Flossmoor H.S.
Various courses	Chicago Public School System

SYNERGISTIC ACTIVITIES/SERVICE
1. Committee Service: Chair of the Committee on Minorities in Physics for the American Association of Physics Teachers (AAPT) (2013 – 2014). Vice-Chair of the Committee on Women in Physics for the AAPT (2013-2014), Member of the Committee on Minorities in Physics for the AAPT (2011-2014), Member of the Committee on Women in Physics for the AAPT (2013-2016)

2. Referee: Effective Practices in Preservice Physics Teacher Education *(2013), Physical Review Special Topics-Physics Education Research (2013), American Journal of Physics (2012-2013), Physics Education Research Conference Proceedings, (2013, 2008-2010), South Florida Education Research Conference Proceedings (2013).*