The Report committee for Clayton Garrett Piehl

Certifies that this is the approved version of the Report

Survey of New Science Teacher Preparedness

Approved By

Supervisor Committee

Supervisor: _____

Susan Empson

_____

Catherine Riegle-Crumb

Survey of New Science Teacher Preparedness

by:

Clayton Garrett Piehl, B.S.

Report

Presented to the Faculty of the Graduate School

of the University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Masters of Arts

The University of Texas at Austin

August 2015

Survey of New Science Teacher Preparedness

By

Clayton Garrett Piehl, MA

The University of Texas at Austin, 2015

SUPERVISOR: Susan Empson

To investigate how well prepared teachers feel to implement inquiry-based science practices in secondary science classrooms, a phenomenological interview was developed and administered to 6 current secondary science teachers with less than 5 years of experience in the classroom. The interview questioned the participants about the science teaching practices they saw as important in their classroom, how well prepared they felt to implement those practices, and what experiences helped them feel prepared. The interview data were then coded using a constant comparison approach and trends across and within cases were identified. It was found that, teachers felt best prepared to teach secondary science if they had exposure to general teaching skills and specialized routines, comfort with their content, the opportunity for applicable experience in the classroom, and the support of experienced educators during their pre-service training program and first years of teaching. These factors can take different forms in certification programs and the importance of each may vary between individuals, but these four elements were present in each case and were the driving force behind teachers' perceptions of their preparedness.

Table of Contents

Chapter 1: Introduction

As a high school science teacher in Central Texas, I have heard statements from my colleagues on numerous occasions that sound something like, "I wish I had learned _____ before I started teaching," or "the last two years would have been so much easier if I had known _____ from the beginning." These sorts of comments have involved a variety of topics ranging from generic teaching practices such as data analysis and classroom management strategies to science specific topics like lab design and how to get students to think more logically about their observations during class. Frequent comments such as these began to develop a curiosity within me about how well prepared most new teachers feel as they enter the field of science teaching. With a renewed and heightened focus on STEM (Science, Technology, Engineering, and Mathematics) education during the last decade or so and with the evolution of science teaching expectations exemplified by the Next Generation Science Standards published in 2013, secondary science teachers are coming under more and more pressure to perform highly varied and skilled tasks. Yet, it seems that many enter the classroom feeling at least somewhat underprepared. In this study, I explore new teachers' perceptions regarding their level of preparedness prior to entering the classroom and what reasons they give for their feelings of preparedness.

There are many ways to address this question of teacher preparedness. Many studies focus on teacher performance and student achievement in order to determine how well pre-service certification programs prepare teachers to meet the challenges of today's science classroom. However, equally important are the perceptions and opinions of teachers themselves. As participants in these programs, they hold an important perspective on their preparation to

teach. In this study, I designed an open-ended, phenomenological interview, Survey of New Science Teacher Preparedness, to elicit new teachers' opinions and perceptions about their preparation to teach science. New teachers are both consumers and producers of educational practice and their perspective on how well pre-service programs have prepared them for the classroom is vital to the improvement of pre-service training programs.

A series of interviews with in-service teachers regarding their perceptions of their preparation could potentially cover many different topics. This study is specifically focused on how well prepared new teachers feel to implement effective, research-based science teaching practices and what experiences in their pre-service training programs they perceive as helping them feel prepared for these practices. Matthew Kloser and a panel of experts created an extensive list of essential science teaching practices that they considered vital to successful secondary science education, and then narrowed this list down to the ten most important practices that all science teachers should seek to implement (Kloser, 2014). However, it cannot be assumed that beginning teachers have been trained in these practices and some new teachers might not even be familiar with all of the practices Kloser and his team developed. Therefore, during this qualitative interview process, it is important that new teachers be allowed to describe what practices they consider important for science teaching and how prepared they feel to implement this vision of teaching science. Both the teachers' opinions about what is important in science teaching and their perceptions about how well prepared they feel to meet this vision of "good science teaching" can shed significant light on the types of practices teachers feel confident applying in their classroom as well as inform potential changes to teacher education in order to better prepare them to implement these vital practices.

In addition to what new teachers see as important practices for good science teaching, there are many factors about a pre-service training program itself that can effect whether new teachers feel prepared or not. There have been several studies linking various program pieces and teachers' perceptions of preparedness. For instance, Ayana Kee used longitudinal data to determine that there are complicated and possibly unexpected relationships between the length of teacher's pre-service student teaching experience and their perceptions of preparedness (Kee, 2012). Similarly, Darling-Hammond used a study conducted in 1998 in New York to show how a teacher's confidence and efficacy can be greatly affected by the student teaching experience as well as the pedagogy and content classes that they are required to take prior to certification (Darling-Hammond, 2002). Because there are many potential factors that could affect a teacher's perspective on how well they were prepared and the goal of this phenomenological study is to avoid making any assumptions about which of these factors would matter to individual teachers, an open-ended interview process is in order. The interview questions were carefully designed to provoke teachers to think deeply about their own perspectives and the reasons behind these perspectives without leading them to certain answers and introducing avoidable bias into the study.

Since the goal of this study was to study the perspectives of secondary science teachers regarding how well prepared they were by their pre-service training program, there were a few additional factors about the participants themselves that were also important to consider. In order to give fresh and relevant perspectives, the participants needed to be relatively new to the classroom so that they would be able to easily recall their pre-service training and their training would be more likely to have been based on recent research and methods. Thus, only

classroom teachers with between one and five years of experience of teaching secondary science were considered for this study. Six interviews were conducted as a part of this survey so that the scope of the study did not become so broad as to be cumbersome, but also to allow sufficient depth into each interview in order to effectively determine how well prepared new teachers truly feel as they enter the classroom.

Chapter 2: Literature Review

During the course of reviewing the literature regarding new science teacher preparedness, two main topics were used to focus the research: what are the teacher practices that science teachers should be prepared to implement in their classrooms and how do teachers feel about their preparedness to implement these practices during their first years of teaching. Two recent and comprehensive articles regarding science teacher practices were found and I used these to define what preparation we would expect teachers to have prior to entering the science classroom. Both of these studies were from the perspective of researchers identifying the science teaching practices experts deemed vital to the classroom, but I was unable to find any research that showed what practices teachers themselves thought were important for successful science teaching. There were also several studies within the last 15 years regarding teacher perceptions about their preparedness although none of them focused on secondary science teachers specifically and very few of the articles described a phenomenological interview process in their methods. These articles and studies have helped to refine and direct my research and I have also adopted some terminology from them in order to define and structure my questioning.

Ideal Science Teacher Practices

To begin my research, I sought to describe the practices of well-prepared science teachers through comprehensive articles and research. I have borrowed my definition of the term "practice" from Mark Windschitl where he defined teacher practices as "routine activities teachers engage in devoted to planning, enactment, or reflection that are intended to support student learning" (Windschitl, Thompson, Braaten, & Stroupe, 2012, p. 882). This definition is

useful because one of my goals is to document the routine activities that new teachers feel prepared to engage in while in the classroom. In his article, Windschitl also describes four primary practices that he and his coauthors see as vital to the science classroom. These practices include: developing big ideas, eliciting student ideas to adapt instruction, helping students make sense of material activities, and pressing students for evidence-based explanations. He argues that these practices should not be necessarily mastered by beginning teachers because it takes many years to develop expertise, but new teachers should feel like they have been trained in the basics of these four primary practices (Windschitl, 2012). These four practices were cross-referenced and combined with a second list of science teacher practices provided by Matthew Kloser.

Matthew Kloser and his team of researchers used the Delphi method in order to generate a list of science teacher practices that a team of 25 science education experts vetted and ranked according to importance in the classroom (Kloser, 2014). The Delphi method is an iterative process where Kloser recruited a large panel of expert stakeholders in science education including experienced teachers, collegiate professors, administrators, and STEM professionals and had them rank, comment on, and add to a list of science teacher practices. After three rounds of vetting the practices, Kloser and his panel of experts were able to expand upon Windschitl's work and generate a more specific and detailed list of 10 science teacher practices and rank them according to importance. These ten practices are: 1. Engaging students in investigations; 2. Facilitating classroom discourse; 3. Eliciting, assessing, and using student thinking; 4. Providing feedback; 5. Constructing and interpreting models; 6. Connecting science concepts to applications; 7. Linking science concepts to phenomena; 8. Focusing on core science

ideas and practices; 9. Building classroom community; 10. Managing materials and lab equipment (p. 1195).

Drawing from the work of Windschitl and the follow-up work of Kloser, I have generated a list of practices that all science teachers should feel at least somewhat prepared to implement when they enter classroom (Windschitl et al., 2012; Kloser 2014). The goal in generating my list of practices is to capture the essence of Windschitl's and Kloser's work while maintaining the integrity of an interview setting which would require a somewhat shorter list. Thus, I compared the lists of Kloser and Windschitl in order to blend, slightly modify, and whittle down the list to generate a list of five practices to include in the interview: 1. Engaging students in authentic investigations; 2. Centering curriculum around central ideas or concepts; 3. Encouraging classroom discourse and debate; 4. Getting students to construct/interpret scientific models; 5. Adapting/adjusting instruction to meet student needs. I have chosen to call this list Inquiry-based Science Practices. The third practice that I have included in the interview list is a good example of how several of the practices from Windschitl and Kloser have been combined. Encouraging classroom discourse and debate obviously includes "Facilitates classroom discourse," but it also helps to "Elicit student ideas to adapt instruction" and "Eliciting, assessing, and using student thinking." In addition to meshing practices together, "Connecting science concepts to applications" and "Managing materials and lab equipment" were excluded from the interview list altogether. The first was omitted because I feel it is likely that scientific applications will be mentioned or included in participants responses when discussing modeling and adapting instruction. The second was left off of the list because it is a practice with the lowest importance mentioned in Kloser's work and brevity was needed for the purpose of these

interviews (Kloser, 2014, p. 1195). This process of combining and whittling down the practices to the shortened list captures most of the essence of Windschitl's and Kloser's lists of core practices and allows the interview to continue to flow naturally without devolving into a verbal Likert survey.

A summary figure of all of the practices appears below:

Windschitl's Practices	**Kloser's Core Practices**	**Inquiry-based Science Practices**
1. Developing big ideas 2. Eliciting student ideas to adapt instruction 3. Helping students make sense of material activities 4. Pressing students for evidence-based explanations	1. Engaging students in investigations 2. Facilitating classroom discourse 3. Eliciting, assessing, and using student thinking 4. Providing feedback 5. Constructing and interpreting models 6. Connecting science concepts to applications 7. Linking science concepts to phenomena 8. Focusing on core science ideas and practices 9. Building classroom community 10. Managing materials and lab equipment	1. Engaging students in authentic investigations and inquiry 2. Centering the curriculum around central ideas/concepts 3. Encouraging classroom discourse and debate 4. Getting students to construct/ interpret models 5. Adapting/adjusting instruction to meet student's needs

Figure 1. Core Science Teaching Practices.

Teacher Perceptions of Preparedness

In addition to studying the literature on science teacher practices, I focused on studies that sought to determine new teachers' perceptions of their preparedness based on their certification programs. There were several studies found that touched on the topic of teacher perceptions of preparation, but none of them focused on science teachers and science teacher practices and very few of them relied on qualitative data from interviews with participants. Most of the studies involved quantitative surveys in combination with short answer interviews that were analyzed by coding responses and running statistical analysis on the results. A notable exception from this trend was the Voice of the Teacher study which will be discussed in a later section of this review.

One of the aspects of teacher preparation that I expect to discuss in the interview is the length and quality of the field or student teaching experience in the participants' programs. Ayana Kee conducted a quantitative study of teacher perceptions of preparation and compared the different reports of preparation between alternatively and traditionally certified teachers (Kee, 2012). She concluded that first-year teachers who followed an alternative certification route felt less prepared to teach than students in their first year out of a traditional program and that this was largely due to the difference in student teaching experiences offered between the two options. Sharon Chambers and James Hardy conducted a similar study comparing first year teacher's perceptions of their preparation and self-efficacy after 1 semester and 2 semester student teaching experiences. They were able to conclude that there were no significant differences in the feelings of preparation or self-efficacy in the teachers based on their length of field experience prior to teaching (Chambers, 2005). These two studies show that, while

significant field experiences embedded within certification programs are essential, they do have a diminishing return on investment after a certain point. This data is valuable and important for educators designing pre-service training programs for teachers, however the studies were not designed to delve into the underlying reasons why teachers might feel more or less prepared based on their length of field experience. Further investigation is needed where the voices of new teachers are heard in order to determine why they feel their experiences may or may not be valuable for their preparation.

In a similar study, Linda Darling-Hammond and her coauthors analyzed a set of Likert scale and interview data from a study that sought to determine whether teacher pre-service education has significant effects on teacher efficacy as well as what things teachers feel well prepared to do in the classroom (Darling-Hammond, Chung, & Frelow, 2002). They concluded that a combination of the content and pedagogy classes embedded in the programs as well as the quality of field experience component had an effect on teacher's perceptions of preparedness and efficacy. These conclusions, while broader than the conclusions from both Kee and Chambers, were also based on quantitative analysis of the old survey data and the interview questions were relatively brief and not designed to be open ended to allow teachers to really share their voice and also focused on teachers of all levels and content areas.

Patricia Simmons and a large team of coauthors conducted a similar, although more longitudinal study that involved a combination of Likert scale questions as well as interviews in order to study beginning teacher's perceptions of how well they were implementing their teaching ideals. The teacher's perceptions about their ideals and quality of teaching is somewhat different from studying their perceptions about their preparation, but one very

interesting trend was observed by the authors that is relevant. Simmons and her team observed that teachers felt like they were very successful at implementing "student-centered" learning practices when they first entered the classroom, but, toward the end of their first year of experience, they began to "wobble" on their initial perceptions of their own performance (Simmons et al., 1999). As they became more familiar with their own craft, the teacher's perceptions and self-evaluation of their practice became much more rigorous and they began to feel less prepared to meet the challenges of teaching. This sort of trend might very well affect early teachers' perceptions of their pre-service training programs as well. As they gain more experience as teachers, their perspectives might shift to a more critical view of their pre-service training or they might gain a greater appreciation of the practices in which they were trained. The teachers themselves might even be reflective enough to be able to observe the shifts in their perspectives and shed light on why these shifts occur.

All of the studies that have been mentioned thus far regarding teacher perceptions of their preparation have involved teachers of all content areas and some have included several different levels of education. Many of the trends the authors have observed can be extrapolated to science teachers, but different content domains and different levels of teaching require vastly different skill sets and more focused studies need to be used in order to analyze beginning teacher's preparation for these skills. For instance, beginning science teachers must be prepared to engage students in scientific investigations and constructing models which would require a different type of preparation from other content domains. Mark Windschitl's *Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice* (Windschitl, 2003) and Elizabeth Davis's *Challenges*

New Science Teachers Face (Davis, Petish, & Smithey, 2006) are two sources that deal specifically with new science teachers and their experiences within the literature.

Windschitl's study involved observations of the pre-service teachers while they were training, interviews with these teachers, and observations of the teachers in the classroom while they implemented a scientific inquiry lesson (Windschitl, 2003). The interviews were more focused than the open-ended interviews for this study and they were focused on the pre-service teacher's experience with inquiry prior to implementing an inquiry lesson themselves. What he found was that, the more experience the novice teachers had with scientific inquiry during their own education, the more effective they were at implementing these types of lessons in the classroom and, as noted by both Windschitl and Kloser in their articles on science teacher practices, engaging the students in effective investigations, thoughtful discussions, and clear explanations is vital to successful science teaching (Windschitl, et al., 2012; Kloser, 2014). Windschitl was able to discern these improved implementations of scientific inquiry through both his direct observations of the teachers during training and in the classroom as well as through interviewing the teachers about their experiences with science and their feelings about their lesson after they had implemented it in the classroom through his interview process. This study is designed significantly different than the current phenomenological interview study, but Windschitl's conclusions are still applicable in that his participants were able to demonstrate and perceive better preparation through their own experiences with inquiry.

Elizabeth Davis and her team focused their research on identifying the challenges that new science teachers encounter as they first enter the classroom (Davis, Petish, & Smithey, 2006). Through a very thorough search of all of the available research from 1993 until 2004, they

compiled and analyzed a list of challenges specific to teaching science at the secondary level. Similar to Windschitl, Davis and her team found a significant portion of articles relating to the teacher's abilities to implement scientific inquiry and found that many teachers' are not adequately prepared in this area:

> Some studies investigating pre-service teachers' knowledge of science processes or thinking skills indicate that these teachers' knowledge would be inadequate to prepare them for teaching through science inquiry. (p. 317)

These areas of science processes and thinking skills are necessary in order for teachers to feel prepared to teach science as both Windschitl and Kloser would argue through their lists and Davis found many articles through her research that would indicate these are significant challenges that teachers may or may not feel confident in their training in order to implement (Windschitl, et al., 2012; Kloser, 2014). Davis also found articles within other broad topics of science teaching such as: understanding and feeling well prepared with the learners themselves, the curriculum and instruction, the learning environment, and the professional community of educators. All of these areas are vital and Davis's research identifies each of these areas as challenges to new teachers, but the articles do not offer new teachers a voice to express how prepared they feel to meet these challenges.

Voice of the New Teacher

Through all of the research reviewed above, the authors employed mostly quantitative methods in order to explore teachers perceptions through Likert scale questioning, compiling of old articles, and/or focused interviews where the questioning was relatively rigid in order to

produce statistical data that could easily be analyzed to produce concrete results. And, while all of this research is vital to the field of science education research, the voice of new teachers and their opinions regarding their pre-service training regimens is still conspicuously missing. There has been one study that attempts to address this gulf in the research: *The Voice of the New Teacher* which was published by the Public Education Network in 2003 (The Voice of the New Teacher, 2003). This report is essentially a series of more open ended interviews with some Likert type and scale questions after the interview in order to determine areas that teachers feel well prepared or underprepared in. The methods and goals of the Voice of the New Teacher are very similar to the goal of this study. The primary difference is that the Voice of the New Teacher study was broad, interviewing teachers in all content areas and addressing areas of concern such as "Understanding Student Development" and "Addressing Learning of ELL students." This study has a similar open-ended interview process, but it is focused on new science teachers and the specific areas of concern and practices that science teachers need to be prepared for. The Voice of the new Teacher study made many conclusions about what teacher felt prepared to do:

> Teachers from the PEN sites felt most prepared in knowing and understanding their students, teaching their subject areas, using a variety of instruments to assess students, and planning instruction with their colleagues. They felt least prepared to teach special-needs students and English language learners, to work with parents, to assume leadership roles in their schools, and to create interdisciplinary curricula. (The Voice of the New Teacher, 2003, p. 7)

> Teacher satisfaction with pre-service education ranged from feeling that their courses were a waste of time to feeling that they were a valuable foundation for teaching. There was consensus, however, that student teaching and other classroom experiences were, by far, the most valuable pre-service training. (The Voice of the New Teacher, 2003, p. 8)

Through the Survey of New Science Teachers, my plan was to observe trends in the interviews and generate a similar list of practices that new science teachers feel well prepared to implement in their teaching and practices they feel unprepared for as well as what experiences helped them feel well prepared or unprepared. The primary differences lie in the more focused demographic of my study and my interviews will be more open ended to allow the teachers to speak freely about their own experiences.

Research Questions

Through my review of the available literature, it is evident that there are many studies that measure the perceptions of teachers regarding their pre-service preparations, but none of them focus on secondary science teacher training and the specific practices that this domain entails almost none of the studies use an open-ended, qualitative approach in order to really hear the voice of the teachers. Therefore, through the Survey of New Science Teachers, I have developed an open-ended, phenomenological interview study that will determine how well prepared new science teachers feel to implement the science practices necessary in order teacher secondary science successfully based on their pre-service training and what experiences caused them to feel prepared.

Chapter 3: Methods

Overview of the Research Method

In order to effectively hear the voices of new secondary science teachers regarding their feelings of preparation, I developed an open-ended interview questionnaire and interviewed six different science teachers at a central Texas high school with between one and five years of experience in the classroom. This interview was designed to allow me to analyze how well prepared teachers feel to teach science and what experiences they had during the course of their pre-service certification program that has enabled them to feel prepared. After the interviews were completed, they were analyzed using a qualitative, basic constant comparison coding method to discern patterns and trends relating different feelings of preparation to different experiences in different programs.

Participants

The goal for the research component of this study was to conduct six interviews with current, high school science teachers with fewer than five years of experience. To recruit participants, I contacted department chairpersons and canvased members of the science department at a local high school which shall be referred to as Central Texas High School (CTHS) for the rest of the study. The participants earned their teacher certificates through six different pre-service training programs throughout central Texas. Three of these six programs could be categorized as alternate certification programs, meaning the participants had already achieved at least a Bachelor's degree before enrolling in a program outside of a University in order to become certified. The other three programs could be classified as traditional programs where the participants earned their teaching certificate while earning a degree through an accredited

university program. All six of the participants had less than five years of experience in the classroom in order to make it more likely that they would have a fresh perspective on their training programs, but their experience ranged from one semester to five full years of teaching. The participants were also selected with varying content specialties to study patterns across different science topics; one was a physics teacher, one was chemistry, one was anatomy and physiology teacher, and three were biology teachers. This diversity among the participants allowed for more specific trends to develop and it could also grant additional credibility to trends that might appear across all of the participants. A summary table of the participants and their programs are below:

Table 1

Summary table of all of the participants, the programs they attended, their content area, and the characteristics of the program. All traditionally certified participants have 2 syllable names while alternatively certified participants have 1 syllable names.

Type of Program	Pseudonym of Program	Participant	Content area	Characteristics of program
Traditional	Blanco University	Jordan	Physics	• 1 year Master's program • Required previous completion of Bachelor's in science field • Classes included instruction on Special Education (SPED), reading strategies, positive behavior interventions, high needs, Bloom's taxonomy, and cultural considerations • 1 yr student teaching experience
Traditional	Plain's University	Emily	Biology	• 4 year Bachelor's program • Education major with a focus in Biology • Classes on Classroom Management and SPED • 2 to 3 science classes per semester • 1 semester field experience, ½ semester student teaching
Traditional	Colorado River University	Holly	Anatomy and physiology	• 4 ½ year Bachelor's program • Biology Major • Classes on Laying the Foundation, SPED, Adolescent Psychology, Education Technology • 1 semester student teaching (3 weeks co-teach, 10 weeks independent teaching)
Alternative	Central Region Teachers	Jane	Biology	• 2 semester program (usually Spring and summer) • Classes included: pedagogy, classroom management, SPED, understanding students • 4 observations in spring semester • 10 day student teaching • 1 year probationary certificate
Alternative	Teaching in Texas	Bob	Biology	• 1 month on-line, 1 week in class program • Classes included development of classroom management and teaching philosophies • 48 hour field experience (any type of field experience including observations, substituting, co-teaching, or student teaching) • 1 year probationary certificate
Alternative	Teach Centex	Beth	Chemistry	• 1 year program, mostly on-line • Classes included SPED, legal, classroom management, child development, and a curriculum/instruction class • Field component waived due to 1 year experience teaching middle school science in a private school (did not require certification) • 1 year probationary certificate

Interview Protocol

The interview was developed with the goal of eliciting the participants' perspectives on their experiences during their pre-service training program as well as during their first couple of years of teaching. To establish a level of comfort, the interview opened up with a series of factual questions about the participant's pre-service training and certification program which also served to provide significant background information that was used in the coding and analysis part of the research. After the initial, factual questions, the interview shifted to questions regarding the teaching practices that the teachers saw as vital for teaching science at the high school level. Before asking how well the teachers how well prepared they felt to teach science, I first wanted to establish what these teachers meant by teaching science, so the second main question asked, "Think back to the last unit that you taught. What were the some of the important teaching practices that went into planning the lessons and/or delivering the lessons in class?" In addition to establishing a groundwork for the next few questions about preparation during the interview, this question enabled me to compare the science teaching practices that the teachers described to the ones that Kloser and Windschitl described in their work. The next section of the interview focused on how well prepared participants felt to implement these practices in their own classrooms and what sorts of experiences, whether in their pre-service training program or outside of it, helped them develop this feeling of preparedness. Participants were encouraged to think of specific examples of times when they felt prepared or unprepared and what things had led them to feel prepared or unprepared. Finally, the participants were asked to rate their level of preparedness on the five science teaching practices that I adapted from Kloser's and Windschitl's work and why they ranked themselves the way they did. In

summary, the interview not only focused on the type of preparation the teachers received in their programs, what types of practices they saw as important for teaching science and how well prepared they felt for teaching those practices they deemed important, but it also enabled the participants to reflect on their level of preparedness to implement Inquiry-based Science Practices for which they may or may not have been trained for during their programs.

Interview Questions	
1	I'd like to start by getting a little information about the pre-service training program that you earned your Texas Teacher Certification through.
2	Think back to the last unit that you taught. What were the some of the important teaching practices that went into planning the lessons and/or delivering the lessons in class?
3	How well prepared do you feel for these important teaching practices?
4	Are there any additional comments you have regarding how your pre-service training program prepared you for teaching?

Figure 2. The four primary interview questions. A full list of follow-up questions and the interview document are given in Appendix A.

Data Collection and Analysis

Once the six participants were recruited and selected, interview appointments were scheduled so that there was at least one hour of uninterrupted time in a quiet, private room. The participants were then given the informed consent document, given the opportunity to ask any questions, and then the interview commenced with an audio recording and hand written notes for data. The interviews ranged in time from around 30 minutes to 75 minutes and were transcribed within two days of the completion of each interview.

Once all of the interviews were recorded and transcribed, the text was sorted into chunks of data related to several different codes relevant to the research questions of the study. The

codes for the data were created once the transcriptions were complete and a general sense of the data was developed. These codes underwent several revisions as the data was parsed into smaller and more relevant data chunks. The final coding scheme consisted of a descriptive system where a word or phrase was used to refer to a certain type of teaching practice, opinion, statement, or experience that participants may have described during their interviews (Miles, Huberman, & Saldana, 2014, p. 75). The interview data were then reviewed and statements or quotes by the participants were labeled with the various codes. First in this scheme is a Primary Coding Category which is defined broadly in order to group more specific sub-codes together. This hierarchical system was implemented to first keep the large amount of data organized and easily accessible and, second, to be able to compare trends across cases as well as within cases. In this way, teachers' descriptions of their experiences and teaching practices could be compared to their perceptions about their level of preparedness. In the table below, the Primary Coding Categories, Sub-codes, definitions, and examples are presented and summarized:

Feelings of Preparation: statements from the participants regarding how well prepared they feel to complete various tasks in the science classroom.		
Sub-code	**Sub-code definition**	**Example data for sub-code**
General Statements	These statements are the participants overall feelings of preparation to teach science on the whole.	-I don't feel like I was very prepared.
Likert Ratings	These Likert Ratings are the ways teachers rated themselves on the five science teaching practices on a scale from 1 to 5.	-4, 3.5, 3.5, 3, 4.5

Figure 3. The code and sub-code definitions and examples for Feelings of Preparation.

Teaching Practices: classroom practices that teachers felt were vital to teaching secondary science		
Sub-code	**Sub-code definition**	**Example data for sub-code**
General Teaching Practices	The practices listed under general teaching practices would be those that would have some amount of carryover for all classrooms. The skills might be situated within science and thus require a science background, but they are still applicable to all secondary classrooms.	-Standards- Based -Classroom Management -Engage Students -Formative Assessment
Science Teaching Practices	The practices listed here are those that are applicable in a science classroom specifically, but do not fit the true definition of one of Kloser's ten Science Teaching Practices.	-Get students to follow lab safety -Get students to think about what they're doing
Inquiry-based Science Practices	The practices listed under this category are those that were listed as vital by teachers and accurately fit one of the ten practices listed by Kloser.	-Inquiry with lesson examples -Modeling with examples -Classroom debates to get students thinking

Figure 4. The code and sub-code definitions and examples for Teaching Practices.

Relationships with experienced educators: any type of experience related to participant's interaction with experienced educators that was described as being helpful		
Sub-code	**Sub-code definition**	**Example data for sub-code**
Feedback from an experienced educator	Anytime a participant references receiving feedback from another teacher, mentor, or supervisor as being helpful for their preparation.	-It is also really helpful when those teachers come and observe me and give me feedback about my teaching and how to improve.
Training Program Mentor	Anytime a participant references that their program provided a mentor outside of student teaching that has helped them feel prepared.	-I didn't feel like I was thrown to the wolves because I had support from the program and I had a school and program mentor which has helped me throughout the year.
School Mentor	Anytime a participant references a mentor educator assigned by the school has helped them feel prepared	-So, I would have a better science mentor to help me sift through ways to teach it.
Working with a Team of Experienced Educators (PLC)	Anytime a participant references working with their team, department or other group of experienced teachers as helpful for their perceptions of preparedness.	-My neighbor teachers and others on my Biology team have really helped me improve too
Observing Experienced Educators	Anytime a participant references observing experienced teachers as an experience that has helped them feel prepared.	-Well, I think the observations were helpful because I got to see how she taught and how she did labs.

Figure 5. The code and sub-code definitions and examples for Relationships with experienced educators.

Opportunity to apply training: pertains to participants practicing or applying the principles, practices, or skills that they learned in their pre-service training program.		
Sub-code	**Sub-code definition**	**Example data for sub-code**
Outside classroom practice as a part of program	Anytime a participant references practicing a specific skill outside of their student teaching experience during their pre-service training program as helpful to feeling prepared.	-One of the things we had to do for my SPED classes, we had to work with a student with an IEP…
Prior experience	Anytime a participant references any experience prior to enrolling in their program that helped them feel prepared.	-I felt prepared because I had taught at the private school and I was really committed to lots of hands-on learning
Classroom experience during student teaching	Anytime a participant references practicing skills (including general statements about student teaching) during student teaching as helping them feel prepared.	-My student teaching, even though it was short and intense, it really helped me develop confidence and classroom management.
Classroom experience after student teaching	Anytime a participant references feeling prepared based on their teaching experience post student teaching.	-And since I've practiced it, since student teaching, I feel ready or prepared to do so.
Field Experience	This code is a quick summary of each participant's field experience component for their program.	-2 weeks, all day teaching
Opportunities to apply that did not occur, but would have helped.	Anytime a participant references an experience that would have been helpful during the pre-service program, but was not included as a component of the program.	-If I had student teaching where I had set up a lab as a part of it, I would have felt much better prepared when I started.

Figure 6. The code and sub-code definitions and examples for Opportunities to Apply.

Specific Skill Codes: any specific skill that participants either obtained or wish they had obtained during their pre-service training program that was helpful or would have been helpful in making them feel prepared		
Sub-code	**Sub-code definition**	**Example data for sub-code**
Comfort with Content	Anytime a participant references content knowledge as helpful to their perceptions of preparation.	-It's mostly just my comfort with the content.
Planning for Instruction	Anytime a participant references their training to plan lessons and units as helpful to their perceptions of preparation.	-I just wish I had a class like how do you want to structure your class. Do you want to use POGILs, inquiry, problem-based, etc.
Resources	Anytime a participant references the ability to find helpful and relevant resources for lesson ideas or planning as helpful to their perceptions of their preparation.	-I feel like I don't know where to find good resources. I've got like information overload and I can't find good ideas. Lots of ideas, but not really what I'm looking for.
Other Skills	Anytime a participant references other skills as helpful to their perceptions of their preparation that do not fit into other sub-codes.	-It has been helpful learning the acronyms and disabilities and how to work with students with special needs.

Figure 7. The code and sub-code definitions and examples for Specific Skill Codes.

Once all of the codes were defined and interview data was sorted into these various categories and sub-codes, the reliability of coding was checked by having a second, experienced researcher code a portion of an interview. In the process of reviewing the code reliability, around 80% of the data was coded consistently and any discrepancies were resolved through discussion. After the first cycle was checked, the data was analyzed to determine patterns within each interview and between the different participants. First, larger trends were examined based on the categorical data before patterns within cases were defined based on the more specific sub-codes. These trends were then described and defended from the coding system in order to produce the findings and conclusions.

Chapter 4: Results

Several patterns, both within cases and across cases, regarding how well prepared teachers feel to teach science and what types of experiences have enabled them to feel prepared emerged from the data after the second round of coding. These patterns are situated within the highly complex, life experiences of each teacher and many of the experiences, opinions, and perceptions that are consistent across the cases are frequently present in different forms. I start with a brief summary of each participant, their experiences, and how well prepared they feel to teach science at the secondary level and then discuss findings within and across the cases.

Beth

Beth is an alternatively certified chemistry teacher with three years of experience as a certified science teacher and one year as a private middle school science teacher prior to being certified. She transferred into the field of teaching after working for several years as a metallurgical engineer. Beth ranked herself as fairly well prepared to implement the five Inquiry-based Science Practices, however, she stated that overall, "I don't feel like I was very prepared." In addition, almost all of the practices that she listed as vital to teaching science were very general sorts of teaching practices such as helping the students stay organized or using simultaneous questioning techniques and, when she did mention some of the Inquiry-based Science Practices as her teaching ideals, she said that she was not implementing them right now.

The major things that Beth referenced in relation to feeling prepared were the experiences she had applying science in her engineering job and science teaching practices in the classroom.

Her experience in the engineering field gave her significant confidence in the content that she was teaching, but she did mention struggling to bring the content she worked with on a regular basis down to a high school appropriate level. In the classroom, she described her year teaching science at a private middle school as the thing that most prepared her for teaching Inquiry-based Science Practices because she had a lot of freedom with her instruction and used a lot of inquiry type instruction where the students developed their own labs, researched questions, discussed options, and produced basic conclusions. Thus, she felt very prepared to implement the content and practices that she had previously applied in her classroom. However, when she first completed her certification program and switched to the public school setting, she felt unprepared for the different environment and low-income demographic. Her observations and field experience as a part of her pre-service training program were waived due to her experience in the private school, so she had virtually no experience working with classroom management challenges, special needs students, and English Language Learners and many of her teaching ideals were derailed due to these issues. Thus, in retrospect, Beth wished that she had been trained more specifically for classroom management issues and been able to see strategies in action through teacher observations and been given the opportunity to work with different demographics. After three years teaching at CTHS and gaining significant experience working with the student population, Beth did say that she feels much more confident and prepared now because she is teaching lessons that she has taught before and she has been working with a team of other experienced educators on her Chemistry team. This team relationship and support was described by Beth as helping her improve her teaching practice as well as help her

feel more confident and prepared while in her first years of teaching. She even went so far as to say that she felt that teaching as an apprentice would be her ideal for learning how to teach.

Outside of the opportunities for applying her training that she had or wished she had and the benefit of working alongside other experienced educators, Beth mentioned her training in how to plan and write lesson plans, training about educational terminology (such as IEP, ELL, differentiation, etc.), and training in how to find resources as valuable experiences that helped her feel prepared. She took a curriculum and instruction class outside of her certification program and she credited that class as the reason she felt most comfortable planning lessons because she was taught how to write lesson plans and was given a lot of practice. Her pre-service training program included a lot of training about terminology which helped her feel comfortable in a setting where there were lots of terms she would not have otherwise been familiar with. Finally, her program also included a few links to resources for planning lessons, labs, and the like and she has relied on those links several times when she was at a loss during planning.

Thus, even though Beth felt well prepared to teach using Inquiry-based Science Practices and she felt that she had the general teaching skills necessary to teach secondary science, her lack of applicable experience in a classroom with behavioral and management challenges caused her to feel unprepared.

Bob

Bob is an alternatively certified Biology teacher who earned an undergraduate degree in Biology and had some experience in a graduate level Biology lab before beginning to substitute

teach and earn his teaching certificate. He has now been teaching at CTHS for five years and is the team leader for the Biology teachers. The majority of the practices that he described as vital to teaching science were general practices or basic science practices and he only mentioned one that would really fit the Inquiry-based Science Practices. On the Likert questions regarding the Inquiry-based Science Practices, Bob rated his feelings of preparation as very low during his first year of teaching, but, after five years in the classroom, feels much better prepared for teaching science now. Overall, he described his preparation this way: "Right now, since it's my fifth year, I feel pretty prepared. My first year, I was terrified of doing a lab."

Bob's pre-service training program was one summer long and his field experience was waived due to his experience substitute teaching in elementary and middle schools the spring prior to his program. Thus, when he began teaching Biology at CTHS, he had no experience in a high school classroom teaching science and had never conducted a laboratory type lesson in a secondary setting. In addition, he described his program as primarily lecture based training with periodic collaborative sessions with prospective teachers of all content and all levels. He said that those collaborative sessions were most helpful because he retained the information in them better, but he really wished that he had the opportunity to practice running labs or implementing some science teaching practices as a part of his training program. Through this, he was able to plan out his classroom procedures, policies, and some practice lessons which helped him feel slightly prepared for his first year. After five years of teaching at CTHS, Bob said that he felt much more prepared than at the beginning largely because he had been working with experienced educators as a part of a team for the entire time and he was able to get valuable feedback from them as well as the experience of implementing the teaching practices

he was learning. As he said, “the top things I feel most well prepared for are the things I’ve done already.”

Ultimately, Bob originally felt unprepared to teach science due to a lack of applicable classroom experience, but feels better prepared now due to working with a strong team and improving his teaching through practice and feedback. He did mention district initiatives and test data as additional motivation to improve, but the agents of that improvement were the relationship with experienced educators and his own experience teaching science.

Jane

Jane is an alternatively certified, first year teacher who was still technically in the last part of her program at the time of the interview. The Central Region Teachers program that she earned her certificate through is a spring and summer program, but continues to support their participants through mentor observations and feedback throughout the first full year of teaching. During her interview, Jane described in detail how she implemented several Inquiry-based Science Teacher practices during different units that she taught. However, despite these specific examples of lessons in her classroom, her Likert ratings regarding her feelings of preparation were lower than almost all of the other teachers except in the area of “Centering curriculum on central ideas/concepts” and “Encouraging classroom discourse and debate” which were comparable to the other teachers. Overall, she stated, “I feel as prepared as you can get.”

Jane cited several things as helping her feel more prepared including her life experience prior to earning her teacher certification, the skills she learned through her program, her experience applying her skills during her two week student teaching experience, and the support of

experienced educators from the school and from her program. Jane discussed how she felt comfortable in the classroom and feels like she has fairly good instincts and creativity for lessons because she has extensive experience working with children as a mother and volunteer prior to entering her certification program. That sense of comfort was greatly aided by the skills that she learned in her program such as lesson planning, applying the state standards, and incorporating inquiry into the classroom. Then, because she had the opportunity to apply these skills in a supportive environment during a very intense, two-week student teaching experience, Jane described herself as "baptized by fire" and "as prepared as you can get." However, as she began teaching in the classroom, she had continued support from the staff from her program as well as the support of the Biology PLC team which she described as very helpful to her confidence as she "didn't feel like she was thrown to the wolves." The one thing she said would have been more helpful was "more practice creating labs for specific purposes."

Even though she rated herself fairly low on the Likert Scale questions regarding Inquiry-based Science Practices, Jane seemed to be well established in her role as an inquiry science teacher and, with the skills she learned, the experiences she's had, and the support she enjoys, it seems like she feels that she is growing in confidence and she has a strong foundation of preparation.

Holly

Holly is a traditionally certified teacher who majored in Biology with a minor in Education through a four year university. She was in her first year teaching anatomy and physiology as a senior science elective at CTHS and, because no one else taught the same content, she was on a team by herself and she received minimal support from her university program after she

completed her student teaching experience. Similar to Jane, Holly described a couple of inquiry types of activities that she had used in her classroom, but she ranked herself very low on the Likert scale questions and even said, overall, “I wouldn’t say I feel the most prepared.”

Holly felt somewhat unprepared for teaching anatomy and physiology largely because she felt unsupported in the classroom and she didn’t feel like she had the resources or curriculum knowledge to effectively teach a content other than the Biology content she had taught during her student teaching. When she talked about the things that did help her feel prepared, Holly discussed the mentorship of her cooperating teacher, working with 8 other teachers in the Biology PLC, and the experience of applying her teaching practices in the classroom during her 13 week student teaching program. However, when she transitioned to teaching a senior science without the support of a PLC or significant mentorship from her pre-service training program and without sufficient experience with the curriculum, she felt somewhat overwhelmed. She talked about how, when she was trying to find activities to match certain curriculum standards that she was seeking to implement, she would frequently find too much information and she would have a hard time making structural and content decisions based on the sheer quantity of data she had. She wished that her program had given her more education and practice with structuring curriculum and making decisions regarding unit design.

Another aspect that Holly discussed at length regarding her preparation was the level of peer interaction during her pre-service program. There were a total of four teachers in her cohort and she was the only science major. This made it very difficult to develop helpful peer relationships as she practiced writing and giving lessons. She did say that her professor had a science background and really tried to mentor her, but the lack of peer feedback really impeded

her confidence. This was mitigated by working with a team of teachers during student teaching, but after the 13 weeks, she felt like she was back on her own.

Holly felt reasonably well prepared to teach Inquiry-based Science Practices in a team environment where she was supported by experienced educators and was not expected to make all of the curriculum decisions. However, when placed on her own, with no significant support, she felt overwhelmed and somewhat unprepared for the role of curriculum decision maker.

Jordan

Jordan is a traditionally certified teacher who majored in physics during his undergraduate work before earning his teacher certification through a Master's of Education program through a local university. He was completing his second year of teaching physics at CTHS and had been promoted to the physics team lead about halfway through the year. He also continued to receive support from his Master's program in the form of mentorship, peer discussion, and minor professional development which would continue through his first three years of teaching. Jordan said that he felt mixed about how well prepared he felt to teach science and described his feelings of preparation for Inquiry-based Science Practices as decent when he started teaching his first year, but that he feels less prepared now. His Likert scale ratings reflect this same decrease from feeling well prepared his first year to feeling less prepared at the end of his second year.

Jordan's unique path from feeling well prepared to teach Inquiry-based Science Practices to feeling less prepared is largely due to two different experiences between his training program

and his work experience. His prior experience as a graduate student teaching physics labs gave him a lot of practice with lab set-up, instruction, and questioning strategies that helped him feel prepared for transitioning to a high school classroom. In addition, after he began his Master's program, he was taught a lot of techniques that included Inquiry-based Science Practices and he was able to apply many of these techniques during practice lessons at the university and during his year-long student teaching experience. Thus, beginning his first year of teaching, he felt well prepared because he almost felt like he had been teaching with those practices for a year already with a lot of support from his mentors through the program. However, once he began teaching, the physics team that he was a part of already had a pre-developed curriculum that was fairly teacher-centered and the rest of the team was resistant to changing any lessons or units. He felt peer pressured into using the other teachers' techniques and he felt like he had very little influence over the curriculum decisions. After two years of not applying and using the Inquiry-based Science Practices, he felt less prepared to implement these practices. Even toward the beginning of the interview when asked what science teaching practices were vital to teaching science, Jordan almost exclusively listed practices that were more teacher-centered and are related to science, but would not really fit into Kloser's definitions of science teacher practices. Jordan's experience shows that the opportunity to apply training during his student teacher program was vital to his perceptions of feeling prepared, but the negative peer support on his team negated a large portion of that original confidence.

Outside of his varied experience with applying Inquiry-based Science Practices in the classroom, Jordan also attributed his positive feelings about his preparedness to teach science to skills that he learned as a part of his program, his comfort with the physics curriculum, and

the mentorship relationships that he had though the university. He described his work with Individual Education Plans (IEPs) and accommodations for Special Education students and learning the working vocabulary of education as being especially helpful skills which helped him to transition into teaching easily without getting distracted from the physics content by some of the more education oriented processes that he was not familiar with as a physics graduate student. Jordan also felt like he was not supported very well at the school by his physics team, so he described the mentorship meetings where he was able to reflect on his work and receive feedback from an experienced educator as really helping him feel better prepared. He said that the reflection part of these meetings and the mandatory reflection parts of his pre-service training program were both very helpful for him and he has continued to record reflections on the lessons from each day throughout his first two years.

On the negative side of Jordan's mixed feelings about preparation, he described his lack of leadership training as a primary factor. In the middle of his second year of teaching, he became the leader of the Physics PLC and he experienced distractions from teaching and a lot of resistance to implementing different, more inquiry-based teaching practices. He received virtually no training in leadership as a part of his program and the stress and personality issues within his team kept him feeling like he was always scrambling trying to prepare lessons and improve his teaching when most of his time was spent trying to assist others with the logistics of their lessons.

All told, Jordan felt well prepared to teach Inquiry-based Science Practices when he completed his pre-service training program due to his experience using inquiry in the classroom,

the skills he learned as a part of the program, and mentorship and reflection, but negative peer relationships and being distracted by leadership eroded his confidence.

Emily

Emily is a traditionally certified teacher who majored in secondary science education with a specialization in Biology through a four year university. She was completing her third year of teaching Biology at CTHS where she also worked on a team of 8 other Biology teachers in a PLC. As a part of her program, she completed a half semester student teaching experience where she received feedback and evaluations from her cooperating teachers and program support staff. When describing the practices essential for teaching science, she only mentioned one Inquiry-based Science Practice which was Encouraging classroom discourse and debate. The rest of the practices she mentioned were more general practices. Despite not describing many of the practices, Emily rated herself very well on the Likert scale questions regarding Inquiry-based Science Practices during her first year and rated her feelings of preparation higher than any of the other participants after three years of teaching science. Overall, she stated, "I feel fairly well prepared for teaching Biology."

Emily felt well prepared to teach Biology largely due to her student teaching experiences, the feedback and relationships she built with experienced educators and the opportunity she had to apply teaching practices during student teaching. In the interview, when talking about what helped her feel prepared, Emily talked about many of the mentoring type relationships that she has had during her entire life as well as in her educational career. To start with, both of her parents were high school teachers and she described their discussions and experiences while

she was growing up as a primary factor in her career choice as well as a catalyst for her developing confidence as a teacher. During her student teaching, she also described in detail, her relationship with the AP Biology teacher at the school where she was teaching. She didn't feel a connection with her cooperating teachers, so she sought out the advice and feedback of another teacher and she described this relationship as vital to her feelings of preparedness. And, when discussing her first three years of teaching, she described herself as gaining more and more confidence, largely because of her ability to work with a team of experienced teachers and educators in her Biology PLC. Emily did relate how the opportunity to apply her teaching practices in the classroom was integral to her feelings of preparation, but, from her descriptions, it seemed that this experience was made valuable because of the feedback and mentorship of those experienced educators around her. She also mentioned that she wished her student teaching experience was longer so that she could have gained more confidence prior to entering her own classroom which shows the importance of the experience in her feelings of preparation.

Emily's feelings of preparation, like many of the other participants, are largely due to mentoring relationships that she had and the opportunity to apply teaching practices, but her case highlights how interwoven these two factors might be as well as the variety of mentoring relationships that can help build confidence in a young teacher.

Chapter 5: Discussion

The goal of these interviews was to determine how well prepared to teach science using the Inquiry-based Science Practices these teachers were and what experiences aided their perceptions of preparedness. From the coded data obtained from the six interviews, there are several trends within and across cases that can be deduced. For instance, all six participants discussed exposure to general teaching skills and specialized routines, their comfort with the content they were responsible for teaching, the opportunities they had to apply those skills in a classroom, and being supported by experienced educators while they were in the classroom as very significant in helping them feel prepared to teach science. However, these broad components can take many different forms in the different programs and several of the teachers even had experiences that reduced their confidence in the classroom and these differences and experiences are well worth exploring further.

Almost all of the skills that the participants mentioned learning during their pre-service training programs that helped them feel more prepared to teach science seemed secondary to the experience of student teaching and experienced educator support, but they still held a significant role in some of the participants' minds and I believe the other participants would have considered them more important if they had considered these skills further. The most significant teaching skills that teachers described as being prepared for included writing lesson plans, familiarity with educational vocabulary, assessing students with formative and summative assessments, linking instructional activities to curriculum standards, and understanding the needs of Special Education students. On the other hand, some of the participants mentioned

feeling unprepared for science teaching due to a lack of skills including: deciphering and making decisions regarding instructional resources and classroom management.

Of the skills that the participants said helped them feel prepared to teach science, virtually every case involved the learning and practicing of this skill during the pre-service program. Beth, Jane, and Emily all specifically mentioned practicing lesson writing or basing lessons on standards in their program as helpful and this makes intuitive sense. On the other hand, Beth and Jordan both mentioned practicing with educational vocabulary as aiding in their preparation. This makes sense because both of them came from non-education backgrounds and wouldn't have used a lot of the "lingo" or educational buzzwords where all of the other teaching skills and practices are situated. As they both described, this new vocabulary helped them transition into this new environment. Three of the participants specifically mentioned that their content classes and/or comfort with the content aided them in their teaching and helped them feel prepared while two of the other participants also alluded to this phenomenon. Almost all of the participants also mentioned receiving some training with different types of assessment and working with Special Education students and that these trainings helped them feel more comfortable applying these skills in their classrooms. Comparing the skills that the participants described as feeling well prepared for to the skills studied in the Voice of the New Teacher, many of the list match up fairly well (The Voice of the New Teacher, 2003, p. 8). Assessments, Standards, and Planning Instruction with colleagues are all in the top five of the skills teachers felt prepared to do according the Public Education Network. However, working with Special Educations students was one of the skills the Voice of the New Teacher listed on the

low end of preparation, so the match is not perfect, but, with a small sample size, the results were very similar.

Four of the six participants, however, also mentioned feeling unprepared to make curriculum decisions when faced with either a shortage or an overabundance of resources. Holly described feeling overwhelmed trying to decide which one of the many labs or activities to try in a new course she was teaching while Jane wished that she had been able to take a class on how to create labs for specific purposes or improve labs that she could find online. These problems were described evenly between traditionally and alternatively certified teachers and all four of the teachers described how they would have felt more prepared if they had some sort of class teaching them how to design activities or decide which activities were ideal for their classroom from a resource list. The Voice of the New Teacher study did not have this skill mentioned explicitly within its list of teacher practices that it surveyed, but this does partially fit into the Planning Instruction with Colleagues category which was one of the highest skills listed (The Voice of the New Teacher, 2003, pg. 8). These two results do not seem to match up, but the skills are also not a direct correlation and, again, the sample size is small, so the discrepancy is not unexpected or problematic.

Beth also described herself as not well prepared in the area of classroom management largely because her experience and program prepared her for an environment much different than the demographic she found herself teaching at CTHS. This is important to note because, while she had an entire year of teaching experience under her belt and, as will be discussed in a moment, this usually leads to a greater feeling of preparedness, feeling unprepared in a crucial general teaching skill can erode the overall feeling of preparedness from other positive factors. This

follows with other research as Davis, Petish, and Smithey write in their survey of educational studies called review of educational research:

> *In sum, based on the few studies we identified in this area, we see that new teachers tend to have concerns about and struggles with management, sometimes leading them to engage in less reform-oriented teaching practices (Davis, Petish, Smithey, 2006, 628).*

Beth is not unusual in her lack of confidence in management and the resulting decline in Inquiry-based Science Practices. Thus, it is important to ensure new teachers feel prepared in the realm of classroom management and creating a positive learning environment or all of the other training and positive teaching practices will likely be diminished significantly.

Bob, Jane, and Jordan mentioned their comfort with the content they were responsible for teaching as key to their feelings of preparedness. Jane and Jordan mentioned that they felt reasonably well prepared for teaching their first year and comfort with their content was just the first step toward that confidence. Bob, however, felt unprepared his first year and described his content knowledge as really the only thing that he felt confident in and the rest of his educational confidence was built during his first years of experience. All three seemed to view their content knowledge as a foundation on which the rest of their teaching skills were built.

The next important theme for helping teachers feel prepared for teaching science is the opportunity to apply training. Consistently throughout all of the interviews, the participants described a greater feeling of preparation due to implementing teacher practices or skills in their classroom. In pre-service programs, the most obvious form of these opportunities to apply

training come in the form of student teaching, but the interviews show that this is not the only way to help teachers feel prepared and certain factors are essential for the success of these experiences. Based on these six interviews, it seems that the quality of the student teaching experience is more important than the quantity. Jane, with only two weeks of very intense student teaching, felt that she was "as prepared as you can get" while Jordan, who had an entire year of student teaching, had "mixed feelings" about how well prepared he felt. This phenomenon appears to be due more to the support that Jane and Jordan received during their pre-service program and into their first year of teaching rather than the length of their student teaching. This seems to follow with Chamber's and Hardy's findings in their study on the effect of length of student teaching on classroom management styles and self-efficacy where they determined that there was no significant difference between one semester or two semester long student teaching assignments (Chambers and Hardy, 2005). On the other hand, Emily and Bob both wished that they had experienced longer or more in depth student teaching. This seems to follow more with Kee's findings that alternatively certified teachers tend to feel less prepared than traditionally certified teachers due, in part, to the shorter field experience (Kee, 2012). Due to the small sample size of this study and the seemingly incompatible trends, no correlation can be made between the length of field experience and teacher preparedness. A larger, more focused research study would be needed to form any conclusion on this topic.

It seems that the two most important factors regarding student teaching or other previous life experiences prior to entering the classroom are the applicability of the experience and the level of support received during the experience. The three participants who described themselves as feeling the least prepared described their student teaching experiences as not

necessarily relevant to the situation in which they taught. Beth taught middle school science at a well-to-do private school for one year before getting certified and teaching at CTHS where she felt her classroom management skills were undeveloped and she felt unprepared to implement her other skills. She wished that she had been given the opportunity to conduct observations and possibly even student teach in a school where classroom management was a bit more of a challenge to help her prepare. Bob's student teaching experience involved substitute teaching in a fifth-grade English classroom and he described himself as "terrified of running a lab" during his first year of teaching because his previous experience was unrelated to his actual teaching. Finally, Holly's student teaching involved teaching Biology to freshmen with a group of eight team members before she transitioned to teaching Anatomy and Physiology as a senior science by herself and she described herself as unprepared because she felt didn't feel ready to make instructional decisions for a new course on her own. As can be seen, whether it be because of the type of students, the grade level, the content, or the number of colleagues on a team, student teaching experiences that do not reflect the first teaching assignment can negatively affect a teacher's perception of preparation. On the other hand, Jane, Jordan, and Emily all had student teaching experiences in very similar environments to their first teaching assignment and they all reported feeling fairly well prepared.

The support of experienced educators during student teaching and the first years of teaching also seems to be vital to the participants' feelings of preparation regardless of whether this support comes from preservice training staff, colleagues on content teams, mentors, or administration. All six of the participants described at least one mentoring type relationship that helped them improve their craft, but also aided them in gaining confidence in the

classroom. Many of these relationships took place during student teaching and these participants tended to feel more confident when they entered the classroom. Jordan, Jane, and Emily all exemplify this type of relationship. However, Beth and Bob both described relationships with colleagues and administrators as helping them gain in confidence when they initially felt unprepared based on their previous experiences. It is important to note that these continued relationships after student teaching are also appear to be incredibly important for teachers to maintain their confidence. Jordan describes feeling less confident after two years in the classroom than he did at the beginning due to a lack of support and even negative interactions with his colleagues. Holly, even after a positive student teaching experience, described herself as not feeling very well prepared when she shifted into a teaching role with no team members and very little mentorship support. Jane also mentioned how the support she experienced during her first year helped continue to build her confidence after just having two weeks of intense student teaching. Thus, it appears that educator support during student teaching and through at least the first couple of years of teaching are vital to build confidence and a sense of feeling well prepared in beginning teachers.

These three preparedness factors of content and pedagogical skills, applicable experience, and teacher support roughly follow the extensive studies of Darling-Hammond, Chung, and Frelow as well as the study of alternatively certified teachers by Kee. The Darling-Hammond study surveyed data from many different research studies to determine that content and pedagogy classes as well as field experience are the primary factors that help new teachers form a sense of preparedness and self-efficacy at the end of their pre-service training program (Darling-Hammond, Chung, and Frelow, 2002). In her 2012 study of first year teachers, Ayana

Kee found that the same three factors of content classes, pedagogy classes, and field experience help first year teachers feel more prepared (Kee, 2012). The six interviews in this study support these conclusions from the much larger studies, but the related experiences from the participants seem to qualify the field experience to ensure that it is applicable to the teacher's assignment and add support relationships as another key factor. Kee's study, however, also found that traditionally certified teachers felt better prepared overall than alternatively certified teachers and, while this study's sample size is too small to really statistically analyze a trend of this nature, it does not seem to support this conclusion as the ranges of preparedness are relatively equal between alternative and traditional certifications.

Applicable experience during the field assignment or student teaching is also an important component to help teachers feel prepared to specifically teach science with Inquiry-based Science Practices. During the course of the interviews, while most of the participants mentioned at least one, only Beth, Jane, and Holly described significant examples of practices that would fit Kloser's definitions of core science teaching practices and Jane was the only one who described actually implementing more than one Inquiry-based Science Practice in her classroom. Beth and Jordan both specifically admitted that they did not implement these practices very often if at all while Bob and Emily only very basic examples of modelling and debate respectively. While Jane, Holly, and Jordan all mentioned receiving training with inquiry type instruction and Beth experienced inquiry through her work as an engineer and her year teaching at a private middle school, most of the participants did not relate implementing more than one of these practices. In addition, all but Jane and Holly rated themselves as feeling fairly well prepared to implement Inquiry-based Science Practices. There seems to be a possible

discrepancy in this data from the interviews and, while Davis, Petish, and Smithey concluded that many new teachers might not have the knowledge to be able to implement inquiry, due to this only being an interview-based study, it is beyond the scope of this study to be able to form any conclusions about how prepared the participants actually were to implement Inquiry-based Science Practices (Davis, Petish, and Smithey, 2006). However, it is significant that Jane, being the one teacher who accurately described implementing several activities that fit these practices, mentioned feeling most prepared because of receiving inquiry instruction during her classes, then implementing those practices in the classroom during her student teaching while receiving feedback from her cooperating teachers and program mentors. It appears that, in order to feel prepared to complete certain tasks and teach science effectively, teachers need to feel comfortable enough with general teaching skills, specialized routines, and their content so that they do not feel overwhelmed in an unfamiliar environment and had the opportunity to apply their skills in relevant environment with the support of experienced educators to provide feedback and guidance.

Chapter 6: Conclusion

In conclusion, it appears that teachers feel most prepared to teach science using Inquiry-based Science Practices when they have had exposure to general teaching skills and specialized routines through their pre-service training program classes and/or previous life experience, when they feel competent with their content, when they have had the opportunity to apply these skills in a relevant field experience, and when they have the support of experienced educators throughout their field experience and into their first years of teaching. These factors can take many shapes and forms as different individuals can feel prepared from shorter field experiences while others prefer longer student teaching and many feel the need for different specific skills or varying levels of support based on their past experience or personal preference. However, if a pre-service training program successfully implements these major components, it appears that many of the new teachers being certified through this program would feel fairly well prepared whether that program is a more traditional program or an alternative program.

The next step in this line of research of how well prepared teachers feel to teach secondary science using Inquiry-based Science Practices would be to increase the sample size and include observation data as well as interviews in order to see the teachers and their practices in action. This type of study would be able to look at the experiences of multiple teachers from the same program or type of program to be able to build a more in depth understanding of how the structure of the training affects the teachers' perceptions of their preparation. In addition, the researchers would be able to analyze not only how well prepared the teachers feel, but also how these teacher perceptions translate into the classroom and whether the students are reaping the benefits of their teachers' preparation.

Appendix A: Research Instrument

Survey of Pre-service Science Teacher Preparedness: Researcher Form

My name is Clayton Piehl and I am a graduate student at the University of Texas at Austin and I am working on my Master's Degree through the UTeach Master's program. The purpose of this survey is to investigate new teacher's perspectives on their pre-service preparation to teach science.

1. I'd like to start by getting a little information about the pre-service training program that you earned your Texas Teacher Certification through.
    i. What was the name of the program/institution that you participated in?
    ii. How long was the training program?
    iii. What types of classes did you take as a part of the program?
    iv. What was the field experience like as a part of the program?

2. Think back to the last unit that you taught. What were the some of the important teaching practices that went into planning the lessons and/or delivering the lessons in class?

3. How well prepared do you feel for these important teaching practices?
    i. What experiences in your pre-service training program stand out to you as important to preparing you for your classroom teaching?

    ii. What do you think might have helped you be more prepared prior to becoming a teacher?

    iii. What is an example of a time, either in planning or during class, where you felt well prepared for the task at hand. Describe why you think you felt prepared for that situation.

    iv. What is an example of a time, either in planning or during class, where you felt unprepared for the task at hand. Describe why you think you felt unprepared for that situation.

    v. On a scale from 1 to 5 (1 being not at all and 5 being very well) how well prepared do you feel regarding _____? Describe why you feel this way about _____.
        1. Engaging students in authentic investigations

2. Centering curriculum around central ideas or concepts
3. Encouraging classroom discourse and debate
4. Getting students to construct/interpret scientific models
5. Adapting/adjusting instruction to meet student needs

4. Is there anything else you would like me to know regarding how your pre-service training program prepared you for teaching?

References

Chambers, S. M., & Hardy, J. C. (2005). Length of time in student teaching: Effects on classroom control orientation and self-efficacy beliefs. *Educational Research Quarterly*, *28*, 3-9.

Darling-Hammond, L., & Bransford, J. (Eds.). (2005). *Preparing Teachers for a Changing World*. San Fransisco, CA: Jossey-Bass.

Darling-Hammond, L.; Chung, R.; & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education September*, *53,* 286-302. doi:10.1177/0022487102053004002

Davis, E., Petish, D., & Smithey, J. (2006). Challenges New Science Teachers Face. *Review of Educational Research, 76*, 607-651. doi: 10.3102/00346543076004607

Kee, A. (2012). Feelings of preparedness among alternatively certified teachers: What is the role of program features? *Journal of Teacher Education*, *63,* 23-38. doi:10.1177/0022487111421933

Kloser, M. (2014). Identifying a core set of science teaching practices: A delphi expert panel approach. *Journal of Research in Science Teaching*, *51,* 1185–1217. doi: 10.1002/tea.21171

Miles, M., Huberman, M., & Saldana, J. (2014). *Qualitative data analysis: A methods resourcebook (3rd ed.)*. Thousand Oaks, CA: SAGE Publications.

Schwartz, B., Landrum, E., & Gurung, R. (2012). *An easyguide to APA style*. Thousand Oaks, CA: SAGE Publications.

Simmons, P. E., Emory, A., Carter, T., Coker, T., Finnegan, B., Crockett, D., Richardson, L., Yager, R., Craven, J., Tillotson, J., Brunkhorst, H., Twiest, M., Hossain, K., Gallagher, J., Duggan-Haas, D., Parker, J., Cajas, F., Alshannag, Q., McGlamery, S., Krockover, J., Adams, P., Spector, B., LaPorta, T., James, B., Rearden, K. & Labuda, K. (1999). Beginning teachers: Beliefs and classroom actions. *Journal of Research in Science Education*, *36,* 930–954. doi: 10.1002/(SICI)1098-2736(199910)36:8<930::AID-TEA3>3.0.CO;2-N

The Voice of the New Teacher. (2003). Washington, DC: Public Education Network.

Windschitl, M. (2003), Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice?. *Science Education, 87,* 112–143. doi: 10.1002/sce.10044

Windschitl, M., Thompson, J., Braaten, M. and Stroupe, D. (2012), Proposing a core set of instructional practices and tools for teachers of science. *Science Education*, *96*, 878–903. doi: 10.1002/sce.21027