IDENTIFYING PATTERNS OF RELATIONSHIPS BETWEEN PROFESSIONAL DEVELOPMENT AND PROFESSIONAL CULTURE WITH TEXAS HIGH SCHOOL SCIENCE TEACHERS AND STUDENTS

A Dissertation

by

LAURA ELIZABETH RUEBUSH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2012

Major Subject: Curriculum and Instruction

Identifying Patterns of Relationships between Professional Development and Professional Culture with Texas High School Science Teachers and Students

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Approved by:

Chair of Committee,	Carol L. Stuessy
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ABSTRACT

Identifying Patterns of Relationships between Professional Development and Professional Culture with Texas High School Science Teachers and Students. (August 2012)

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Chair of Advisory Committee: Dr. Carol L. Stuessy

Professional development (PD) is used as the primary means for ensuring the continued learning of teachers. PD opportunities and support vary in type and quality. Little is known about the participation in and support of PD for high school science teachers. The establishment of supportive professional cultures provides a means to support teachers' PD in addition to providing meaningful interactions between teachers to improve practices related to teaching, learning, and assessment. Even less is known about patterns of relationships between professional culture with high school science teachers and students. PD and professional culture have been reported to increase teacher retention and student achievement. The studies presented in this dissertation use mixed methods approaches to explore data collected by the Policy Research Initiative in Science Education Research Group during the 2007-2008 academic year.

The first study assessed PD of high school science teachers from two perspectives: (1) teachers' participation in PD, and (2) schools' practices to support teachers' participation. Teachers' participation was determined using self-reported survey data. Schools' PD support was operationalized using data collected from administrative interviews. Descriptive statistics revealed little relationship between teachers' participation in PD, schools' PD support, and teacher retention. Descriptive statistics of schools' PD support indicated associations with student achievement.

The second study operationalized school science professional culture with a rubric developed for the study. Elements within the rubric addressed many components mentioned in the literature as indicative of positive professional culture. School science professional culture had little relationship with either teacher retention or student achievement. Strong associations were found among the elements associated with school science professional culture. These results provide support for the inclusion of these elements in future studies of school science professional culture.

The final chapter provides a summary of both studies. Recommendations are made for improving policies in place to support PD and professional cultures experienced by high school science teachers. Specific attention should be directed at the development of cohesive PD programs that address both schools' and teachers' needs. Additionally, more opportunities for in-depth communication regarding school practices for teaching, learning, and assessment need to be provided.

DEDICATION

I would like to dedicate this dissertation to my family and friends. To my husband and daughter, who have witnessed all the triumphs and tribulations associated with this journey, words cannot express the gratitude I have for your continued support and love. To other members of my family and friends, thank you for providing the listening ear and encouraging words when I needed them most. The unconditional love and belief you all have had for me throughout this journey has left a lasting impression on my heart and in my mind.

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I would also like to thank my colleagues and classmates who have been with me throughout my time at Texas A&M University. Their support and assistance enhanced my graduate experience. I am especially grateful to the members of the PRISE Research Group. Without your tireless dedication to the project, this dissertation would not have been possible. Additionally, I would like to thank all the school administrators and high school science teachers who agreed to participate in the PRISE research study.

I am also thankful for the support provided by the National Science Foundation, whose funding made this research possible. This research was supported in part by the National Science Foundation, Grant ESI-0455679, and the Department of Teaching, Learning, and Culture at Texas A&M University. Any opinions, findings, or conclusions expressed in this dissertation are those of the author and do not necessarily reflect the views of the funding agencies or Texas A&M University.

Finally, I would like to thank God because through him all things are truly possible.

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CHAPTER I

INTRODUCTION

America is competing in an increasingly global, technology-driven economy. An examination of economic indicators reveals that America is losing its competitive edge (Augustine, 2007). Competitiveness in this global, technology-driven economy is driven by investments in science, technology, engineering, and mathematics (STEM; Augustine, 2007). American students, however, are losing interest in these fields as indicated by decreased enrollment in advanced STEM degree programs (Augustine, 2007). The lack of interest in STEM degree programs may be related to declining levels of student achievement in STEM related courses in K-12 education (e.g., Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008; Hilton, 2010; Organisation for Economic Co-operation and Development [OECD], 2007). Even if students choose not to pursue careers in STEM, the skills gained in STEM courses enable them to be competitive in the 21st century workforce (Augustine, 2007). The combination of lack of interest and declining achievement in STEM has placed mathematics and science education at the center of the domestic political agenda.

One of the best practices for increasing students' interest and achievement in STEM is through the availability and retention of highly-qualified teachers in the classroom (Barnes, Crowe & Schaefer, 2007; U.S. Department of Education [USDE], 2010). Few schools, however, have systems in place for differentiating high-quality,

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This dissertation follows the style of *Journal of Science Teacher Education*.

effective teachers from their less effective colleagues (USDE, 2010). National policy has defined a highly-qualified high school teacher as (1) holding a bachelor's degree in content area, (2) obtaining state certification, and (3) passing a state content exam (USDE, 2002). Being a highly-qualified teacher, however, goes beyond obtaining initial certification requirements. Many states require continuing professional development (PD) to ensure that teachers remain current with both their content and pedagogical content knowledge (Wei, Darling-Hammond, & Adamson, 2010).

Introduction to Professional Development and Professional Culture

Professional Development

Currently, PD is a complex term to describe opportunities designed to increase teachers' knowledge and skills. As such, identification and implementation of appropriate PD continues to challenge school administrators and teachers (Knapp, 2003). Researchers have found evidence suggesting participation in high-quality PD may result in both increased teacher retention and student achievement (e.g., see Desimone, Smith, & Phillips, 2007; Garet, Porter, Desimone, Birman, & Yoon, 2001; Joyce & Showers, 2002; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). PD provides an effective means for overcoming barriers (Garet et al., 2001; Loucks-Horsley et al., 2003) associated with low levels of teacher retention including being able to (a) establish day-to-day routines associated with classroom management, (b) provide instruction to an ethnically and culturally diverse student population, and/or (c) teach science effectively using an increasingly standards-based curriculum (Hilton, 2010).

PD designed to increase teachers' effectiveness in processes and daily routines in a learner-centered classroom, presentation of content, implementation of reform- and standards-based curricula, and the development of teacher leaders has been found to increase student achievement (Akerson & Hanuscin, 2007; Desimone et al., 2007; Fogleman, Fishman, Krajcik, 2006; Garet et al., 2001; Loucks-Horsley et al., 2003). National surveys indicate that while teachers are participating in a wide variety of PD they are receiving limited amounts of school support (Wei et al., 2010). Additionally, national samples of teachers were not robust enough to determine participation and support within various content areas (Wei et al., 2010). Consequently, school administrators are left with little guidance as how to support high school science teachers' participation in PD.

Professional Culture

The establishments of supportive professional cultures and policies have been shown to increase the rate of teacher participation and the quality of classroom implementation associated with PD (Johnson & Kardos, 2005). However, establishing strong, supportive professional cultures goes beyond PD. Professional culture has been defined as a commitment by all teachers and administrators to improving teaching and learning through the creation of relationships among all members of the school community (Kardos, Johnson, Peske, Kauffman, Liu, 2001; Kardos & Johnson, 2007). Professional culture at a school is often created through the interaction of teachers, specialists, and administrators (Kardos & Johnson, 2007). A strong, supportive professional culture often "promotes frequent and reciprocal interaction among faculty members across experience levels; recognizes new teachers' needs as beginners; and develops shared responsibility among teachers for the school and its students" (Kardos & Johnson, 2007, p. 2085).

Policies that school administrators may put in place to support a positive professional culture include providing time and space for collaboration, observation, and feedback among colleagues (National Research Council [NRC], 2007). The structure of a teacher's department or program can foster a comfortable, supportive environment that provides meaningful opportunities for interaction. In contrast, programs can be structured in ways that cause teachers' relationships with one another to be strained, discouraging, and focused on routine procedures (Kardos et al., 2001). According to Kardos and Johnson (2007), teachers are more likely to be satisfied and remain in the profession if they are provided opportunities for frequent interactions with colleagues of various experience levels. Currently, there is little information regarding the measure of these practices and their impact on high school science teachers and their students. Consequently, school administrators and high school science teachers are often unaware of the strengths associated with professional culture practices that are available to help increase teacher retention and student achievement.

Purpose of the Dissertation

The purpose of my dissertation was two-fold. I uncovered the current state of PD in Texas high schools. PD is generally defined as opportunities and supports designed to increase teachers' content and pedagogical content knowledge. I also operationalized the concept of school science professional cultures in place for Texas high school science teachers. School science professional culture is generally defined as the development of school environments supporting collegial interactions regarding teaching, learning, and assessment. Mixed method approaches were used to investigate both the concepts of PD and school science professional culture (e.g., Creswell & Clark, 2011). Patterns of relationship with both PD and school science professional culture with teacher retention and student achievement were also explored.

Research Questions

The following research questions were used to guide the investigation regarding professional development:

(1) In what types and at what levels do Texas high school science teacher participate in professional development?

(2) Are there differences in science teachers' participation in types of professional development by their identification of experience levels within the teacher professional continuum (TPC)?

(3) What types of and at what levels do schools provide professional development support in Texas?

(4) What is the relationship between science teachers' participation in professional development and schools' professional development support?

(5) How do science teachers' participation in professional development and schools' professional development support contribute to the schools' science teacher retention rates?

(6) What are the relationships between and among science teachers' participation in professional development, schools' professional development support, and schools' science teacher retention rates in predicting scores for students' science proficiency and college readiness?

The following research questions were used to guide the investigation of school science professional culture:

(1) What characteristics describe the school science professional cultures experienced by Texas high school science teachers?

(2) What relationships exist between elements of the school science professional culture rubric and schools with high versus low rates of science teacher retention?

(3) What relationships exist between elements of the school science professional culture rubric and schools with high versus low scores for students' science proficiencies and college readiness?

(4) What are the associations among elements contained within the school science professional culture rubric and their associations with schools' science teacher retention rates and scores for students' science proficiencies and college readiness?

Organization of the Manuscript

The first chapter of this manuscript has provided relevant background information on teachers' participation in PD, schools' PD support, and professional culture. Additionally, this chapter has outlined the purpose and significance of the research presented in the following chapters. Chapter II provides an analysis of national and state policy and research relevant to the topics contained throughout this dissertation. Chapters III and IV are independent studies with independent research questions, methods, analysis, discussion, and implications. Chapter III examines the role of teachers' participation in PD and schools' PD support on both schools' science teacher retention rates and scores for students' science proficiencies and college readiness. Chapter IV operationalizes school science professional cultures experienced by Texas high school science teachers and its impacts on schools' science teacher retention rates and scores for students' science proficiencies and college readiness. Chapter V provides a summary of the results with recommendations and implications for school administrators and high school science teachers.

Definition of Terms

The following are definitions of terms associated with this dissertation. These definitions are intended to provide clarification regarding the presentation of ideas throughout the dissertation.

Professional Development

Professional development (PD) is the primary means for ensuring the quality of new and in-service teachers through addressing both content and pedagogical content knowledge. PD as related to science teachers' participation, however, is a complex and overused term describing a range of opportunities that vary in quality (Garet et al., 2001; Wei et al., 2010). Additionally, schools have reported a variety of practices used to support teachers' participation in PD (Wei et al., 2010).

Teachers' Participation in Professional Development. Members of the Policy Research Initiative in Science Education (PRISE) research team developed a series of questions contained in the Texas Poll of Secondary Science Teachers (TPSST; see Stuessy & PRISE Research Group, 2007a; Appendix A) to measure teachers' participation in a variety of types of professional activities. Activities included participation in recruitment, induction and mentoring, leadership, professional development, and science/science education. All teachers (n=385) who provided instruction for at least one science class at a PRISE school were asked to complete the TPSST. For purposes of my dissertation, all activities contained within the professional activities portion of the TPSST were considered PD. Teachers' participation in PD was determined using a principal component analysis of TPSST data to determine the types of PD most frequently attended by Texas teachers.

Schools' Professional Development Support. Administrative (n=50) representatives were identified at each school to provide in-depth semi-structured interviews regarding policies and practices associated with each phase of the TPC. Administrator interviews regarding schools renewal practices (Stuessy & PRISE Research Group, 2007b; see Appendix B) were examined using constant comparison method to determine the range of PD supports. These supports were then organized into a rubric and applied to all 50 PRISE schools to generate a school's PD support score. The data from the schools' PD support rubric was analyzed using an exploratory, principal axis factor analysis to identify most frequently used practices and determine the underlying structure of supports provided.

Professional Culture

Three types of professional culture have been found in schools: (1) veteran-oriented, (2) novice-oriented, and (3) integrated professional culture (Kardos et al., 2001; Kardos & Johnson, 2007). Teachers in veteran-oriented professional cultures often worked independently of one another with little opportunity for collaboration. Expectations for development and innovation were often determined by the needs of more experienced teachers, leaving novice teachers with little support for implementing their new ideas. Teachers in novice-oriented professional cultures were often eager to collaborate and integrate innovative instruction into their classrooms, however, they had little support or guidance from experienced teachers to help them troubleshoot their implementations. Very few experienced teachers or engaged administrators were found in novice-oriented cultures. Teachers in integrated professional culture found themselves in school environments valuing both the wisdom of experienced teachers and energy and innovation of novice teachers. All teachers were actively engaged in discussions regarding teaching, learning, and assessment in their classrooms with support from school administrators (Kardos et al., 2001; Kardos & Johnson, 2007).

School Science Professional Culture. Using the characteristics of an integrated professional culture (e.g., Kardos et al., 2001; Kardos & Johnson, 2007) a rubric was developed to operationalize school science professional culture using existing PRISE data. If appropriate measures for characteristics were not already developed, then they were developed as part of this study. The school science professional culture rubric combines information from five different PRISE data sources (i.e., TPSST; Stuessy &

PRISE Research Group, 2007a; administrator interviews for induction and renewal; Stuessy & PRISE Research Group, 2007b; science program interviews; Stuessy & PRISE Research Group, 2007c; master schedules; and Public Education Information Management System, PEIMS, data) and two pre-existing instruments (i.e., schools' PD support; Ruebush, 2012; and induction rubric; Ivey, 2009) to operationalize the professional cultures experienced by Texas high school science teachers.

Teacher Retention

Teacher retention has become an important topic of concern due to large numbers of teachers nearing retirement and increasing student enrollment (Ingersoll, 2003). High-need areas (i.e., math, science, and special education) have been found to have lower levels of teacher retention than other academic areas. Teacher retention can be divided into two broad categories, migration and attrition. Migration includes teachers who leave their current teaching position to teach at another school, while attrition refers to teachers who leave the profession altogether. From a school perspective, however, both migration and attrition have the same effect on retention. A national sample of high school math and science teachers revealed numerous reasons for teachers' leaving their current position. Science and math teachers reported the following reasons for leaving, in order of increasing frequency: (1) retirement, (2) school staffing actions, (3) to pursue another job, (4) family or personal, and (5) dissatisfaction with their current position. Science and math teachers often reported being dissatisfied with level of administrative support, lack of input to school decisions, and low levels of student motivation (Ingersoll, 2003).

Schools' Science Teacher Retention Rates. Master schedules were obtained from all 50 PRISE schools for both the 2007-2008 and 2008-2009 school years to identify science teachers. Members of the PRISE research team contacted representatives of the PEIMS database maintained by the Texas Education Agency (TEA) to determine demographic and mobility of all science teachers at each PRISE school for both the 2007-2008 and 2008-2009 school years. Examination of the master schedule (see Appendix D for an example) in conjunction with PEIMS data enables PRISE researchers to track teachers who have *stayed* at their school, *moved* from one school to another within the Texas public school system, or *left* the Texas public school system. For purposes of my dissertation, teachers identified as *movers* or *leavers* were combined to represent teachers who did not stay at their schools. Teachers identified as *stayers* were used to determine school science teacher retention rates at each PRISE school.

Student Achievement

Student achievement is often assessed through a variety of measurements including (1) standardized testing, (2) ability for schools to close the achievement gap between majority and minority populations, and (3) increased enrollment in advanced placement (AP) classes. In Texas, the Texas Essential Knowledge and Skills (TEKS) provide a detailed description of both content and skills students should have mastered upon completion of a course (Texas Education Agency [TEA], 2011c). A statewide exit-level standardized assessment (i.e., Texas Assessment of Knowledge and Skills [TAKS]) is administered to students in 10^{th} grade to gain a snap-shot of their performance and level of understanding regarding the mastery of the TEKS (TEA, 2011c). Achievement gains made on TAKS throughout the school and within various ethnic groups are additional factors in determination of a school's accountability rating (TEA, 2011a).Texas high school students may also opt to enroll in advanced placement or dual-credit courses (Maloney, Lain, & Clark, 2009). Advanced placement and dual credit courses have been cited as an effective means for increasing achievement and college readiness (Augustine, 2007; Maloney et al., 2009).

Schools' Scores for Students' Science Proficiencies and College Readiness. Members of the PRISE research team developed an algorithm to measure and compare scores for students' science proficiencies and college readiness (SPCR) throughout the state of Texas (Stuessy, 2010a). SPCR was measured using the student aggregate science score (SASS) algorithm. Variables included in the SASS algorithm include percentage of 10th grade students passing state administered science test (TAKS), percentage of students taking college entrance examines (CEET), percentage of students passing college entrance examines at or above criterion (PEET), percentage of students completing advance placement (AP) or dual credit course (APDE), and the school's state accountability rating (SR; TEA, 2011a; see Equation 1.1).

$$SASS = \sum(1.5 \bullet TAKS - 0.5) + CEET + PEET + APDE + SR \text{; where} \quad (1.1)$$

TAKS = school's aggregate 10th grade TAKS

CEET = school's aggregate participation rate for college entrance examinations

PEET = school's aggregate passing rate for college entrance examinations

APDE= school's aggregate participation rate in AP or dual credit courses

SR= school's state accountability rating (Ivey, Hollas, & Stuessy, 2009).

Delimitations and Limitations

The studies presented in this study use data collected as part of the PRISE project. The PRISE project employed a two-stage stratified random sample of all 1,333 high schools in the state to select 50 schools representative of the entire state (Stuessy, McNamara, & PRISE Research Group, 2008). Therefore, the findings presented provide insights that are generalizable to the state of Texas. Findings, however, may not be applicable in other states. Instruments developed for data collection and analysis may be useful in other contexts.

Significance of the Research

The studies presented in this dissertation provide an assessment of "what is" currently happening in the state of Texas regarding professional development and professional cultures of schools supporting the science education of high school students. For the first time, the type and frequency of high school science teachers' participation in PD was identified for the state of Texas. Additionally, schools' PD support was investigated in order to operationalize this very important component of school policies and practices. A detailed analysis of current PD support practices in place at the school level has not yet been reported. Professional culture is a relatively new term used to understand the support and interactions experienced by teachers. However, no instrument was found that could readily measure and compare professional cultures experienced by high school science teachers. Therefore, a rubric was developed for this research to operationalize current school science professional cultures experienced by Texas high school science teachers. Professional development and school science professional culture were also examined to determine patterns of relationship with science teacher retention and student achievement.

CHAPTER II

LITERATURE REVIEW

American high school students' performances on international tests indicate their achievement in science and readiness for college is below that of many other countries (e.g., Gonzales et al., 2008; Hilton, 2010; OECD, 2007). Students' science achievement and college readiness is of concern in light of the need for public schools to prepare students to continue to learn, live, and work in a rapidly changing and technologically driven society. Research results have consistently identified both teacher quality and retention as important predictors of student achievement and college readiness (e.g., Johnson, Berg, & Donaldson, 2005; NRC, 2007; Schroeder, Scott, Tolson, Huang, & Lee, 2007). As a result, many national and state policies have been put into place to ensure that teachers are highly qualified upon entering the profession (e.g., USDE, 2002; state preparation and certification requirements) and that they remain in the profession (e.g., TEA, 1999). Teacher preparation programs prepare teachers to enter the classroom, but even with sustained pre-professional development (PD), new science teachers require a variety of supports during their first professional years to acclimate them to the complex world of science teaching (Kardos et al., 2001). In-service teachers also rely on PD as a vehicle for continuously ensuring the quality of retained science teachers.

Relationships between Professional Development, Professional Culture, and the Teacher Professional Continuum

Schools are now faced with growing demands regarding improved student science achievement, as seen by increased accountability legislation (e.g., TEA, 2011c; USDE, 2002). Science teachers' quality may play an essential role in addressing these challenges (e.g., American Association for the Advancement of Science [AAAS], 1998; USDE, 2002). The primary means for ensuring the preparation of science teachers to meet these challenges is through continued professional development (PD). Currently, PD is a complex and overused term to describe many opportunities that vary in quality, and are designed to increase teacher knowledge and skills. Researchers have found increasing evidence suggesting participation in "high-quality" PD may result in both increased teacher retention and student achievement (e.g., Desimone et al., 2007; Garet et al., 2001; Joyce & Showers, 2002; Loucks-Horsley et al., 2003).

Several researchers have synthesized characteristics useful in identifying high-quality PD (e.g., Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Garet et al., 2001; Desimone et al., 2007; Loucks-Horsley et al., 2003; Penuel et al., 2007). For the purpose of this literature review, high-quality PD is defined as enabling teachers to:

(1) focus on subject-specific content and how students learn;

(2) participate in intensive, prolonged training sessions;

(3) participate in multiple follow-up sessions with PD leaders;

(4) assure that the new methods will be aligned with state and national standards;

(5) practice the new methods in a risk-free environment before implementing in the classroom;

(6) collaborate with peers, administrators, and experts throughout the learning and implementation process (Desimone et al., 2007; Loucks-Horsley et al., 2003; Mundry, 2003; NRC, 1996; Weiss & Pasley, 2006).

Teachers who engage in high-quality PD are likely to have more substantial changes to their classroom practices (Johnson et al., 2005; Loucks-Horsley et al., 2003). As teachers implement high-quality PD in their classroom, increases in student science achievement and college readiness have been reported (Johnson et al., 2005; Joyce & Showers, 2002). However, researchers have also found it challenging to directly link teachers' involvement in PD with student achievement.

Teachers' participation and implementation of PD may also be influenced by the professional culture in place within the school setting (Kardos et al., 2001). Professional culture at a school is often created through the interaction of teachers, specialists, and administrators (Kardos & Johnson, 2007). Teachers, especially those new to the profession or to the school, are more likely to be satisfied and remain in the profession if they are provided frequent interactions with colleagues across various experience levels (Kardos & Johnson, 2007).

Several researchers have identified the need for specific types of PD at various points in the teacher professional continuum (TPC; e.g., Cameron, Berger, Lovett, &

Baker, 2007; Day, 2008; Feiman-Nemser, 2001; Kardos et al., 2001; National Science Foundation [NSF], 2003; Sato, Roehrig, & Donna, 2010). The TPC provides a framework that allows for identifying the unique needs of teachers as they progress through their teaching careers (Feiman-Nemser, 2001; Kahle & Kronebush, 2003). While the TPC is idealistically viewed as a seamless continuum of growth in experience and expertise, distinctions of teacher types (e.g., Novice, Mid-Career, and Veteran) are used to provide approximate “stages” of teacher knowledge, skills, and habits of mind (NSF, 2003). Novice teachers have been defined as teachers in their first three years in the profession; mid-career teachers, as those in the profession for four to seven years; and veteran teachers, as those in the profession for eight or more years. Cameron and associates (2007) found that teachers new to the profession who received training appropriate to their needs and their school environment were more likely to be satisfied with their work and remain in the profession. Additionally, Day (2008) reported that differentiating PD by placement within the TPC resulted in increased job satisfaction, teacher retention, and student achievement. Researchers also recommend that PD should appropriately match not only content, but also pedagogical content knowledge to the special needs of novice, mid-career, and veteran teachers (e.g., Cameron et al., 2007; Day, 2008; Kardos et al., 2001). Again, little is known about how matching PD with level of experience directly impacts high school science teachers and their students.

The following three concepts were revealed through the course of researching and writing this literature review.

(1) PD is a complex and overused term to describe many types of opportunities with varying quality designed to increase teacher knowledge and skills.

(2) Researchers have found increasing evidence to suggest that teachers' involvement in high-quality PD increases both teacher retention and student achievement.

(3) However, researchers have found it challenging to directly link PD to student achievement and college readiness.

Students' science proficiencies and college readiness have been defined and measured in relation to numerous multi-level characteristics related to the school environment including students' extracurricular activities, teachers' qualifications, retention, and instructional strategies used in the classroom (Schroeder et al., 2007). It is, however, difficult to define and measure the relationships between these multi-level characteristics. Many national education policy documents affecting state and local policy, such as No Child Left Behind (USDE, 2002) and *Benchmarks for Science Literacy* (AAAS, 1998), view the teacher as a central player in increasing students' science proficiencies and college readiness. Therefore, it is essential that we understand how these policies impact teacher quality in relation to both student achievement and teacher retention within the profession.

Purpose of the Review

PD is a complex system. PD opportunities typically vary in quality, duration, and assessments of impacts on teacher learning, retention, and student achievement. This literature review seeks to examine national and state policies supportive of the development of various types of PD opportunities. I will also review evidence supporting the impact of these types of PD opportunities on both teacher retention and student achievement. Finally, I will explore what is currently known about teacher retention and student achievement and the nature of the professional cultures within schools that enable teachers to implement high-quality PD.

Significance of the Review

Schools provide few examples of policies that support teacher participation in PD (e.g., Day, 2008). Additionally, limited attention has been given to the impact of PD opportunities customized to meet the needs of teachers at various points within the TPC (e.g., Cameron et al., 2007; Day, 2008; Feiman-Nemser, 2001). Furthermore, research results have not firmly established that customized PD opportunities have significantly impacted either teacher retention or student achievement. This review seeks to bring the little bit we know about policy and research in these domains together to examine possible relationships that may exist between them.

Method for Reviewing Literature

Articles contained in this literature review were obtained through database (i.e., ERIC and Google Scholar) searches regarding science teacher professional development, student science achievement, college readiness, and teacher retention. Articles were selected for inclusion if they demonstrated either qualitative, quantitative, mixed-methods or theoretical support for the implementation of high-quality PD and its impacts on student science achievement, college readiness, and/or teacher retention. The parameters for inclusion were expanded based on the low number of articles returned by original search keywords. Additional searches included articles focused on the impact of student achievement, college readiness, and teacher retention in disciplines other than science education. International studies that were relevant to United States public school contexts were also included in the review. Articles included in the search were also limited based on language of publication (i.e., English) and accessibility through searchable databases (i.e., ERIC and Google Scholar).

The remainder of the review delineates policies and research regarding professional development, teacher retention, students' science proficiencies and college readiness, and relationships among each other. The literature review also provides a description of a contemporary, more inclusive term, professional culture, and how it may impact our understanding of teacher retention and student achievement. The review concludes with implications regarding the gap in knowledge between and among science teachers' professional activities, schools' professional development support, professional culture, teacher retention, and students' science proficiencies and college readiness.

Professional Development

The following section describes what is currently known about PD. A summary of both national and Texas policies regarding PD for high school science teachers is presented. The next sections highlight selected research publications supporting participation and implementation of the PD in high schools and the science classroom.

National and Texas Policies Regarding Professional Development

The National Research Council (NRC) provides a vision of learner-centered classrooms specific to various disciplines that call for teachers to be proficient at paying "close attention to students' ideas, knowledge, skills, and attitudes, which provide the foundation on which new learning builds" (NRC, 2005, p. 14). Creating learner-centered classrooms also means teachers must pay attention to their students' background, culture, and academic abilities in order to create opportunities to connect new knowledge to prior knowledge (NRC, 2005; 2007). Teachers should be given the opportunity to attend high-quality PD that integrate these policies and appropriate time to practice and reflect on the integration of these ideals in their classrooms to ensure successful implementation (Mundry, 2003; NRC, 2007).

The Texas Education Agency (TEA) provides a vision of learner-centered PD that enables "teacher[s], [to act] as reflective practitioners dedicated to all students' success, to demonstrate a commitment to learn, to improve the profession, and to maintain professional ethics and personal integrity" (TEA, 1995, p. 8). However, with the subject-neutral language of TEA policy, school leaders are faced with the task of determining PD needs that treat all disciplines equally (Grossman, Stodolsky, & Knapp, 2004). This policy gives school leaders little guidance on how to differentiate in an increasingly standards-based, accountability-driven school system. As a result, most school leaders increasingly rely on PD that does not provide teachers with adequate time or resources for changing classroom practice (Wei et al., 2010). This conclusion is supported by a review of 2003-2004 SASS data that indicates only a minority of all Texas teachers reported attending PD expected to support change in classroom practices (e.g., university courses), while the majority reported attending PD focused on inert content (Darling-Hammond et al., 2009).

Many documents relating to education policy tend to treat teaching as a nonspecific practice removed from the subtleties of school context and subject-matter (Grossman et al., 2004). However, especially at the secondary level, much of teaching occurs within specific subject-matter disciplines. Therefore, as Grossman and associates state (2004), "the design, implementation, and effects of policy related to teaching are unlikely to be understood…unless they explicitly examine the interaction of subject matter with these policies" (p. 3). Frameworks that enable the examination of relationships between policy, teaching, and learning with specific attention to content are needed to better understand the relationship between PD policies and practice (Grossman et al., 2004).

Both national and Texas policy documents discuss a variety of domains in which teachers should be proficient. The following sections compare both national and Texas policies which provide descriptions of similar types of professional activities. These groupings serve as a framework for understanding the types of professional activities in which teachers should participate to maintain proficiency and remain "highly-qualified" (USDE, 2002).

Policies Regarding Content, Process, and Daily Routines in the Learner-Centered Classroom. The *National Science Education Standards* (NSES) calls for all science teachers to participate in PD that engages them in "actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding" (NRC, 1996, p. 59). These experiences should also integrate opportunities for teachers to reflect on the "process and outcomes of understanding science through inquiry" (NRC, 1996, p. 59). In order to ensure that teachers can successfully implement NSES associated with providing an effective science program, all teachers must possess a deep understanding of the content standards and the supports available within their school context to facilitate implementation (NRC, 1996). More recently, the NRC has also recommended that both pre-service and in-service PD should focus on content and reform-based pedagogy that engage teachers as learners and provide the opportunity for reflection on how those experiences will translate into their classrooms (NRC, 2007).

TEA describes a domain of learner-centered content knowledge that enables teachers to "possess and draw on a rich knowledge base of content, pedagogy, and technology to provide relevant and meaningful learning experiences for all students" (TEA, 1995, p.3). TEA (1995) also describes providing equity in excellence for all learners as teachers "respond appropriately to diverse groups of learners" (p. 6). According to 2007-2008 SASS data, at least 80% of Texas teachers reported attending

PD that focused on content, and at least 51% of Texas teachers reported attending PD that provided training on teaching students with disabilities (Wei et al., 2010). Several researchers have identified the following topics as teachers' top priorities for PD: (1) classroom management, (2) teaching students with special needs, and (3) use of technology (e.g., Darling-Hammond et al., 2009; Desimone et al., 2007; Wei et al., 2010). According to Desimone and associates (2007), no differences were reported among teachers of various science disciplines as to their priorities for PD.

Policies Regarding Reform- and Standards-based Proficiencies in the Science Classroom. The NSES states that "skilled teachers of science have special understandings and abilities that integrate their knowledge of science content, curriculum, learning, teaching, and students" (NRC, 1996, p. 62). Additionally, the NSES calls for teachers to create opportunities in science classrooms that are "developmentally appropriate, interesting, and relevant to students' lives; emphasize student understanding through inquiry; and connect with other school subjects" (NRC, 1996, p.212). National policy documents, such as *Taking Science to School* (NRC, 2007), remind us that teachers must be well prepared to engage students in experiences which are increasingly more sophisticated in both scientific content and authentic practices. Teachers must also be proficient at ongoing assessment and guidance to help students effectively communicate, present, and defend their scientific understanding (NRC, 2007). Reform-based instructional methods include inquiry and problem-based learning, cooperative learning models, and the development of 21st century skills (Bybee, 2010; Joyce & Showers, 2002; Loucks-Horsley et al., 2003; NRC, 2007).

In Texas, the TEA encourages teachers to orchestrate a classroom environment which creates "a learner-centered community, [in which] teachers collaboratively identifies needs; and plans, implements, and assess instruction using technology and other resources" (TEA, 1995, p. 4). According to 2007-2008 SASS data, at least 67% of Texas teachers reported attending PD on the use of computers in the classroom (Wei et al., 2010). On the other hand, these same teachers reported a decline in attendance in PD designed to increase their abilities to integrate reform- and standards-based curricula in the classroom (Wei et al., 2010). These findings indicate that teachers' PD needs go beyond instruction in how to use equipment to also include implementation within the classroom context.

Policies Regarding the Development of Teacher Leaders. The NSES explains clearly defined roles regarding leadership to ensure the "support, maintenance, assessment, review, revision, and improvement of the [science] program" for improved teaching and learning (NRC, 1996, p. 212). According to national policy documents, teacher leaders often take the role of science specialists at the school level (NRC, 1996; 2007). These teachers are typically charged with a variety of tasks such as developing, training, and implementing reform-based science curricula and acting as communication liaisons between teachers, administration, parents, and the community (NRC, 2007). Researchers have documented positive influences of teacher leaders on the development of their colleagues; however, little attention has been paid to documenting effects of teacher leadership on student achievement (NRC, 2007).

While not explicitly advocating for the development of teacher leaders, TEA calls for teachers to create an environment in which learner-centered communication enables teachers to act "as an advocate for all students and the school … [and] demonstrate effective professional and interpersonal communication skills" (TEA, 1995, p. 7). Therefore, state policy documents emphasize the role of teacher leaders as that of communication liaisons and not the development of science specialists who may foster and improve the development of colleagues.

Policies Regarding the Implementation of Schools' Professional Development Support. The NSES calls for teachers to be engaged in PD opportunities that provide feedback regarding classroom implementation and time for both individual and group reflection regarding the quality of their implementation (NRC, 1996). Policies aimed at increasing PD support should engage teachers in life-long learning as they gain new content and skills, revise existing practices to meet new demands, and learn innovative approaches to teaching and learning (NRC, 1996). PD support policy can also be fostered through increasing opportunities for teacher collaborations within various groups suited to the school context (e.g., discipline teams, grade-level teams, or vertically aligned teams; NRC, 2007). Additionally, schools should provide teachers with increased access to opportunities aimed at improving (a) teachers' science content knowledge, (b) understanding associated with how students learn, and (c) examinations of instructional practices used in the classroom (NRC, 2007).

At the state level, TEA (1995) calls for school administrators to create a school environment conducive to life-long learning. Schools that have established PD support policies often create an environment in which "all members of the learning community seek and attain excellence [through] … instructional strategies designed to promote optimal learning for all students" (TEA, 1995, pp. 12-13). As noted through various national and state policy documents, it is important that these PD supports be suited to the school context.

Research Regarding Professional Development

Numerous research reports have called for PD designed to increase teachers' content knowledge, pedagogical knowledge and skills focused on improving student achievement and college readiness (e.g., Akerson & Hanuscin, 2007; Desimone et al., 2007; Garet et al., 2001; Loucks-Horsley et al., 2003). These reports encourage the design of PD to include well-defined standards regarding effective learning and teaching, extended opportunities to examine teaching practice and student artifacts, and opportunities for collaboration and design of strategies to meet the unique learning needs of their students. PD may include both formal and informal activities that are designed to engage teachers or administrators in new learning about professional practices (Knapp, 2003).

Teacher participation in PD varies depending on many contexts. These contexts include (a) time in the profession, (b) school culture and setting, and (c) state and local policy environment (e.g., Darling-Hammond et al., 2009; Wei et al., 2010). Data regarding these contexts have been collected nationally through the administration of the School and Staffing Survey (SASS). A number of researchers have used the SASS as a data source for examining trends concerning teacher participation in PD across the nation (e.g., Darling-Hammond et al., 2009; Desimone et al., 2007; Wei et al., 2010).

Desimone and associates (2007) used data from the 1999-2000 SASS to examine the influence of policy on teachers' participation in PD with respect to school context and PD support. They found that teachers in urban schools were more likely to participate in content-focused and interactive PD (Desimone et al., 2007). Despite more opportunities for PD, urban teachers reported less satisfaction with leadership opportunities than their suburban counterparts (Darling-Hammond et al., 2009). The majority of teachers surveyed in 2003-2004 reported that the most common type of PD they attended was directly related to the content they teach (Darling-Hammond et al., 2009). However, these teachers also indicated receiving no more than 16 hours of this type of PD. The 2003-2004 SASS also revealed that nearly half of all teachers in the United States were dissatisfied with their PD experiences; many reported receiving little to no funding for attending PD (Darling-Hammond et al., 2009). A shortcoming of nationally representative data regarding PD is that they do not sample enough subject-specific teachers at each school to conduct a school-level analysis of subject-specific participation in PD (Desimone et al., 2007).

The following sections provide research supporting participation and implementation of the types of professional activities which were revealed through the analysis of national and Texas policies. The studies presented are intended to provide a snap-shot of anticipated results and implications for participation and implementation of the types of professional activities. These studies serve as benchmarks for understanding how other types of professional activities may be grouped to serve similar purposes as outlined in national and Texas policy documents.

Research Regarding Content, Process, and Daily Routines in the Learner-Centered Classroom. Upon completion of initial certification, most teachers have gained adequate content knowledge needed to enter the classroom. However, many argue that PD is essential to help in-service teachers learn the necessary skills needed to succeed in the classroom (e.g., Angrist & Lavy, 2001; NRC, 2007). Teachers participating in a study conducted by Angrist and Lavy (2001) received weekly training on improving classroom instruction aligned to their school's curriculum. Participating teachers received prompt feedback regarding the quality of implementation. As a result, these teachers noted increases in student achievement as compared to schools not implementing the PD (Angrist & Lavy, 2001).

In Kentucky, researchers were interested in assessing the relationships between teachers' needs, student achievement, and PD in language arts and mathematics (Corcoran, Passantino, & Gerry, 2001). Results indicated that teachers lack appropriate content knowledge necessary to meet new standards-based instruction (Corcoran et al., 2001). Additionally, the ability to find effective PD was complicated by fragmented policy and inadequate dissemination of appropriate opportunities (Corcoran et al., 2001). Ultimately the researchers concluded that the quality of PD implemented in Kentucky schools was highly dependent on the vision of school leadership (Corcoran et al., 2001). Desimone and associates (2007) found this trend mirrored nationally with science teachers. Thus, indicating that the consistency between PD and other school policies, along with stability of school leadership, impact teachers' participation and implementation of PD in the classroom (Corcoran et al., 2001; Desimone et al., 2007).

Research Regarding Reform- and Standards-based Proficiencies in the Science Classroom. Fogleman and associates (2006) describe an in-depth examination of a large district-university partnership designed to scale-up innovative science inquiry instruction in urban middle school classrooms. They suggest that ongoing PD is necessary for teachers to implement reform-based curricula in the classroom (Fogleman et al., 2006). During PD, teachers must be given time and additional support to learn how to use reform- and standards-based strategies presented during the course of the PD to result in changes to classroom practice (Fogleman et al., 2006). Supovitz and Turner (2000) provided PD focusing on the integration of reform-based instructional methods designed to engage students in obtaining 21st century skills. According to Supovitz and Turner (2000), teachers needed approximately 160 hours of this type of PD before changes in classroom practices were observed. PD regarding teachers' preparedness in teaching 21st century skills may be necessary, as many teachers have never experienced instruction designed to foster 21st century skills (Hilton, 2010). These findings are supported by others in the literature implying that teachers need multiple and prolonged PD experiences to successfully integrate reform- and standards-based proficiencies into classroom practices (e.g., Akerson & Hanuscin, 2007; Garet et al., 2001; Loucks-Horsley et al., 2003)

Research Regarding the Development of Teacher Leaders. York-Barr and Duke (2004) summarized 20 years of research on teacher leadership. They viewed teacher leadership as enabling "teachers [to], individually or collectively, influence their colleagues, principals, and other members of school communities to improve teaching and learning practices with the aim of increasing student learning and achievement" (York-Barr & Duke, 2004, pp. 287-289). According to York-Barr and Duke (2004), the development of teacher leaders has many benefits to the school system. These benefits include (a) providing support to administration, (b) enabling more effective decisions regarding daily operation with respect to student needs, and (c) increasing ownership and commitment through the direct participation in the development and refinement of school goals (York-Barr & Duke, 2004).

Saunders, Goldenburg, and Gallimore (2009) reported that direct training of all levels of leadership (i.e., for both teachers and principals) may provide explicit support for students. Their results also indicated increases in student achievement as all levels of leadership received PD (Saunders et al., 2009). Teacher leaders may also provide PD to their colleagues as a means of increasing participation for all teachers at their school (Fogleman et al., 2006; Loucks-Horsley et al., 2003). In addition, teachers take on leadership roles as they enter into mentor/mentee relationships (Sato et al., 2010). Teacher leaders are often a catalyst for ensuring that successful and prolonged changes occur within a school (Dutro, Fisk, Koch, Roop, & Wixson, 2002).

Research Regarding the Implementation of Schools' Professional Development Support. Darling-Hammond and Snyder (2003) found schools that had PD support practices often enabled collaborative learning among teachers, which often resulted in increases to student achievement. They found that effective PD support practices provided teachers with dedicated time for meeting collaboratively to discuss issues related to classroom practice (Darling-Hammond & Snyder, 2003). Schools' PD support that enables collaboration between teachers may also foster increases in student achievement and teacher retention (Bybee, 2010; Kardos et al., 2001).Similar effects have been seen when teachers' placement with the TPC has been taken into account (Cameron et al., 2007; Wei et al., 2010). Cameron and associates (2007) found that teachers who experience PD support practices suited to their needs at specific points within the TPC were more likely to be retained (Cameron et al., 2007).

PD support practices can often dictate the willingness of teachers to participate in PD opportunities. Knapp (2003) describes four different methods for eliciting participation in PD:

(1) Mandates requiring participation and carrying consequences for those who do not participate.

(2) Inducements encouraging participation through incentives (e.g., stipends, resources, etc.) for attendance and participation.

(3) Capacity building opportunities connecting participating teachers with community resources that strengthen relationships and increase opportunities for students and available resources.

(4) Orchestrated systemic change that allows those more directly impacted by the policies in need of reform to create tailor-made development plans.

Additional complexities may also exist while establishing and implementing PD support practices. These complexities include (a) the role of various administrators' knowledge and beliefs regarding PD, (b) the availability and allocations of resources necessary to implement and support PD, (c) content that will be supported and disseminated through PD, and (d) measures for ensuring successful implementation of PD (Knapp, 2003).

Desimone and associates (2007) reported stability of administrators as an important factor regarding PD supports to predicting teachers' participation in PD. Increases in school PD support often require direct attention from both teachers and administrators (Newmann, King, & Youngs, 2000). Many researchers believe PD support practices, such as values of openness, trust, genuine reflection, and collaboration, embraced by all teachers may be an effective method for increases in student achievement (Louis & Marks, 1998; Newmann et al., 2000). Nonetheless, there is little research as to how policy for PD support can influence teachers' commitment to the school and the profession (Johnson et al., 2005).

Teacher Retention

This section describes what is currently known about teacher retention. Both national and Texas policies are presented. The relationship between PD and teacher retention is also discussed.

National and Texas Policies Regarding Teacher Retention

The retention of effective teachers has been cited as the primary means for increasing student achievement (USDE, 2010). However, there are few mechanisms in place for differentiating effective teachers from their ineffective colleagues (USDE, 2010). Revision to current United States policy will implement various evaluations to determine effectiveness and reward the integration of innovations in practices designed to improve student achievement (USDE, 2010). These policies will likely result in the retention of the most effective teachers in science classrooms.

Texas has recently passed legislation requiring four years of science and mathematics for all students (Maloney et al., 2009). These new requirements have raised questions regarding the recruitment and retention of teachers with appropriate qualifications for implementing the new standards (Maloney et al., 2009). High-quality PD can provide relevant training regarding the standards of this new legislation to ensure more successful implementation (Maloney et al., 2009; NRC, 1996; USDE 2010).

Professional Development and Teacher Retention

Policies are often aimed at the preparation of new teachers, with little if any acknowledgement of practices specifically aimed at retaining teachers (Hilton, 2010). Research findings indicate that high percentages of beginning teachers leave the profession within the first three to five years of being in the profession (e.g., Cameron et al., 2007; Ingersoll, 2003; Johnson et al., 2005). Hilton (2010) identifies a number of factors contributing to teacher attrition including not being prepared to (a) establish day-to-day routines associated with classroom management, (b) provide instruction to an ethnically and culturally diverse student population, and/or (c) teach science effectively using an increasingly standards-based curriculum (Hilton, 2010). Additionally, research has shown that science teachers often leave the profession due to competing interests from fields outside of education or general dissatisfaction including low student motivation, discipline problems, lack of influence over school decision making, and low administrative support (Ingersoll, 2003). Retention rates have been shown to increase when teachers engage in collaborative planning regarding curriculum and instruction, feel that they have input in school decisions regarding teaching and learning, and general administrative support (Johnson et al., 2005). Furthermore, Johnson and associates (2005) suggest that PD aimed at improving teachers' understanding of various community characteristics and the cultural practices of their students may increase teacher retention. In addition, Johnson and associates (2005) suggest that as teachers participate in high-quality PD that results in changes to classroom practice both teacher retention and student achievement will increase.

Feiman-Nemser (2001) provided a framework for the development of a seamless TPC. This framework took into account the development of beginning teachers as they work to master not only their content, but also process daily routines necessary to be effective in the classroom. The framework also accounts for the needs of more experienced teachers as they work to implement reform- and standards-based curricula to create a dynamic learning environment for all students. The definitions and examples of programs provided in Feiman-Nemser's (2001) framework allow for a broad interpretation of her proposed methods. However, she did not identify the role of teacher leaders within the continuum, nor did she explore their possible impacts on student achievement.

Sato and associates (2010) suggested the bending of the TPC to increase teacher retention. Bending the TPC increases involvement of experienced teacher leaders in preparing new teachers and inducting beginning teachers. These authors believe that bending will alleviate the high attrition rates associated with beginning teachers while also increasing the retention rates of more experienced teachers. As experienced teachers are giving back to the profession, they are energized and often find a reason to stay in teaching. Sato and associates (2010) suggested a variety of local and state policies aimed at increasing and improving the role of teacher leaders to increase teacher retention rates. On the contrary, there was no discussion of how to create PD support policy at the school level; nor did they discuss the implications of these practices on student achievement. In an earlier article, Johnson and associates (2005) did, however, encourage further research to investigate the role of teacher PD on retention.

Students' Science Proficiencies and College Readiness

This section describes where we currently are in defining and measuring students' science proficiencies and college readiness indicators. A summary of both national and Texas policies are presented. The impact of PD on students' science proficiencies and college readiness is also discussed.

National and Texas Policies Regarding Students' Science Proficiencies and College Readiness

Analysis of current national standards and curricula materials indicate that too many topics are often covered with too little depth (NRC, 2007). Results included students possessing superficial understandings of many topics rather than dynamic understandings of the interconnected themes associated with science (NRC, 2007). Teachers have long been encouraged to rely on a variety of assessments to determine students' science proficiencies and college readiness performance in the classroom (NRC, 1996). National policy documents have also emphasized the role of benchmark assessments in guiding teaching and learning in the science classroom (NRC, 1996; 2007). Benchmark assessments that are commercially available as components of curricula do not necessarily provide the kind of feedback conducive to improved teaching and learning (NRC, 2007).

The state of Texas began adopting state-wide standards in a variety of science disciplines over 25 years ago (TEA, 2011c). The Texas Essential Knowledge and Skills (TEKS) provide a detailed description of both content and skills students should have mastered upon completion of a course. A statewide exit-level standardized assessment (i.e., Texas Assessment of Knowledge and Skills [TAKS]) is administered to students in 10th grade to gain a snap-shot of their performance and level of understanding regarding the mastery of the TEKS (TEA, 2011c). Achievement gains made throughout the school and within various ethnic groups are additional factors in determination of a school's accountability rating (TEA, 2011a).

The TEA in a collaborative relationship with the Texas Higher Education Coordinating Board (THECB) developed the Texas College and Career Readiness Standards (CCRS). The CCRS were adopted by the state in January 2008 to ensure that students were prepared upon completing K-12 education to enter into higher education or become a member of the increasingly skilled workforce (THECB & TEA, 2008). Beginning in 2010, schools performance on CCRS became an additional factor in determining a school's accountability rating (TEA & THECB, 2010). Additionally, high schools in Texas may provide advanced placement or dual credit classes as means for improving students' college readiness (Maloney et al., 2009).

Professional Development and Students' Science Proficiencies and College Readiness

Clune (1998) conducted an analysis of student achievement in schools that were part of a program sponsored by the National Science Foundation (NSF) regarding statewide systemic reform. His assessment used various aspects of student achievement in nine schools. Most schools in the sample provided results on either state assessment and/or the National Assessment of Educational Progress (NAEP). The design of these standardized assessments may not have necessarily been aligned with the pedagogical techniques and content associated with the reform initiatives, therefore the combination of these factors limit measurements of student achievement (Clune, 1998). He also accounted for schools' ability to close the achievement gap between white and minority students and the alignment of state assessments with policy goals. Student achievement was determined based on increases in scores on any of the aforementioned categories over the course of five years.

Clune found that successful, sustained reform for many of the schools took more than the five years allowed during one cycle of NSF funding. The focus of many of these reforms was on pedagogy rather than on content or guidance and support for addressing change in the classroom. As successful schools progressed in their reform agendas, they began integrating new materials, model teaching units, or curriculum replacement units, all of which are considered the effects of successful PD practices (e.g., Loucks-Horsley et al., 2003). Research has shown that students of teachers who participated in high-quality PD have increases in both achievement and college readiness (Desimone et al., 2007; Joyce & Showers, 2002; Wei et al., 2010). As a result, Clune (1998) suggested a causal model to examine the impact of systemic reform and policy focused on development of teachers' content knowledge along with classroom processes and routines designed to support implementation of reform- and standards-based curricula impact on student achievement. Clune (1998) suggested that purposeful activities associated with systemic reform will lead to system policy that establishes a rigorous curriculum, which when implemented for all students results in higher achievement. This study did not examine the development and role of teacher leaders in the implementation of systemic reform.

Conversely, York-Barr and Duke (2004) suggested a causal model of the impact of teacher leadership on school environment and student achievement. Their model drew attention to the impact of strong teacher leaders in a supportive community. These teacher leaders often influenced teaching and learning that ultimately resulted in higher student achievement (York-Barr & Duke, 2004). However, they did not investigate the importance of successful implementation regarding content, process, daily routines, or reform- and standards-based proficiencies in the classroom. Johnson and associates (2005) discussed the impact of teacher participation in a variety of PD opportunities within a supportive environment as having positive impacts on student achievements.

Teacher Retention and Students' Science Proficiencies and College Readiness

One mechanism for increasing student proficiency and college readiness is to develop policies and practices that increase teacher retention. Teacher placement within the TPC has been shown to have impact on student achievement and college readiness (Guarino, Santibañez, & Daley, 2006; Johnson et al., 2005). Attrition of high school science teachers typically follows a U-shaped distribution, implying that teachers leave either early or late in their careers (Guarino et al., 2006; Ingersoll, 2003). Beginning teachers replaced by other beginning teachers implies that students are often taught by a "string of teachers who are, on average, less effective than more experienced teachers" (Johnson et al., 2005, p. 11). Therefore, researchers have shown that teacher attrition is often linked to lower student achievement (e.g., Guarino et al., 2006; Johnson et al., 2005).

Teachers' decisions regarding whether to stay or leave the profession are often heavily influenced by relationships with their students and their academic success (Johnson et al., 2005). Additionally, student characteristics (e.g., socioeconomic status and race) sometimes mitigate teacher-student interactions and expectations (Johnson et al., 2005). PD is one method to provide teachers with tools that aid in the cultivation of relationships with students from diverse backgrounds (Guarino et al., 2006). PD requirements of teachers may need to go beyond content and pedagogical knowledge to address more critical issues of establishing cultures supportive to our increasingly diverse student population. Due to the strong undercurrents regarding both reform- and standards-based education, schools that are organized to support interdependence and collaboration amongst teachers will likely see increases in student achievement and college readiness and teacher retention (Johnson et al., 2005).

Professional Culture

Professional culture can be used as a meaningful construct for understanding the intricate dynamics within a school that affect both teacher retention and student achievement (Kardos et al., 2001). Kardos and associates (2001) have defined school professional culture for the first time as a "distinctive blend of norms, values, and accepted modes of professional practice, both formal and informal that prevail among colleagues" (p. 254). Prior to this definition, many researchers examined professional culture as a product of professional learning communities or within the context of school culture that took into account the contribution of students (e.g., see Bloor & Dawson, 1994; Bryk, Camburn, Louis, 1999).

Professional culture may also be influenced by the distribution of teachers in various stages of the TPC employed at the school (Johnson & Kardos, 2005; Kardos & Johnson, 2007; Kardos et al., 2001). This notion has become essential in understanding the supports necessary for novice teachers to collaborate with their more experienced colleagues (i.e., mid-career and veteran teachers) and increase novice teacher retention rates (Feiman-Nemser, 2003; Kardos & Johnson 2007). Recent extensions suggest a "bending" of the TPC to accommodate the notion that all teachers, regardless of their experience levels, benefit from a positive school culture that allows veteran teachers to learn from nurturing and mentoring less experienced teachers, in a sense of "giving back" and enhancing the system in which they were first enculturated (Feiman-Nemser, 2003; Sato et al., 2010).

A school’s professional culture may be determined through the presence of a variety of characteristics associated with its structure and interaction amongst colleagues. Kardos and Johnson (2007) identified the following characteristics as being necessary for the establishment of a strong, supportive professional culture within a school:

(1) formal mentoring system,

(2) classroom observations with feedback,

(3) official and informal meetings among teachers,

(4) interaction among teachers of various levels of experience,

(5) special status granted to novice teachers,

(6) collective responsibility amongst all teachers regarding student expectations and success,

(7) participation in professional development, and

(8) administrative support.

The combination of the above characteristics provides a framework for beginning to understand and compare the effects of professional cultures within various school contexts. However, little is known about the relative contribution of each of these characteristics to the overall professional culture. Furthermore, there are few studies that measure and compare professional cultures across schools and associations with teacher retention or student achievement.

Implications of the Literature Review

This literature review has presented information from both policy and research documents regarding the involvement of teachers in a variety of types of professional activities. Information has included examples and effects of each of these types of professional activities. The foundation for the importance of schools' support for PD, and research indicating an impact of PD on both teacher retention and student achievement were also presented. However, much remains to be investigated regarding the effects of these variables within high school science programs. Little is known about the types and levels of professional activities of Texas high school science teachers or what types of school support for PD exist throughout the state. Much less is known regarding the match between professional activity and schools’ levels of PD support as they relate to the development of teachers in various stages of the TPC.

This literature review has also provided a summary of what is currently understood regarding a contemporary, more inclusive term, professional culture. Professional culture is a construct useful for understanding the dynamics in place at a school between teachers at different stages within the TPC, which may impact both teacher retention and student achievement. This construct builds on the more traditional, separate philosophies of teachers’ professional activities, which emphasize what teachers do to enhance their abilities to teach science more effectively and the schools’ PD support which emphasizes what schools do to assist teachers in their pursuit of excellence. The construct of "professional culture" combines both teachers’ actions and school support to describe interactions between and among components associated with both. At this point in the progression of our understanding of this new term that has come to be used in the literature within the past ten years, few research methods are currently available to support measuring and comparisons of professional cultures among schools that support high school science teachers.

Research Presented in the Dissertation

Two papers are presented in this dissertation within the broad umbrella of the science teacher professional continuum. The first presents a more traditional approach by investigating the impacts of teachers’ participation in PD and schools’ PD support on science teacher retention and students’ science proficiencies and college readiness. The second embraces the more contemporary construct of professional culture, operationally defining it and then investigating the relationships between elements within high school's professional cultures for science teachers and their impacts on science teacher retention and students’ science proficiencies and college readiness. Both papers involve the development of rubrics to assess the level and frequency of teachers’ participation in PD, schools’ PD support, and professional cultures within the science program. Research findings from this dissertation will be used to develop recommendations for school administrators and high school science teachers regarding professional development and professional culture as possible means for improving science teacher retention and students’ science proficiencies and college readiness.

CHAPTER III

TEACHERS' PARTICIPATION IN PROFESSIONAL DEVELOPMENT AND SCHOOLS' PROFESSIONAL DEVELOPMENT SUPPORT: PATTERNS OF RELATIONSHIPS WITH SCIENCE TEACHER RETENTION AND STUDENT ACHIEVEMENT

Declining levels of students' interest and achievement in science have raised awareness of the current state of science education (Augustine, 2007; Gonzales et al., 2008; Hilton, 2010; OECD 2007). The qualifications of teachers have often been identified as the primary means for increasing students' interest and achievement (Johnson et al., 2005; Schroeder et al., 2007; USDE, 2010). What happens to student achievement, when we face shortages of highly-qualified high school science teachers (Maloney et al., 2009)? Many national documents encourage science teachers to pursue various types of PD as a means to increase their effectiveness (AAAS, 1998; NRC, 2007). Policies in place at the school level often determine the relative ease with which teachers can participate in and/or implement PD experiences within the classroom (Desimone et al., 2007; Garet et al., 2001; Penuel et al., 2007). This paper provides a description of teachers' participation in PD, schools' level of PD support and their impacts on schools' science teacher retention rates and students' science proficiencies and college readiness (SPCR).

Problem Statement

The relationship between teachers' participation in high-quality PD and changes in classroom practice have been well established (e.g., see Clune, 1998; Joyce & Showers, 2002; Loucks-Horsley et al., 2003; Maloney et al., 2009). However, we know that even high-quality PD can take many types and forms (Darling-Hammond et al., 2009; Kahle & Kronebusch, 2003; Penuel et al., 2007; Wei et a., 2010). Several national and state policies have been established to support teachers' participation and schools' support of a variety of PD types (NRC, 1996; 2005; 2007; TEA, 1995; USDE, 2002). However, little is known about how teachers' participation in PD and schools' PD support impact both schools' science teacher retention rates and scores for students' science proficiency and college readiness.

Literature Review

Numerous research reports have called for PD designed to increase teachers' content knowledge, pedagogical knowledge and skills, as well as student achievement and college readiness (e.g., Desimone et al., 2007; Garet et al., 2001; Loucks-Horsley et al., 2003). These reports encourage the design and support of PD to include well-defined standards regarding effective learning and teaching, extended opportunities to examine teaching practice and student artifacts, and opportunities for collaboration to design strategies for meeting the unique learning needs of students. Teacher participation in PD may be mitigated by a variety of contexts. These contexts include (a) time in the profession, (b) school culture and setting, and (c) state and local policy environment (e.g., Darling-Hammond et al., 2009; Wei et al., 2010).

Darling-Hammond and Snyder (2003) found that schools having effective PD support practices often enabled collaborative learning among teachers, which then resulted in increased student achievement. They found that effective PD support practices provided teachers with dedicated time for meeting collaboratively to discuss issues related to classroom practice (Darling-Hammond & Snyder, 2003). Teacher collaborations can take various forms suited to the school context (e.g., discipline teams, grade-level teams, or vertically aligned teams; NRC, 2007). PD opportunities provided to teachers should be aimed at improving (a) teachers' science content knowledge, (b) understanding associated with how students learn, and (c) examinations of instructional practices used in the classroom (NRC, 2007). Finally, teachers' participation in these types of PD may also provide increases in both teacher retention and student achievement (Bybee, 2010; Johnson et al., 2005; Kardos et al., 2001).

In addition to collaborative PD, Johnson and associates (2005) suggested that PD aimed at improving teachers' understanding of various community characteristics and the cultural practices of their students may increase teacher retention. Hilton (2010) identified a number of factors contributing to teacher attrition including not being prepared to (a) establish day-to-day routines associated with classroom management, (b) provide instruction to an ethnically and culturally diverse student population, and/or (c) teach science effectively using standards-based curricula (Hilton, 2010). Therefore, we can see that participation in PD aimed designed to increase teachers' abilities to establish routines in the classroom with regard to student and school context are likely to increase both teacher retention and student achievement (Feiman-Nemser, 2001; 2003; Hilton, 2010; Johnson et al., 2005)

Participation and implementation of high-quality PD can result in increased student achievement (e.g., see Joyce & Showers, 2002; Loucks-Horsley et al., 2003). PD also provides teachers with tools that aid in the cultivation of relationships with students from diverse backgrounds (Guarino et al., 2006). PD needs of teachers may need to go beyond content and pedagogical knowledge to address more critical issues of establishing cultures supportive of a student population becoming increasingly diverse. Due to the strong undercurrents regarding both reform- and standards-based education, schools organized to support interdependence and collaboration amongst teachers will also likely see increases in teacher quality and retention, as well as student achievement and college readiness (Johnson et al., 2005). Student needs may be determined by examining state and national policy documents that delineate what students need to know upon completion of high school.

Texas currently has three initiatives in place to ensure student achievement and college readiness. These initiatives address (1) content standards, (2) college and career readiness standards, and (3) availability of advanced placement or dual credit courses. The state of Texas adopted content standards to provide guidance about what teachers and students need to accomplish in the classroom (TEA, 2011c). The Texas Essential Knowledge and Skills (TEKS) are the current state standards used in all Texas public schools. The TEKS provide a detailed description of both content and skills students should master upon completion of a defined science course (e.g., Biology, Chemistry, and Physics). Additionally, education leaders within the TEA working with members of the Texas Higher Education Coordinating Board (THECB) developed the Texas College and Career Readiness Standards (CCRS). The CCRS were adopted to ensure the preparation of Texas high school graduates to enter post-secondary education or become a member of the skilled workforce (THECB & TEA, 2008). Finally, high schools in Texas may also provide advanced placement or dual credit courses as an additional means for improving students' college readiness (Maloney et al., 2009).

The purpose of this paper is to identify associations among teachers' participation in PD, schools' PD support, schools' science teacher retention rates, and schools' scores on students' science proficiencies and college readiness. The following research questions were used to guide the research:

(1) In what types and at what levels do Texas high school science teachers participate in professional development?

(2) Are there differences in science teachers' participation in types of professional development by their identification of experience levels within the TPC?

(3) What types of and at what levels do schools provide professional development support in Texas?

(4) What is the relationship between science teachers' participation in professional development and schools' professional development support?

(5) How do science teachers' participation in professional development and schools' professional development support contribute to the schools' science teacher retention rates?

(6) What are the relationships between and among science teachers' participation in professional development, schools' professional development support, and schools' science teacher retention rates in predicting scores for students' science proficiency and college readiness?

Methods

Context of Study

The Policy Research Initiative in Science Education (PRISE) is a five-year project designed to investigate various aspects of the teacher professional continuum for Texas high school science teachers. The project aims to answer three questions: (1) Where are we? (2) Where do we want to go? and (3) How do we get there? The project uses both qualitative and quantitative data to examine current policies and practices regarding the recruitment, induction, renewal, and retention of Texas high school science teachers (Stuessy, 2009).

PRISE Participants

A two-stage stratified random sampling plan was designed to select 50 representative schools from the 1,333 Texas public high schools that offer science (Stuessy et al., 2008). Schools were selected for participation based on school size and minority student enrollment proportion (MSEP). Schools were identified as small (n=15; student enrollment ≤ 189), medium (n=17; student enrollment ≥ 190 and ≤899), or large (n=18; student enrollment ≥ 900) based on total high school student enrollment. Schools' MSEP was divided into four categories based on state-established proportions: *lowest* (n=21; < 35% minority student enrollment), *low* (n=8; 36%-49% minority student enrollment), *high* (n=9; 50%-74% minority student enrollment), and *highest* (n=12; > 75% minority student enrollment). For purposes of this study, lowest and low MSEP schools were combined to represent schools of low minority status (i.e., <50% minority student enrollment); whereas high and highest were combined to represent schools of high minority status (i.e., ≥50% minority student enrollment). Additionally, geographic location of schools was used to ensure random sampling throughout the state. Schools choosing not to participate were replaced with schools of the same characteristics (n=11). The stratified random sample including replacement schools enables the results of PRISE research to be generalizable to all high schools (n=1,333) in the state of Texas (see McNamara & Bozeman, 2007 for a detailed description of the sampling plan).

PRISE Data Collection

A variety of types of information were gathered from individuals within each participating school. Administrative (n=50) and science liaison (n=50) representatives were identified at each school to provide in-depth semi-structured interviews regarding policies and practices associated with each phase of the TPC. All interviews were audio recorded and transcribed, unless participants did not grant permission to do so. For the administrators (n=5) and science liaisons (n=8) who did not grant permission to be audio recorded, field notes were used as primary data sources. Additionally, all teachers (n=385) who provided instruction for at least one science class were asked to complete the Texas Poll of Secondary Science Teachers (TPSST; Stuessy & PRISE Research Group, 2007a; see Appendix A); and 89.2% of the teachers at participating schools returned completed surveys (Bozeman & Stuessy, 2009). A Cronbach's Alpha value of

0.86 was achieved during reliability analysis of the survey, thus supporting claims of internal reliability of the instrument.

The Public Education Information Management System (PEIMS) is maintained by the TEA to organize and disseminate information regarding various characteristics of Texas teachers (TEA, 2011b). PEIMS was used to determine the number of years a teacher has been practicing in the Texas public education system and to identify teachers who have changed schools but stayed in the profession. Master schedules (see Appendix D for an example) were obtained from both the 2007-2008 and 2008-2009 school years to identify science teachers. Examination of the master schedule in conjunction with PEIMS data enables PRISE researchers to track teachers who have “stayed” at their school, “moved” from one school to another within the Texas public school system, or “left” the profession.

Members of the PRISE research team also developed an algorithm to measure and compare scores for students’ science proficiencies and college readiness (SPCR) throughout the state of Texas (Stuessy, 2010a). SPCR was measured using the student aggregate science score (SASS) algorithm. Variables included in the SASS algorithm include percentage of 10^{th} grade students passing state administered science test (TAKS), percentage of students taking college entrance examines (CEET), percentage of students passing college entrance examines at or above criterion (PEET), percentage of students completing advance placement (AP) or dual credit course (APDE), and the school’s state accountability rating (SR; TEA, 2011a; see Equation 3.1).

$$SASS = \sum(1.5 \bullet TAKS - 0.5) + CEET + PEET + APDE + SR \text{; where} \quad (3.1)$$

TAKS = school's aggregate 10th grade TAKS

CEET = school's aggregate participation rate for college entrance examinations

PEET = school's aggregate passing rate for college entrance examinations

APDE= school's aggregate participation rate in AP or dual credit courses

SR= school's state accountability rating (Ivey et al., 2009).

Research Design

I used a convergent mixed methods approach to investigate the relationship between teachers' professional activity and schools' PD support with schools' science teacher retention rates and scores for students' science proficiencies and college readiness (Creswell & Clark, 2011). A diagram of the mixed methods approach appears as Figure 3.1.

Analysis and Results

All analyses performed in this study used SPSS 16.0 for Windows.

Teachers' Participation in Professional Development

I conducted a principal component analysis using teachers' self-reported data on the TPSST (Stuessy & PRISE Research Group, 2007a; see Appendix A) regarding participation in various PD activities to determine levels of participation in PD among all teachers. Principal component analysis was used in this analysis as a data reduction strategy to determine underlying factors associated with teacher participation in a variety of professional activities. Varimax rotation with Kaiser Normalization was used to maximize separation between factors by not accounting for correlation between factors.

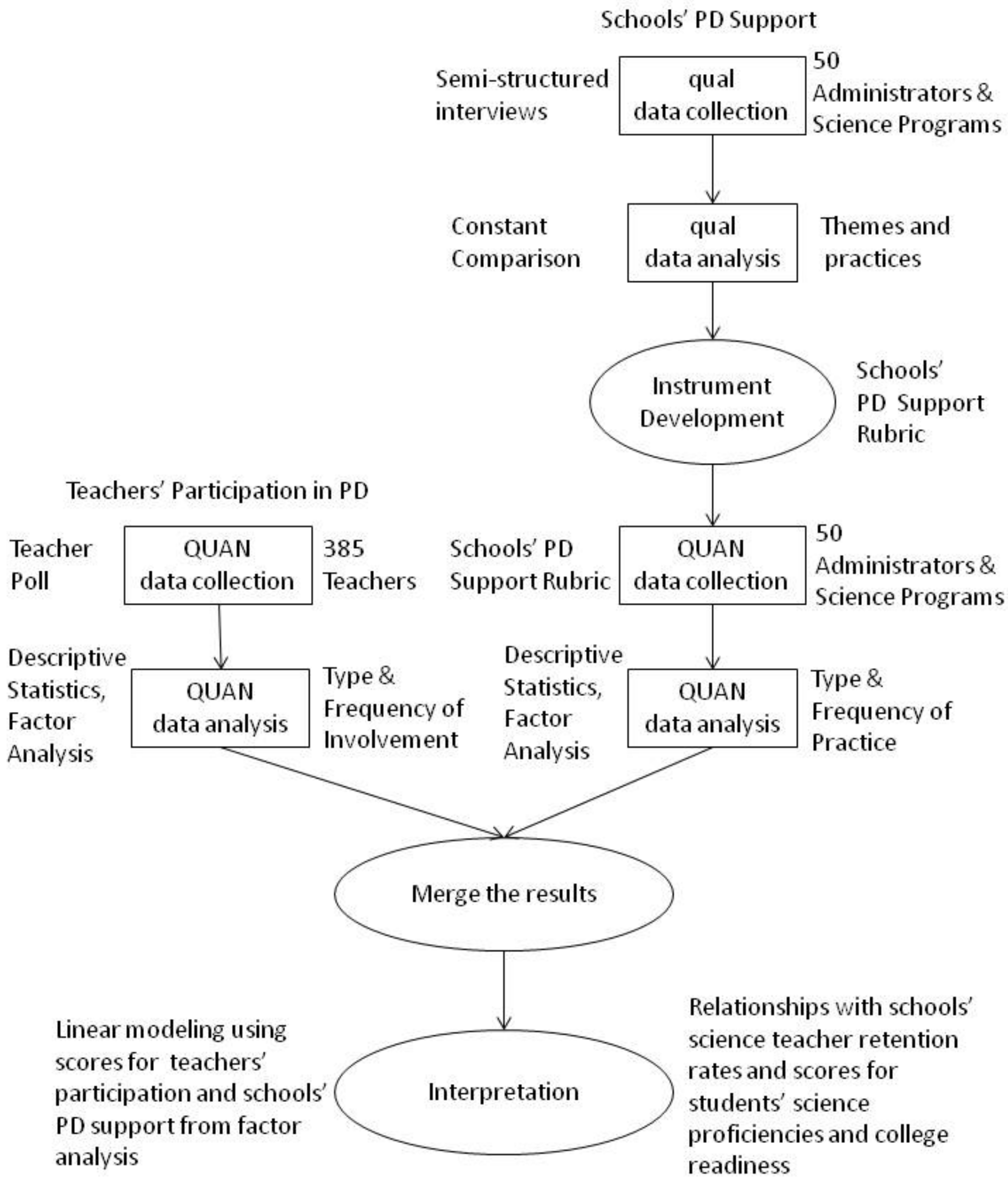

Fig. 3.1. Schematic representation of convergent mixed methods research design.

The initial analysis examined 46 activities that clustered into 3 factors explaining 31.26% of the variance. Additional iterations of the analysis were conducted including activities possessing an extraction value greater than or equal to 0.7 indicating favorable factorability with other activities. The final analysis resulted in 6 factors containing a total of 19 activities explaining 76.17% of the variance. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO; 0.83) indicated that the activities contained in the each of the factors clustered satisfactorily. Bartlett's Test of Sphericity was statistically significant indicating that the factors were independent of one another (χ^2=4454.89, df=171, p<0.0001). I chose this 6 factor solution due to the "leveling off" of the Eigenvalues on the Scree plot (see Figure 3.2). For a description of the 6 factors and activities contained within each factor see Table 3.1.

The first factor was named *Mentoring* due to the high loadings in the following items: assisted with classroom management, participated in the mentoring of new science teachers, provided a new science teacher with a science lesson, modeled teaching for a new teacher, developed a science lesson with a new teacher, observed a new teacher when they are teaching, performed formal mentor duties, and assisted with orientation to school policies. This first factor explained 30.07% of the variance.

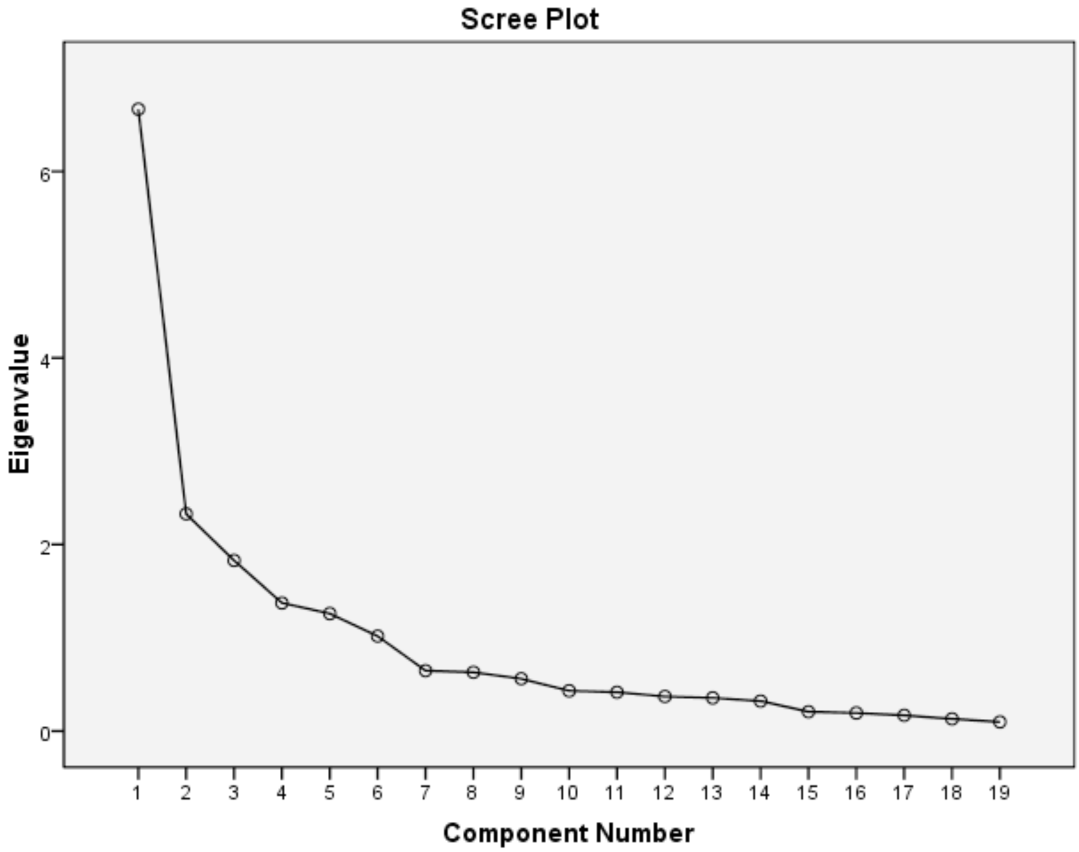

Fig. 3.2. Scree plot of teachers' participation in PD displaying "leveling off" of Eigenvalues after 6 factors.

Table 3.1

Principal Component Analysis Table for Teachers' Participation in PD

	Loadings					
	Factor 1: Mentoring	Factor 2: Recruitment	Factor 3: Science Professional Organizations	Factor 4: Standards	Factor 5: Curriculum	Factor 6: Non-Science Professional Organizations
Assisted with classroom management	.877	.114	.000	.066	.083	-.084
Participated in the mentoring of new science teachers	.870	.110	.063	.057	.228	-.046
Provided a science lesson	.853	.110	.074	.043	.241	-.021
Modeled teaching for new teacher	.840	.076	.046	.052	-.077	-.027
Developed a science lesson with a new teacher	.840	.050	.040	.057	.041	.005
Observed a new teacher when they are teaching	.821	.184	.077	.050	-.022	.074
Performed formal mentor duties	.783	.219	.077	.046	-.078	.046
Assisted with orientation to school policies	.755	.242	.021	.045	.182	.040
Participated in formal recruiting of new science teachers	.175	.879	-.032	.031	.056	-.032
Participated in recruitment through formal interviews	.127	.851	.057	.032	.040	.072
Reviewed job applications	.181	.816	.093	.011	.111	.001
Participated in recruitment through informal visits with new teachers	.181	.763	-.025	.024	-.034	-.014
Participated in a professional science teacher association	.039	.005	.891	.056	.021	.111
Member of a science teacher professional organization	.159	.063	.862	.072	.137	-.078
Participated in PD for teaching strategies using science TEKS	.063	.069	.054	.888	.032	.068
Participated in PD to prepare students for TAKS objectives	.140	.004	.069	.877	.080	-.043
Curriculum writing in science	.114	-.039	.015	.087	.840	.085
Science curriculum writer	.116	.172	.140	.022	.798	-.061
Participated in a non-science specific professional association	-.006	.023	.036	.024	.028	0.985
Eigenvalues	5.71	2.97	1.61	1.60	1.55	1.03
% of Total Variance	30.07	15.64	8.45	8.42	8.17	5.43
Total Variance	30.07	45.71	54.15	62.57	70.74	76.17

The second factor was named *Recruitment* due to high loadings in the following items: participated in formal recruiting of new science teachers, participated in recruitment through formal interviews, reviewed job applications, and participated in recruitment through informal visits with new teachers. Factor Two contributed 15.64% to the total variance explained. The third factor was named *Science Professional Organizations* due to high loadings in the following items: participated in a professional science teacher association and member of a science teacher professional organization. Factor Three contributed 8.45% to the total variance explained. The fourth factor was named *Standards* due to high loadings in the following items: participated in PD for teaching strategies using science TEKS and participated in PD to prepare students for TAKS objectives. Factor Four contributed 8.42% to the total variance explained. The fifth factor was named *Curriculum* due to high loadings in the following items: Curriculum writing in science and science curriculum writer. Factor Five contributed 8.17% to the total variance explained. The final factor was named *Non-Science Professional Organizations* due to high loadings with the item participated in a non-science professional teacher organization. Factor six contributed 5.43% to the total variance explained.

Results from the analysis were used to calculate individual teacher scores for participation in PD. Individual scores were calculated using the formula provided in Equation 3.2.

$$\begin{aligned}&OverallParticipation = (0.28*AssistClassMgmt + 0.36*MentorNew \\ &+ 0.30*ProvideSciLesson + 0.18*Model + 0.22*DevelopSciLesson \\ &+ 0.20*Observe + 0.18*FormalMentor + 0.24*Orient) \\ &+ (0.14*FormalRecruit + 0.08*Interview + 0.06*Application \\ &+ 0.07*InformalVisit) + (0.21*ParticpateSciOrg + 0.21*MemberSciOrg) \\ &+ (0.70*TEKS + 0.71*TAKS) + (0.24*CurrWriting + 0.12*SciCurrWriter) + \\ &0.15*ParticipateNonSciOrg\end{aligned} \tag{3.2}$$

where the numbers represent the mean participation rates for each activity and the variables relate to the activity included in the TPSST (e.g., *AssistClassMgmt* is the assist with classroom management activity). The total possible score for teachers' participation in PD based on principal component analysis was 4.65. The average teachers' participation in PD score was 1.75 with a minimum score of 0.00 and a maximum score of 4.43 obtained. Skewness provides an estimate for the symmetry of a distribution with a normal distribution having a skewness of zero. The skewness for the distribution of teachers' participation in PD scores was 0.25 indicating a nearly normal distribution. Kurtosis provides an estimate of the ratio of height of distribution to the width of the tails with a normal distribution having a kurtosis of zero. The kurtosis for the distribution of teachers' participation in PD scores was -0.73 indicating a non-normal distribution. The value for kurtosis can most likely be attributed to the large number of teachers not participating in any type of PD. Figure 3.3 provides the frequency distribution of scores obtained. Table 3.2 provides descriptive statistics for all schools' PD support scores and by school size and minority student enrollment proportion.

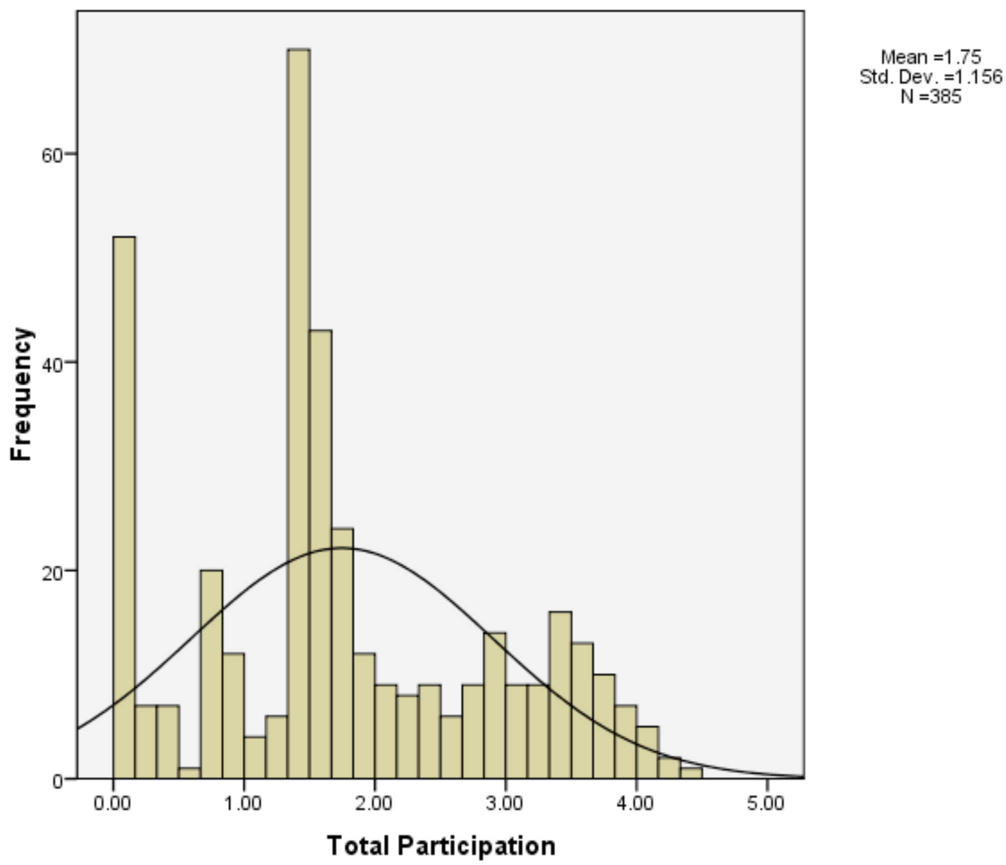

Fig. 3.3. Distribution of scores for teachers' participation in PD for all 385 teachers.

Table 3.2

Distribution of Scores[a] for Teachers' Participation in PD by School Size and Minority Student Enrollment Proportion (MSEP)

		School Size			MSEP	
	All (n=385)	Small (n=26)	Medium (n=87)	Large (n=272)	Low (n=180)	High (n=205)
Mean	1.75	1.17	1.72	1.81	1.74	1.75
Standard deviation	1.16	1.15	1.29	1.10	1.16	1.16
Standard error	0.06	0.23	0.14	0.07	0.09	0.08
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
25^{th} percentile	0.92	0.00	0.39	1.41	0.86	1.11
Median	1.61	1.06	1.56	1.62	1.62	1.56
75^{th} percentile	2.66	1.67	2.98	2.61	2.64	2.67
Maximum	4.43	4.14	4.43	4.31	4.43	4.31

[a] Total possible score was 4.65.

Examination of the descriptive statistics indicated a possible difference in teachers' participation in PD by both school size and MSEP. Therefore, with respect to school size, I conducted a post hoc comparison using the nonparametric Kruskal-Wallis test to determine if there were differences between the three school sizes. The Kruskal-Wallis test confirmed that there was a difference with regard to school size (χ^2=7.99, *p*=0.02). Consequently, I conducted three iterations of the post hoc comparison using the nonparametric Mann-Whitney *U* test to discern which school sizes were different from one another. The Mann-Whitney *U* test confirmed that teachers in medium and large schools participated in PD at similar rates (U=11201, *p*=0.452), while differences existed in teachers' participation between both medium and large schools with respect to small schools, respectively (U=862, *p*=0.07; U=2325, *p*=0.004).

With regard to differences between schools' MSEP status, I conducted a post hoc comparison using the nonparametric Mann-Whitney *U* test to determine if there were differences between the two groups. The Mann-Whitney *U* test confirmed that teachers in both low and high MSEP schools participated in PD at similar rates ($U=18131$, $p=0.77$).

I performed a cross tabs analysis to examine differences in teachers' participation in PD by teacher type (i.e., novice, mid-career, and veteran). Teacher types were determined for 370 of the 385 PRISE teacher participants. Table 3.3 provides the total number of teachers within each teacher type. The number and percentage of participating teachers within each type of PD is also presented. The likelihood ratio test provides a method for determining the significance of differences of means between groups (Scott & Knott, 1974). The likelihood ratio is obtained by comparing the means of each group to that of all groups. The magnitude of the ratio obtained indicates the relative separation of means between the groups (i.e., higher magnitude indicates significant differences between group means; Scott & Knott, 1974).

Table 3.3

Cross Tabs Analysis of Teachers' Participation in PD by Teacher Type

Factor		Novice[a] (n=96)	Mid-Career[b] (n=61)	Veteran[c] (n=213)	Likelihood Ratio (p-value)	Eta squared
Factor 1: Mentoring	n (%)	20 (21)	18 (30)	97 (46)	77.38 (0.07)	0.043
Factor 2: Recruitment	n (%)	8 (8)	9 (15)	36 (17)	14.61 (0.41)	0.011
Factor 3: Science Professional Organizations	n (%)	17 (18)	17 (28)	73 (34)	10.44 (0.03) *	0.024
Factor 4: Standards	n (%)	62 (65)	49 (80)	178 (84)	20.19 (0.003) *	0.044
Factor 5: Curriculum	n (%)	16 (17)	15 (25)	71 (33)	12.17 (0.06)	0.029
Factor 6: Non-Science Professional Organizations	n (%)	10 (10)	6 (10)	38 (18)	4.40 (0.11)	0.011
Overall Participation	n (%)	72 (75)	53 (87)	197 (92)	290.39 (0.35)	0.082

*indicates p<0.05

[a]Novice teachers are identified as being in their first three years in the teaching profession. [b]Mid-career teachers are identified as being in their fourth through seventh years in the teaching profession. [c]Veteran teachers are identified as being in the teaching profession for eight or more years.

Examination of descriptive statistics (i.e., frequency and percentage of participation) revealed that the higher rates of participation amongst veteran teachers' most likely accounted for observed differences in rates of teachers' participation in PD by identification of teacher types. Significant differences in participation were found for both *Science Professional Organizations* ($p<0.05$) and *Standards* ($p<0.05$). These types of PD were found to explain 2% and 4% of the variance, respectively, in differences of participation amongst teacher types. Lower levels of participation were found in *Recruitment* and *Non-Science Professional Organizations* PD related activities regardless of teacher type. Overall, differences between teacher types and their overall participation in PD were not statistically significant. However, 8% of the variance in overall teachers' participation in PD was explained by teacher type. This indicates that teachers' placement within the TPC is a variable of interest when considering who participates in PD and what types of PD they are attending.

Schools' Professional Development Support

A rubric was developed using constant comparison of administrator interviews to determine the range of PD support practices in use throughout the state of Texas (Stuessy, 2010b). As part of my dissertation work, the original rubric was revised to increase reliability and validity. During analysis, I examined both administrator and science program interviews (Stuessy & PRISE Research Group, 2007b; 2007c; see Appendix B and C, respectively) to identify all available PD supports for science teachers. Each practice contained within the revised schools' PD support rubric was weighted with the help of a panel of experts. I asked five experts to provide rankings of either very low (2), low (4), high (6), or very high (8) importance for each practice. I tallied expert responses for each of the practices. A final weight was assigned to each practice based on modal value assigned by all experts (see Table 3.4). In the case of a tie, the final weight assigned was determined by examining the weight assigned by the fifth rater (e.g., if ratings were 2, 2, 4, 4, 6 a final weight of 4 was assigned or 4, 6, 6, 8, 8 a final weight of 6 was assigned). The final weighted rubric appears in Figure 3.4.

Table 3.4

Individual Expert Weightings and Final Weightings of Schools' PD Support Rubric

Type of PD	TB	DB	MC	TH	CS	Final
Mentored classroom practice, observation, and reflection	8	8	8	8	8	8
General whole campus	2	4	6	2	4	4
Non-science specific training participation	4	2	4	4	2	4
Science-related training participation	8	4	4	8	8	8
Science conference	6	6	6	8	6	6
Unspecified graduate university classes	2	2	4	6	4	4
Graduate university science-related classes	6	8	6	6	6	6
Trainers						
School administrators	4	2	2	2	2	2
School non-science teacher	2	2	2	4	4	2
School science teachers	8	6	6	8	8	8
Outside non-science experts	4	4	2	4	4	4
Outside experts in science education	8	8	8	8	8	8
Scientists	6	4	6	6	8	6
Collaborative partners	4	8	4	6	4	4
Topics						
Science specific content or pedagogy	8	8	8	8	8	8
Science TAKS prep	4	8	4	4	4	4
Use and application of technology	6	6	4	6	6	6
General topics non-science related	2	4	2	4	2	2
Location						
School/campus site	6	8	8	8	8	8
Educational Service Center	4	4	6	4	4	4
Non-campus site	4	6	6	6	4	6
Selection						
Self-selected	8	6	8	6	8	8
Nominated	4	4	6	6	6	6
Administrator-mediated	6	2	4	6	4	4
Science dept.-mediated	8	8	4	8	6	8
Mandatory	6	6	2	6	2	6

Table 3.4 continued

Timing	TB	DB	MC	TH	CS	Final
During instructional time	4	6	4	4	6	4
Summer	8	4	6	4	6	6
Summer with school-year follow-ups	8	8	8	6	8	8
Late start/early release/after school	8	6	6	6	4	6
Regularly-scheduled school-year	8	8	6	8	4	8
Financial Comp						
Non-specified money provided for PD	6	2	4	6	4	4
Travel reimbursement	6	8	6	6	8	6
Registration paid	6	8	6	8	8	8
Stipend for PD	6	6	6	8	6	6
Stipend for possessing advanced Degree	8	8	6	8	8	8
Money to obtain graduate tuition	2	6	6	8	8	6
Compensation for state or national certification	8	8	8	6	8	8
Other Comp						
Substitutes provided	8	8	4	6	8	8
Comp days	8	6	6	8	4	6
School generated grant money for teacher PD	8	6	4	6	6	6
Documentation						
Yes	8	8	6	6	6	6
No	2	2	2	2	2	2

Type of PD							Trainers							Topics				Location		
Mentored classroom practice, observation, and reflection	General whole campus (e.g., school year preparation, campus improvement plan)	Non-science specific training participation	Science-related training participation	Science conference	Unspecified graduate university classes	Graduate university science-related classes	School administrators	School non-science teacher	School science teachers	Outside non-science experts (e.g., technology specialist, consultant)	Outside experts in science education	Scientists	Collaborative partners (e.g., consortia, training-for-profit groups, ESCs)	Science specific content or pedagogy	Science TAKS prep	Use and application of technology	General topics non-science related	School/campus site	Educational Service Center	Non-campus site (e.g., district or university)
8	4	4	8	6	4	6	2	2	8	4	8	6	4	8	4	6	2	8	4	6

Selection					Timing					Financial Comp							Other Comp			Documen-tation	
Self-selected	Nominated	Administrator-encouraged (e.g., dissemination of opportunities, suggested participation)	Science dept.- encouraged (e.g., dissemination of opportunities, suggested participation)	Mandatory (e.g., required hours on a topic)	During instructional time	Summer	Summer with school-year follow-ups	Late start/early release/after school	Regularly-scheduled school-year (e.g., weekly, monthly)	Non-specified money provided for PD	Travel reimbursement	Registration paid	Stipend for PD	Stipend for possessing adv. degree	Money to obtain graduate credit	Compensation for state or national certification	Substitutes provided	Comp days (e.g., teacher attend PD at different time get school PD day off)	School generated grant money for teacher PD	Yes (e.g., school logs, PD certificate filing)	No
8	6	4	8	6	4	6	8	6	8	4	6	8	6	8	6	8	8	6	6	6	2

Fig. 3.4. Schools' PD support rubric with final assigned weights.

Inter-rater reliability for the rubric for schools' PD support ranged from 76 to 100 %. After discussion of differences and clarification of practices, raters were in 100% agreement. A Cronbach's Alpha value of 0.73 was achieved during reliability analysis of the survey, thus supporting claims of internal instrument reliability.

An exploratory factor analysis was used to understand how various PD support practices cluster to determine factors that are most likely to explain practices that influence PD support. Nine practices were removed from the analysis due to low levels ($n<5$) of occurrence in schools (see Table 3.5). Principal axis factoring was used in this analysis to partition shared variance from both unique and error variance associated with practices used by schools to provide PD support. The solution from principal axis factoring contains only unique variance that reveals the underlying structure associated with PD support practices (Costello & Osborne, 2005). An oblique rotation was used to confirm that factors were uncorrelated. Therefore, an orthogonal rotation, Varimax with Kaiser Normalization, was used to maximize separation between factors by not accounting for correlation between factors. The initial factor analysis examined 43 activities that clustered into 3 factors that explained 21.04% of the variance. An additional iteration of the factor analysis was conducted excluding activities that possessed an extraction value less than 0.4 indicating unfavorable factorability with other activities (i.e., outside non-science experts and science TAKS prep). The final factor analysis resulted in 6 factors containing 32 activities that explained 42.37% of the variance. The KMO Measure of Sampling Adequacy (0.38) indicated that clustering of practices contained within each factors may not be adequate. However, Bartlett's Test of

Sphericity was statistically significant indicating that the factors were independent of one another (χ^2=735.18, df=496, p<0.0001). This 6 factor solution was chosen due to the 'leveling off" of the Eigenvalues on the Scree plot (see Figure 3.5). For a description of the 6 factors and activities contained within each factor see Table 3.6.

Table 3.5

Practices Removed from Factor Analysis Due to Low Frequency (n≤5) of Occurrence

Category in Rubric	Practices Removed	Frequency
Type of PD	Unspecified graduate university classes	3
	Graduate university science-related classes	2
Trainers	Scientists	3
Selection	Nominated	2
Timing	Summer with school-year follow-ups	1
Financial Comp	Stipend for possessing advanced degree	2
	Money to obtain graduate credit	3
	Compensation for state or national certification	4
Documentation	No	4

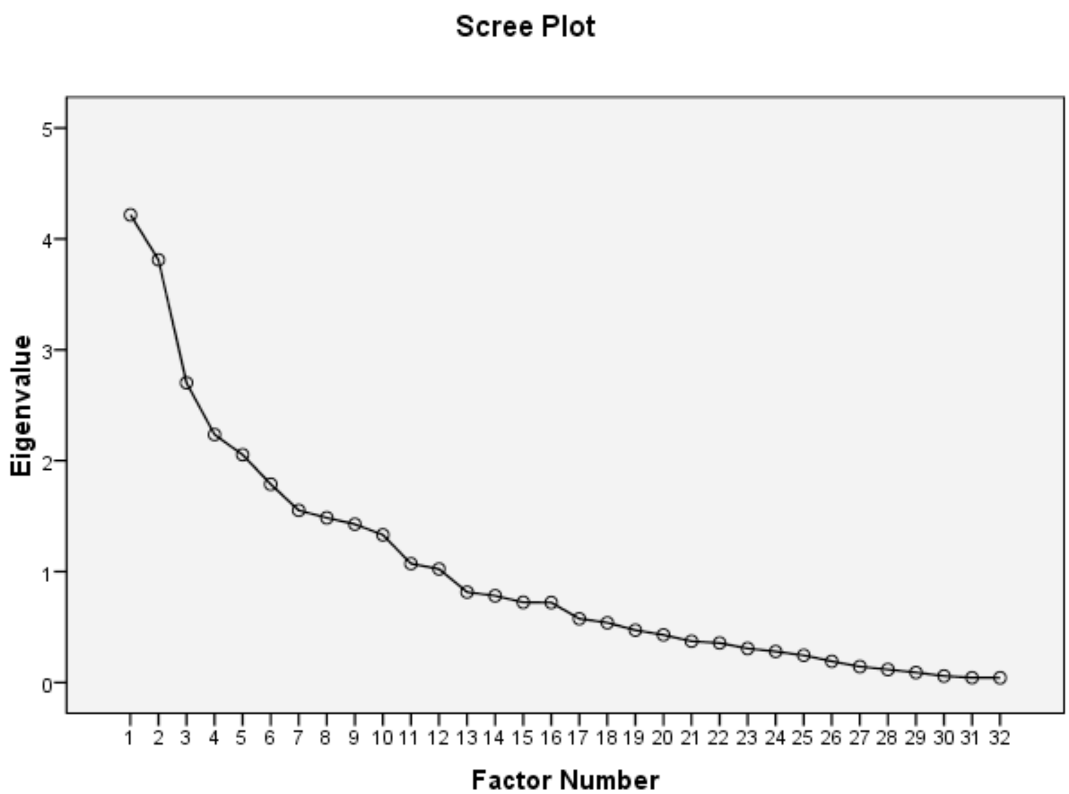

Fig. 3.5. Scree plot of schools' PD support rubric indicating "leveling off" of Eigenvalues after 6 factors.

Table 3.6

Factor Analysis Table for Schools' PD Support

	Loadings					
	Factor 1: Partnerships & PCK	Factor 2: School Commitment to Science PD	Factor 3: Ease & Practicality	Factor 4: Structured PD Support for All Teachers	Factor 5: School-based Non-science PD	Factor 6: School & Teacher Synergy
Collaborative partners	.728	-.405	-.040	-.263	-.119	.129
Mentored classroom practice, observation, and reflection	.719	-.124	-.092	.209	-.068	.129
Science-related training participation	.639	.273	.257	-.262	-.194	-.076
School science teachers	.558	.125	-.093	.339	.099	.051
Non-science specific training participation	.540	-.120	.034	-.218	.361	.103
Educational Service Center	.518	-.417	.032	-.161	-.079	.009
Science conference	.510	.430	-.084	.101	.150	-.102
Outside experts in science education	.488	.343	.005	-.099	.058	-.088
School administrators	.031	.608	-.326	-.261	-.072	.335
Late start/early release/after school	-.064	.525	.062	.180	.191	-.004
Science specific content or pedagogy	.017	.518	.411	.044	-.142	-.014
Non-campus site	.039	.498	.249	.314	.150	.076
Mandatory	.000	.431	-.149	.072	.215	-.235
Non-specified money provided for PD	.022	.293	.005	.019	.101	.035

Table 3.6 continued

	Loadings					
	Factor 1: Partnerships & PCK	Factor 2: School Commitment to Science PD	Factor 3: Ease & Practicality	Factor 4: Structured PD Support for All Teachers	Factor 5: School-based Non-science PD	Factor 6: School & Teacher Synergy
Comp days	-.032	-.020	.644	.179	-.031	.043
Summer	-.132	.331	.563	-.068	-.246	.181
Substitutes provided	-.030	-.045	.534	.076	.162	.055
Use and application of technology	-.089	.242	.521	.060	.501	.243
Administrator-encouraged	.150	-.254	.429	-.243	.066	-.174
During instructional time	-.127	.027	.396	.385	.039	-.016
Travel reimbursement	.103	.040	.328	-.200	-.010	.240
School generated grant money for teacher PD	.193	-.003	.327	.276	.255	-.161
Documentation	.221	.210	.122	.519	-.021	.143
Stipend for PD	-.238	.043	-.012	.497	-.156	-.098
Regularly-scheduled school-year	.012	.170	.019	.429	.291	-.030
School non-science teachers	.223	.040	-.091	.063	.641	.037
General topics non-science related	-.161	.174	.242	-.145	.519	-.109
School/campus site	-.050	.152	.024	.023	.373	-.015

Table 3.6 continued

	Loadings					
	Factor 1: Partnerships & PCK	Factor 2: School Commitment to Science PD	Factor 3: Ease & Practicality	Factor 4: Structured PD Support for All Teachers	Factor 5: School-based Non-science PD	Factor 6: School & Teacher Synergy
Registration paid	.072	.286	.179	-.012	.126	.651
Self-selected	-.032	-.053	.125	.257	-.061	.487
Science department-encouraged	-.038	.287	.087	.179	.092	-.463
General whole campus	.262	.123	-.084	-.291	.254	.339
Eigenvalues	3.21	2.74	2.45	1.87	1.80	1.49
% of Total Variance	10.02	8.57	7.64	5.86	5.63	4.66
Total Variance	10.02	18.59	26.23	32.08	37.71	42.37

The first factor was named *Partnerships & PCK* due to the high loadings on the following items: use of collaborative partners as trainers, mentored classroom practice, observation and reflection, science-related training participation, school science teachers as trainers, non-science specific training participation, use of state-supported Educational Service Centers, science conference attendance, and outside experts in science education as trainers. Factor One explained 10.02% of the variance in PD support practices. The second factor was named *School Commitment to Science PD* due to high loadings on the following items: school administrators as trainers, timing done as late start/early release/after school, topics related to science specific content or pedagogy, non-campus sites, and non-specified money provided for PD. Factor Two explained 8.57% of the variance. The third factor was named *Ease & Practicality* due to high loadings on the following items: providing teachers with comp days, timing done as summer, substitutes provided, topics related to use and application of technology, administrator-encouraged participation, PD occurring during instructional time, travel reimbursement, and school generated grant money for teacher PD. Factor Three explained 7.64% of the variance. The fourth factor was named *Structured PD Support for All Teachers* due to high loadings on the following items: documentation of PD, stipend for PD, and regularly scheduled school-year PD. Factor Four explained 5.86% of the variance. The fifth factor was named *School-based Non-science PD* due to high loadings on the following items: school non-science teachers as trainers, general topics non-science related, and school/campus site. Factor Five explained 5.63% of the variance. The final factor was named *School & Teacher Synergy* due to high loadings on the following items:

registration paid, self-selected, science department-encouraged and general whole campus trainings. Factor Six explained 4.66% of the variance.

Using the results from the factor analysis, a total PD support score was calculated for each school dependent on their participation in each of the activities included within the factor analysis. The following formula (see Equation 3.3) was used to calculate each school's PD support score:

$$\begin{aligned} \textit{Total Support} = {} & (\textit{CollPart} + \textit{MentClass} + \textit{SciTrain} + \textit{SchSciTchr} + \\ & \textit{NonSciTrain} + \textit{ESC} + \textit{SciConf} + \textit{OutExpSciEd}) + \\ & (\textit{SchAd} + \textit{LateStart} + \textit{SciContPed} + \textit{NonCampus} + \textit{Mandatory} + \\ & \textit{NonSpecificMoney}) + (\textit{CompDay} + \textit{Summer} + \textit{Sub} + \textit{UseAppTech} + \\ & \textit{AdminEncourage} + \textit{InstTime} + \textit{Travel} + \textit{SchGrantMoney}) + \\ & (\textit{Doc} + \textit{Stipend} + \textit{RegScheduled}) + \\ & (\textit{SchNonSciTchr} + \textit{GeneralTopics} + \textit{SchSite}) + \\ & (\textit{RegPaid} + \textit{SelfSelected} + \textit{SciDeptEncourage} + \textit{GeneralCampus}) \end{aligned} \tag{3.3}$$

where variables relate to the practice included in the rubric (e.g., *CollPart* is the collaborative partners practice). The total possible score for schools' PD support based on exploratory factor analysis was 188. The average PD support score was 89.92 with a minimum score of 42 and a maximum score of 156 obtained. Skewness provides an estimate for the symmetry of a distribution with a normal distribution having a skewness of zero. The skewness for the distribution of schools' PD support scores was 0.27 indicating a nearly normal distribution. Kurtosis provides an estimate of the ratio of height of distribution to the width of the tails with a normal distribution having a kurtosis of zero. The kurtosis for the distribution of schools' PD support scores was -0.51 indicating a nearly normal distribution. Figure 3.6 provides the frequency distribution of scores obtained. The higher kurtosis value can most likely be attributed to the mode being several points lower than both the median and mean. Table 3.7 provides descriptive statistics for all schools' PD support scores and by school size and minority student enrollment proportion.

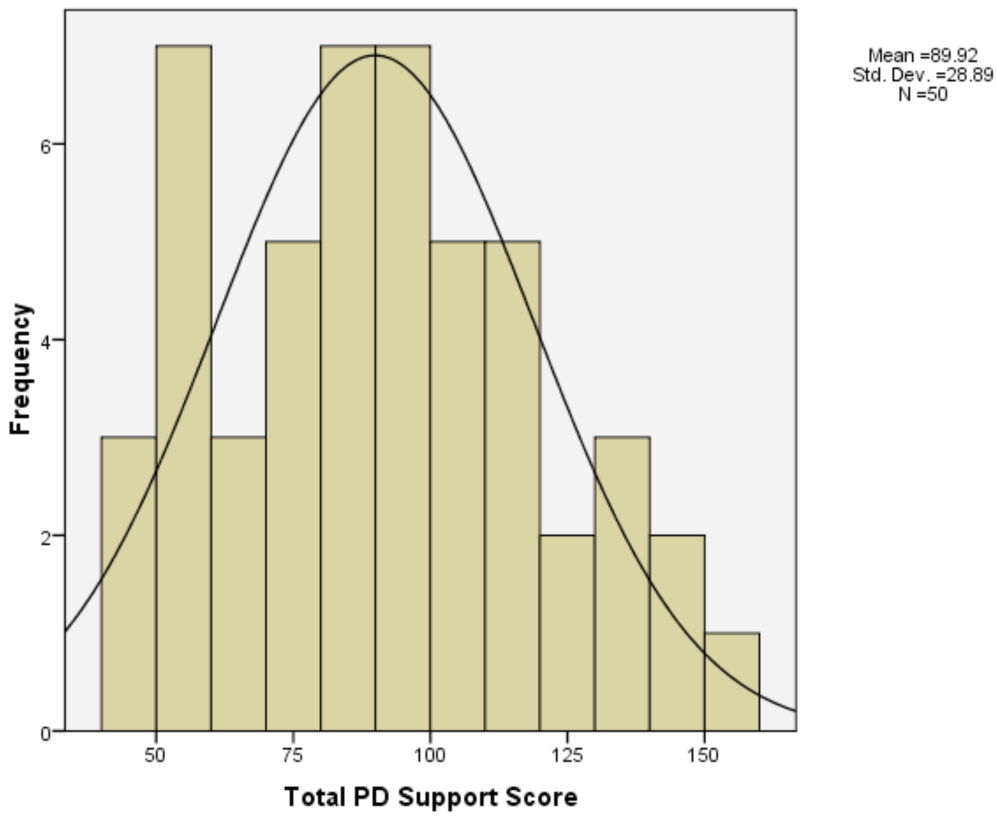

Fig. 3.6. Distribution of PD support scores for all 50 schools.

Table 3.7

Distribution of Schools' PD Support Scores[a] by School Size and Minority Student Enrollment Proportion (MSEP)

		School Size			MSEP	
	All (n=50)	Small (n=15)	Medium (n=18)	Large (n=18)	Low (n=29)	High (n=21)
Mean	89.92	74.53	95.76	97.22	95.72	81.90
Standard deviation	28.89	20.98	31.54	28.42	30.24	25.46
Standard error	4.09	5.42	7.65	6.70	5.62	5.56
Minimum	42.00	42.00	52.00	52.00	42	44
25th percentile	67.50	58.00	61.00	76.50	75.00	58.00
Median	89.00	78.00	102.00	94.00	94.00	82.00
75th percentile	110.00	90.00	125.00	114.00	114.00	97.00
Maximum	156.00	110.00	142.00	156.00	156.00	136.00

[a] Total possible score was 188.

Examination of the descriptive statistics indicated a difference in schools' PD support scores by both school size and MSEP. Therefore, with respect to school size, I conducted a post hoc comparison using the nonparametric Kruskal-Wallis test to reveal statistically signficant differences between the three school sizes. The Kruskal-Wallis test confirmed that there was a difference with regard to school size (χ^2=6.00, p=0.05). Consequently, I conducted three iterations of the post hoc comparison using the nonparametric Mann-Whitney *U* test to discern which school sizes were different from one another. The Mann-Whitney *U* test confirmed that large and medium schools provided similar supports (U=152, p=0.987), while there were significant differences between both large and medium schools with respect to small schools, respectively (U=72, p=0.02; U=75, p=0.05).

With regard to differences between schools' MSEP status, I conducted a post hoc comparison using the nonparametric Mann-Whitney *U* test to determine if there were differences between the two groups. The Mann-Whitney *U* test confirmed that there was a no difference between the supports provided by low and high MSEP schools (U=217, *p*=0.09).

Relationships between Teachers' Participation and Schools' Support

I calculated correlations between teachers' participation in professional activities and schools' PD support to determine possible relationships between them. Little correlation was found between teachers' overall participation and schools' total PD support (r=0.086, *p*=0.09). Therefore, school size was used as a sorting variable to see if differences would be found. Results from correlations between teachers' participation and schools' PD support by school size can be found in Table 3.8.

Table 3.8

Correlations between Teachers' Overall Participation and Schools' Total PD Support by School Size

	Small Schools (n=15)	Medium Schools (n=17)	Large Schools (n=18)
	Total Support	Total Support	Total Support
Overall Participation			
Pearson Correlation (r)	0.227	0.128	0.022
p-value	0.265	0.237	0.714
n	26	87	272

No significant differences were found between teachers' overall participation and schools' total PD support. However, in small and medium schools the relationship between schools' PD support and teachers' participation in PD explained 5% and 2% of the variance, respectively.

Relationships with Schools' Science Teacher Retention Rates

Teacher retention was determined by using a combination of schools' master schedules and the PEIMS database. Retention rates were calculated for each school depending on the number of teachers who remained at school to teach from the 2007-2008 school year to the 2008-2009 school year. Schools were identified as being high-retention schools if the retention rate was 76% or greater; conversely, low-retention schools were schools that retained less than 76% of their teachers. Using schools identified as either high- or low-retention, I performed a binary logistic regression to examine possible relationships with teachers' participation in PD and schools' PD support.

The binary logistic regression was performed using the "Enter" method, which uses all available data at the beginning of the analysis. Prior to running the logistic regression model, all schools were classified as low-retention schools with an accurate classification of 48%. Upon using the binary logistic regression, schools were classified as both high- and low-retention schools, 50% and 62.5%, respectively. The binary logistic regression had an overall 56% accurate classification of both high- and low-retention schools. A comparison of the -2 log likelihood using no model (69.24) and using model with predictors (64.68) indicated improvements in modeling the retention status of schools when teachers' participation and schools' PD support were included in the model. The contribution of average teachers' participation in PD had a larger impact (odds ratio, 2.3) on a school being high- or low-retention, whereas schools' PD support (odds ratio, 0.98) had little or no contribution to schools' retention status. Results for the binary logistic regression are presented in Table 3.9. Equation 3.4 provides the model obtained as a product of the binary logistic regression.

Table 3.9

Results from Binary Logistic Regression for Teachers' Participation and Schools' PD Support on Teacher Retention

						95% C.I.	
	B	S.E.	Wald	Sig.	Odds Ratio	Lower	Upper
Average Teachers' Participation in PD	0.83	0.50	2.46	0.10	2.3	0.87	6.12
Schools' Overall PD Support	-0.02	0.01	2.65	0.10	0.98	0.96	1.00
Constant	0.50	1.05	0.23	0.63	1.65		

$$\hat{y} = 0.50 + 0.83 * PDParticipation - 0.02 * PDSupport \qquad (3.4)$$

Relationships with Schools' Science Teacher Retention Rates and Scores for Students' Science Proficiencies and College Readiness

Scores for students' science proficiencies and college readiness (SPCR) were determined using the algorithm developed by PRISE researchers (see Equation 3.1). I used these scores, along with schools' science teacher retention rates, as dependent variables to examine relationships with average teachers' participation in PD and schools' PD support. A correlation with both dependent variables was calculated to ensure that they were not correlated with one another ($r=0.156$, $p=0.28$). Significant interactions between the overall model and schools' total PD support with SPCR were found. The overall multivariate general linear model accounted for 17% of the variance explained in SPCR and 2% of the variance explained with schools' science teacher retention rates. Schools' PD support contributed 8% to the variance explained with SPCR. The interaction of schools' support and average teachers' participation explained 2% of variance associated with SPCR, while participation by itself contributed 1% to variance explained. Results from the multivariate general linear model can be found in Table 3.10. The model generated from this analysis can be found in Figure 3.7.

Table 3.10

Multivariate Analysis for SPCR and Retention Rates by Teachers' Average Participation and Schools' Total PD Support

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	*p*-value	Partial Eta Squared
Corrected Model	SPCR	125.957[a]	3	41.986	3.052	.04	.17
	Retention Rate	.049[b]	3	.016	.273	.85	.02
Intercept	SPCR	20.634	1	20.634	1.500	.23	.03
	Retention Rate	.606	1	.606	10.082	.003	.18
Average Participation	SPCR	4.898	1	4.898	.356	.55	.01
	Retention Rate	.004	1	.004	.068	.80	.002
Total Support	SPCR	54.995	1	54.995	3.997	.05	.08
	Retention Rate	.004	1	.004	.073	.79	.002
Average Participation * Total Support	SPCR	10.777	1	10.777	.783	.38	.02
	Retention Rate	.000	1	.000	.002	.96	.0001
Error	SPCR	619.145	45	13.759			
	Retention Rate	2.706	45	.060			
Total	SPCR	7054.000	49				
	Retention Rate	30.493	49				
Corrected Total	SPCR	745.102	48				
	Retention Rate	2.755	48				

[a]R Squared = .169 (Adjusted R Squared = .114). [b]R Squared = .018 (Adjusted R Squared = -.048).

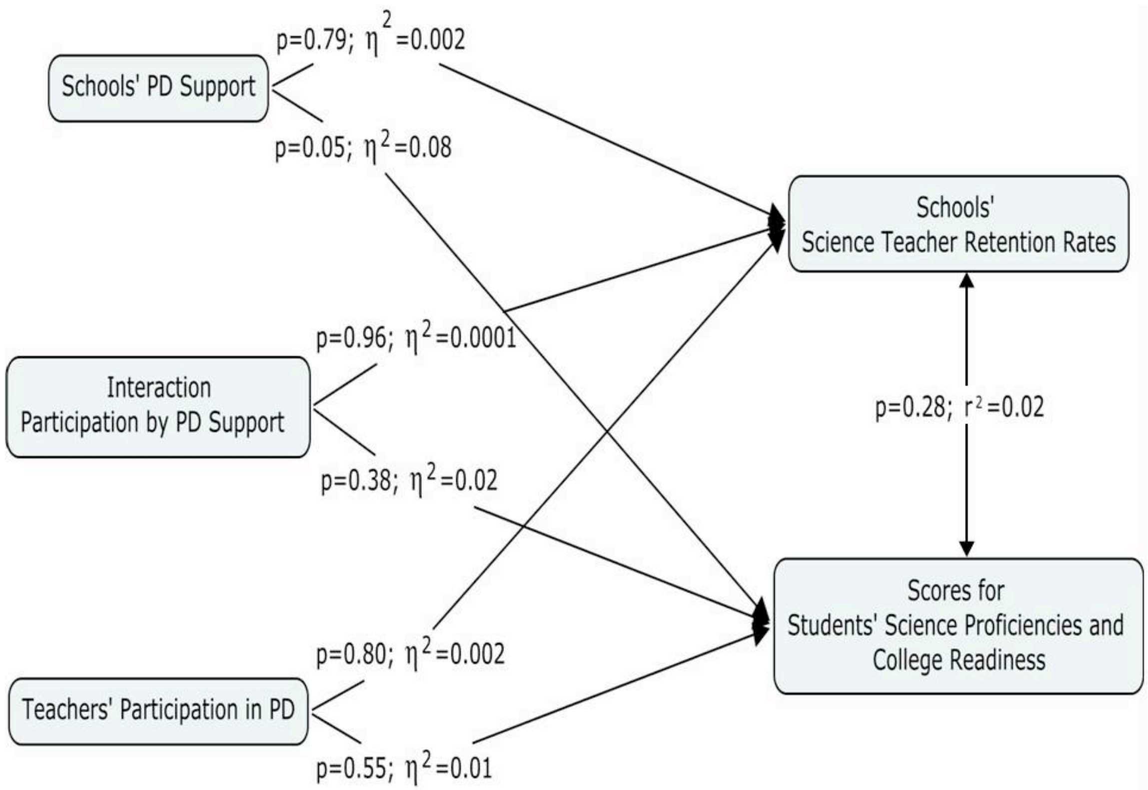

Fig. 3.7. Overall multivariate general linear model for schools' PD support and teachers' participation in PD and the interaction between participation and support with scores for students' science proficiencies and college readiness (SPCR; *p*-value=0.03, η^2=0.17) and schools' science teacher retention rates (*p*-value=0.85, η^2=0.02).

Discussion and Implications

This study contributes to what we know about teachers' participation in PD and schools' PD support in three ways. First, this study described the current state of teachers' participation in PD and schools' PD support. Second, trends within each of these variables were also investigated. Third, relationships with these variables and schools' science teacher retention rates and scores for students' science proficiencies and college readiness were also examined.

Teachers' Participation in Professional Development

With regard to teachers' participation in PD, I found that low numbers of Texas high school science teachers participate in a wide range of professional activities. A principal component analysis revealed that teachers most often participated in six distinct types of PD (i.e., *Mentoring, Recruitment, Science Professional Organizations, Standards, Curriculum,* and *Non-science Professional Organizations*). Comparisons to studies that examined Texas teacher participation in PD using data from the *Schools and Staffing Survey* (2000, 2004, and 2008) revealed that Texas high school science teachers participated in different types of PD when compared to their colleagues (Wei et al., 2010). Texas high school science teachers appeared to be more involved in PD focused on mentoring than their colleagues, but were less involved in PD focused on technology or teaching students with disabilities (Wei et al., 2010). Additionally, Texas high school science teachers seemed to be participating in the types of PD reported to increase both teacher retention and student achievement such as improving content knowledge and examinations of instructional practices used in the classroom (Bybee, 2010; Johnson et al., 2005, Kardos et al., 2001).

A cross tabs analysis was used to examine how teachers' participation in each type of PD and overall varied by teacher identification in the TPC (i.e., novice, mid-career, and veteran). Current research suggests that teachers should participate in a variety of types of PD throughout their career (Feiman-Nemser, 2001; Sato et al., 2010). This study revealed, however, that PD focused on standards seemed to be the most frequently attended PD regardless of teacher type. Additionally, it appeared that veteran teachers attended PD at higher frequencies and with more variety than their less experienced colleagues.

Schools' Professional Development Support

With regard to schools' PD support, I found that Texas high schools implemented varying levels of a variety of PD supports for science teachers. An exploratory factor analysis revealed that schools most often provided six distinct types of support (i.e., *Partnerships & PCK, School Commitment to Science PD, Ease & Practicality, Structured PD Supports for All Teachers, School-based Non-science PD,* and *School & Teacher Synergy*). These results are similar to other reports indicating that teachers should be involved in the selection, content, and presentation of PD, and/or receive financial support to attend PD (Darling-Hammond et al., 2009; Desimone et al., 2007). However, many other practices existed to support science teacher PD that Texas schools are currently not implementing at high frequencies: engagement in university classes, involvement of scientists in PD, financial support to obtain continuing education or certification, and providing follow-ups to PD. These are practices that have been shown to increase teachers' participation in PD and the quality of classroom practices (Darling-Hammond et al., 2009; Garet et al., 2001; Loucks-Horsley et al., 2003).

Relationships between Teachers' Participation and Schools' Support

I examined the relationships between teachers' participation in PD and schools' PD support using correlations. Overall, I found no relationship between teachers' participation in PD and schools' support. Therefore, I performed correlations separating schools by size. This revealed a stronger interaction between teachers' participation in PD and schools' PD support in small (r^2=0.05) and medium (r^2=0.02) schools versus large schools (r^2=0.0005). These numbers indicate that small and medium schools were able to better match supports for PD with teachers' participation. Teachers in large schools, however received lower levels of support matched to their participation in PD. The findings also indicate that levels of participation are largely determined by teachers' willingness to find PD on their own. Research results have consistently confirmed that "one size fits all" approaches do not establish dynamic PD programs within a school context (e.g., Darling-Hammond & Snyder, 2003; Johnson et al., 2005). The unique characteristics associated with schools of various sizes may be the driving force behind the differences in effect sizes calculated to describe relationships between teachers' participation in PD and schools' PD support within this study.

Relationships with Schools' Science Teacher Retention Rates

The relationships between teachers' participation in PD and schools' PD support with schools' science teacher retention rates were examined using binary logistic regression. The inclusion of teachers' participation in PD and schools' PD support as predictors for retention status of a school resulted in an 8% increase in the accurate classification of schools. According to the model, an increase in teachers' participation in PD will result in an increase in the retention status of the school. However, the 95% confidence interval (0.87-6.12) for this variable encompasses one. Therefore, I cannot make the claim that a significant and reliable impact exists on schools' retention status. Johnson and associates (2005) attributed this phenomenon to the positive influence that attending PD may have on teachers' attitude toward the profession and their school community. This idea is further supported when the professional activities within many of the types of PD are embedded within the school environment (e.g., observations, mentoring, modeling and planning lessons, recruitment of new teachers). I found that schools' PD support had little impact on schools' science teacher retention rates. Results indicated that there was a near zero effect between a schools' retention status and the levels of support for PD provided to the teachers. However, the coefficient determined for PD support and the 95% confidence interval (0.96-1.00) indicated that PD support may be negatively related to a schools' retention status. Since the confidence interval includes one, this may not indicate a reliable measure of this relationship. There is little research as to how schools' PD support can influence teachers' commitment to the school and the profession (Johnson et al., 2005). Therefore, these results provide a useful starting place for understanding "where we are" with regard to the relationship between teachers' participation in PD and schools' PD support.

Relationships with Schools' Science Teacher Retention Rates and Scores for Students' Science Proficiencies and College Readiness

I used multivariate general linear modeling to examine the relationships between teachers' participation in PD and schools' PD support with both schools' science teacher retention rates and scores for SPCR. The inclusion of teachers' participation in PD and schools' PD support as predictors for both schools' science teacher retention rates and scores SPCR did result in increased variance explained for both outcome variables. The largest effect was seen with schools' PD support on SPCR (η^2=0.08), indicating that schools supporting their teachers in PD also have higher levels of student achievement. These results support findings reported by Darling-Hammond and Snyder (2003) who stated that, "allocat[ing] greater resources to teaching, teacher learning…appear to create new potential for student learning gains" (p. 202). These results also corroborate the challenges in linking teachers' participation in PD to increases in student achievement (e.g., see Garet et al., 2001; Johnson et al., 2005).

Limitations

Results from the poll were found to be both valid and reliable. Teachers' participation in PD was determined based on self-reported data to a pre-determined list of professional activities, with an option of "other" for teachers to describe activities not provided on the list. Additionally, the survey did not provide a way to assess the "quality" of the professional activities these teachers may have experienced.

Schools' PD support was determined based on practices currently being used in Texas high schools. These practices may not be the "best" available supports to encourage and support teachers' participation in PD. However, results from the rubric were still found to be both valid and reliable.

One of the strengths of this study is based on the PRISE research design that enables findings to be generalizable to all Texas high schools and science teachers. However, results from the study may not be generalizable beyond the state of Texas. Instruments designed to collect and analyze data may be used in other contexts.

Implications

This research indicates that currently there is little if any match between teachers' participation in PD and schools' support for PD for Texas high school science teachers. The relationships in place do, however, seem to be associated with increases in scores for students' science proficiencies and college readiness, while not addressing changes in schools' science teacher retention rates. These findings imply that creating environments conducive to fostering increases in retention and student achievement is about more than just offering a variety of activities and supports. These findings suggest that a better match is needed between what teachers need and desire with regard to PD and what schools can provide to support those interests.

This study also revealed that there is a minimal relationship between participation and support for PD with teacher retention. This may be due to the fact that the decision to remain at or leave a school is largely a personal decision. Therefore, the inclusion of job satisfaction as a mediating variable in future studies may uncover more insightful relationships. Additionally, the majority of practices regarding teachers' participation in PD and schools' support for PD revealed in this study were related to increases in student achievement. If an increase in retention of science teachers is important, then perhaps different types of participation and support are necessary. However, since schools are held increasingly responsible for increasing student achievement, then this may be unlikely to change in the current accountability-driven system.

National and state policy documents that guide requirements associated with student achievement are also the driving force behind many schools' decisions regarding the implementation of various PD policies and practices. These documents highlight the importance of teachers' participation in a variety of types of PD and the importance of dynamic supports available within a school system. However, we have support for only a minimal correspondence between teachers' participation in PD and schools' PD support within the Texas public education system with these policy documents. My results indicate that Texas science teachers are involved in PD designed to foster content proficiency, standards-based instruction, and development of teacher leaders. However, I found minimal participation in PD aimed at increasing proficiencies associated with daily interactions in the classroom (e.g., meeting needs of diverse learners and integration of technology) or reform-based instruction and assessment. Schools throughout Texas seem to be providing a range of supports aligned with national and state policy documents. However, the full impact of these support practices is weakened considering the lack of a match between schools' PD support and teachers' participation in PD.

CHAPTER IV

OPERATIONALIZING SCHOOL SCIENCE PROFESSIONAL CULTURE: PATTERNS OF RELATIONSHIPS WITH SCIENCE TEACHER RETENTION AND STUDENT ACHIEVEMENT

The establishment of a strong, school science professional culture for science teachers at a school, which includes access and support for appropriate types of PD for science teachers, may be a primary means for addressing issues of teacher quality and retention (Cameron et al., 2007; Feiman-Nemser, 2001; Kardos et al., 2001; Kardos & Johnson; 2007). In this paper I will outline the development of a rubric to measure and compare school science professional cultures across high schools in a Texas. School science professional culture scores provide an opportunity for researchers to gain a sense of "where are we" in the creation of professional cultures for science teachers in Texas public high schools. Finally, I will examine relationships between school science professional culture with science teacher retention and student achievement.

Problem Statement

The development of a strong, school science professional culture may be an important mechanism for increasing student achievement and college readiness (Guarino et al., 2006; Johnson et al., 2005). Currently, little is known about the possible impacts of professional culture on student achievement. In this study, I operationalized school science professional culture in order to measure current state school science professional culture in Texas high schools.

Several authors have identified professional culture as one of the ways to improve teacher quality and retention (e.g., see Cameron et al., 2007; Johnson et al., 2005; Kardos et al., 2001; Kardos & Johnson; 2007). Professional cultures mitigated by teachers' placement with the teacher professional continuum (TPC) have varying degrees of influence on teachers' quality and retention (e.g., see Cameron et al., 2007; Feiman-Nemser, 2001; Kardos et al., 2001; Kardos & Johnson, 2007; Sato et al., 2010).

Literature Review

Three types of professional culture have been identified in schools (i.e., veteran-oriented, novice-oriented, and integrated; Kardos et al., 2001). Teachers who find themselves in integrated professional cultures report higher levels of support and meaningful interactions with colleagues regarding teaching, learning, and assessment (Kardos et al., 2001). Kardos and Johnson (2007) identified the following characteristics as being necessary for the establishment of a strong, integrated professional culture within a school:

(1) formal mentoring system,
(2) classroom observations with feedback,
(3) official and informal meetings among teachers,
(4) interaction among teachers of various levels of experience,
(5) special status granted to novice teachers,
(6) collective responsibility amongst all teachers regarding student expectations and success,
(7) professional development, and

(8) administrative support.

An integrated professional culture embracing the strengths and supporting interactions of teachers in all stages of the TPC enable positive impacts on the school environment (Kardos & Johnson, 2007). Positive impacts include increased teacher retention and student achievement (Feiman-Nemser, 2003; Kardos & Johnson, 2007; Sato et al., 2010).

Characteristics of strong, supportive professional cultures have been linked to increases in student achievement (e.g., see Guarino et al., 2006; Johnson et al., 2005; Joyce & Showers, 2002; Maloney et al., 2009). However, little is known regarding the impacts of professional culture on students' science achievement and college readiness.

I developed a conceptual model to define and measure the school science professional cultures experienced by Texas high school science teachers. The model consists of four components (i.e., school, program, teachers, and distribution of science teachers) with varying numbers of elements used to describe the components (see Figure 4.1). A panel of experts was used to determine organization and relative weighting of components and elements within the model. All experts agreed that each component was of equal weight. Experts also agreed that relative weighting of the elements within each component should contribute equally.

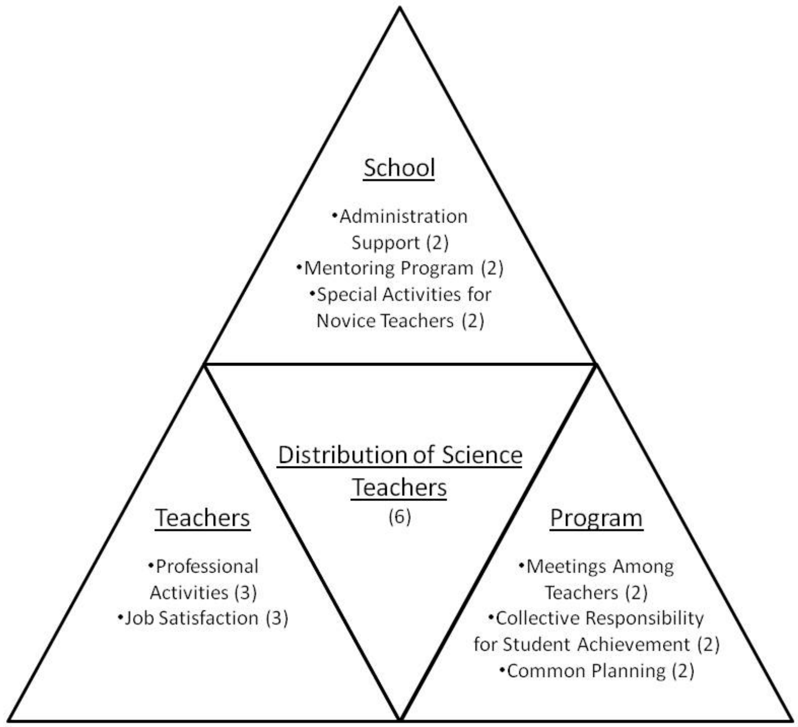

Fig. 4.1. Conceptual model identifying four components and elements within them, used to operationalize school science professional culture. Relative weighting of elements is indicated in parenthesis.

The purpose of this paper is to operationalize school science professional culture and identify patters of relationship with both science teacher retention and student achievement. The following research questions were used to guide the research:

(1) What characteristics describe the school science professional cultures experienced by Texas high school science teachers?

(2) What relationships exist between elements of the school science professional culture rubric and schools with high versus low rates of science teacher retention?

(3) What relationships exist between elements of the school science professional culture rubric and schools with high versus low scores for students' science proficiencies and college readiness?

(4) What are the associations among elements contained within the school science professional culture rubric and their associations with schools' science teacher retention rates and scores for students' science proficiencies and college readiness?

Methods

Context of Study

The Policy Research Initiative in Science Education (PRISE) is a five-year project designed to investigate various aspects of the teacher professional continuum for Texas high school science teachers. The project aims to answer three questions: (1) Where are we? (2) Where do we want to go? and (3) How do we get there? The project uses both qualitative and quantitative data to examine current policies and practices regarding the recruitment, induction, renewal, and retention of Texas high school science teachers (Stuessy, 2009).

PRISE Participants

A two-stage stratified random sampling plan was designed to select 50 representative schools from the 1,333 Texas public high schools that offer science (Stuessy et al., 2008). Schools were selected for participation based on school size and minority student enrollment proportion (MSEP). Schools were identified as small (n=15; student enrollment ≤ 189), medium (n=17; student enrollment ≥ 190 and ≤899), or large (n=18; student enrollment ≥ 900) based on total high school student enrollment. Schools' MSEP was divided into four categories based on state-established proportions: *lowest* (n=21; < 35% minority student enrollment), *low* (n=8; 36%-49% minority student enrollment), *high* (n=9; 50%-74% minority student enrollment), and *highest* (n=12; > 75% minority student enrollment). For purposes of this study, lowest and low MSEP schools were combined to represent schools of low minority status (i.e., <50% minority student enrollment); whereas high and highest were combined to represent schools of high minority status (i.e., ≥50% minority student enrollment). Additionally, geographic location of schools was used to ensure random sampling throughout the state. Schools choosing not to participate were replaced with schools of the same characteristics (n=11). The stratified random sample including replacement schools enables the results of PRISE research to be generalizable to all high schools (n=1,333) in the state of Texas (see McNamara & Bozeman, 2007 for a detailed description of the sampling plan).

PRISE Data Collection

A variety of types of information were gathered from individuals within each participating school. Administrative (n=50) and science liaison (n=50) representatives were identified at each school to provide in-depth semi-structured interviews regarding policies and practices associated with each phase of the TPC. All interviews were audio recorded and transcribed, unless participants did not grant permission to do so. For the administrators (n=5) and science liaisons (n=8) who did not grant permission to be audio recorded, field notes were used as primary data sources. Additionally, all teachers (n=385) who provided instruction for at least one science class were asked to complete the Texas Poll of Secondary Science Teachers (TPSST; Stuessy & PRISE Research Group, 2007a; see Appendix A); 89.2% of the teachers at participating schools returned completed surveys (Bozeman & Stuessy, 2009). A Cronbach's Alpha value of 0.86 was achieved during reliability analysis of the survey, thus supporting claims of internal reliability of the instrument.

The Public Education Information Management System (PEIMS) is maintained by the TEA to organize and disseminate information regarding various characteristics of Texas teachers (TEA, 2011b). PEIMS was used to determine the number of years a teacher has been practicing in the Texas public education system and to identify teachers who have changed schools but stayed in the profession. Master schedules were obtained from both the 2007-2008 and 2008-2009 school years to identify science teachers. Examination of the master schedule in conjunction with PEIMS data enables PRISE researchers to track teachers who have "stayed" at their school, "moved" from one school to another within the Texas public school system, or "left" the profession.

Members of the PRISE research team also developed an algorithm to measure and compare students' science proficiencies and college readiness (SPCR) throughout the state of Texas (Stuessy, 2010a). SPCR was measured using the student aggregate science score (SASS) algorithm. Variables included in the SASS algorithm include percentage of 10th grade students passing state administered science test (TAKS), percentage of students taking college entrance examines (CEET), percentage of students passing college entrance examines at or above criterion (PEET), percentage of students completing advance placement (AP) or dual credit course (APDE), and the school's state accountability rating (SR; TEA, 2011a; see Equation 4.1).

$$SASS = [(1.5 \bullet TAKS - 0.5) + CEET + PEET + APDE + SR]\text{; where} \qquad (4.1)$$

TAKS = school's aggregate 10th grade TAKS

CEET = school's aggregate participation rate for college entrance examinations

PEET = school's aggregate passing rate for college entrance examinations

APDE= school's aggregate participation rate in AP or dual credit courses

SR= school's state accountability rating (Ivey et al., 2009).

Research Design

I used an exploratory mixed methods approach propose to investigate the patterns and impact of school science professional culture on science teacher retention and students' science proficiencies and college readiness (Creswell & Clark, 2011). A diagram of the mixed methods approach appears as Figure 4.2. Table 4.1 provides a description of data sources and type associated with each variable identified in the exploratory mixed methods diagram.

Analysis and Results

All analyses performed in this study used SPSS 16.0 for Windows.

School Science Professional Culture Rubric

The rubric to operationalize school science professional culture appears as Figure 4.3. Table 4.2 describes how each component, element, and indicator of the model corresponds to established definitions of professional culture. Each of the schools was scored using the weighted school science professional culture rubric. A Cronbach's Alpha value of 0.52 was achieved during reliability analysis of the rubric indicating low levels of internal reliability.

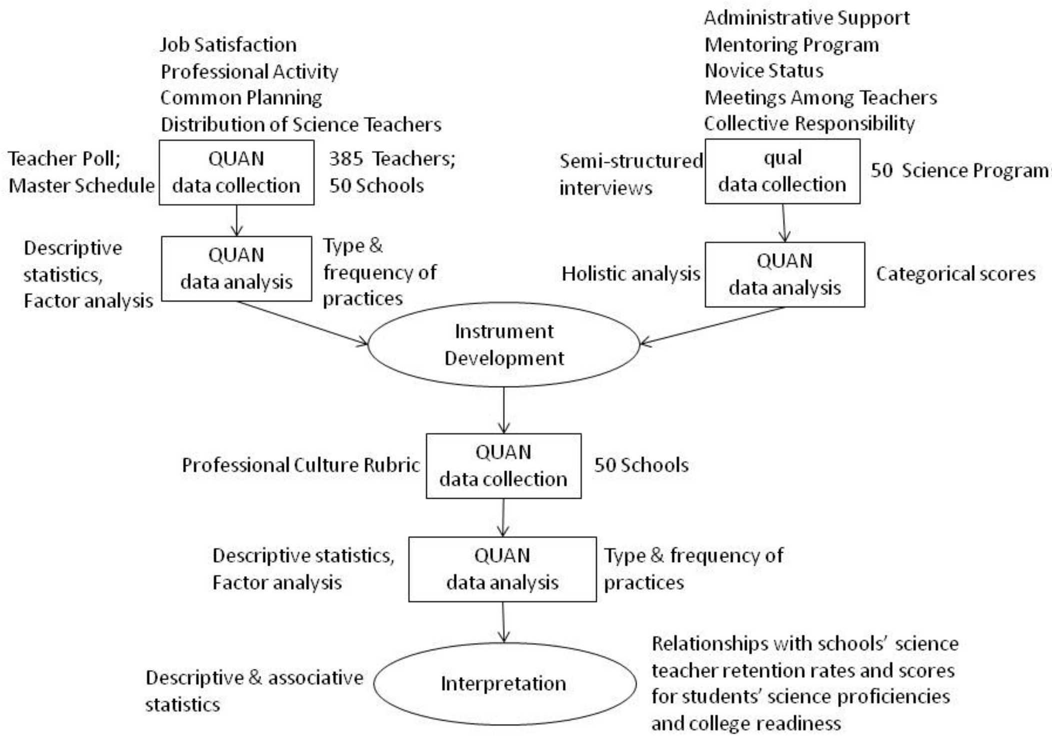

Fig. 4.2. Schematic representation of exploratory mixed methods research design.

Table 4.1

List and Description of Variables with Associated Data Sources and Data Types Included in the School Science Professional Culture Rubric

Variable	Data Source	Data Type
Job Satisfaction	Texas Poll Secondary Science Teachers (TPSST) (Stuessy & PRISE Research Group, 2007a; see Appendix A)	Categorical
Professional Activity	TPSST (Stuessy & PRISE Research Group, 2007a; see Appendix A)	Categorical
Common Planning	School Master Schedule (see Appendix D for example)	Categorical
Distribution of Science Teachers	Public Education Information Management System (PEIMS)	Categorical
Administrative Support	Schools' PD Support Rubric (Ruebush, 2012) Induction Rubric (Ivey, 2009; see Appendix E)	Categorical
Mentoring Program	Induction Rubric (Ivey, 2009; see Appendix E)	Categorical
Novice Status	Induction Rubric (Ivey, 2009; see Appendix E)	Categorical
Meetings Among Teachers	Science Program Interview (Stuessy & PRISE Research Group, 2007c; see Appendix C)	Interview
Collective Responsibility	Science Program Interview (Stuessy & PRISE Research Group, 2007c; see Appendix C)	Interview

<table>
<tr><th colspan="5">Professional Culture Components (Source)</th></tr>
<tr><td>Professional Culture Elements</td><td colspan="4">Explanation of Professional Culture Indicators</td></tr>
<tr><th colspan="5">School Support Characteristics (Administration Interviews)</th></tr>
<tr><td rowspan="2">Administrative Support</td><td colspan="4">Total score from factor analysis of Schools' PD Support Rubric</td></tr>
<tr><td colspan="4">Score from Campus Administrator's Direct Involvement subscale Induction</td></tr>
<tr><td rowspan="3">Mentoring Program</td><td colspan="4">Score from Mentoring Actors subscale Induction</td></tr>
<tr><td colspan="4">Score from Components for Mentor subscale Induction</td></tr>
<tr><td colspan="4">Score from Mentor Selection subscale Induction</td></tr>
<tr><td rowspan="2">Special Activities for Novice Teachers</td><td colspan="4">Score from Mentoring Activities subscale Induction</td></tr>
<tr><td colspan="4">Score from Induction Activities subscale Induction</td></tr>
<tr><th colspan="5">Teacher Characteristics (TPSST)</th></tr>
<tr><td>Job Satisfaction</td><td colspan="4">Average Teacher Job Satisfaction</td></tr>
<tr><td>Professional Activity</td><td colspan="4">Average Teachers' Professional Activity
using mean-weighted score from factor analysis</td></tr>
<tr><th colspan="5">Science Program Characteristics (Science Program Interview)</th></tr>
<tr><td rowspan="4">Meetings Among Teachers</td><td colspan="4">No/low communication expressed between teachers (1)</td></tr>
<tr><td colspan="4">Scarce communication between teachers focused on teaching and learning, primary focus is on administrative duties (2)</td></tr>
<tr><td colspan="4">Infrequent communication between teachers focused on teaching and learning (3)</td></tr>
<tr><td colspan="4">Frequent formal and informal communication between teachers focused on teaching and learning (4)</td></tr>
<tr><td rowspan="4">Collective Responsibility for Student Achievement</td><td colspan="4">Haphazard, random attempts for collective responsibility for student achievement (1)</td></tr>
<tr><td colspan="4">Has some characteristics of the ideal (2)</td></tr>
<tr><td colspan="4">Approaches the ideal (3)</td></tr>
<tr><td colspan="4">Ideal; All teachers actively engaged in the effort to support all students in a coordinated, whole school or whole program effort organized by frequent meetings throughout the school year (4)</td></tr>
<tr><td>Common Planning</td><td>No common planning or only 1 teacher at school (1)</td><td>Small schools meet as department (2)</td><td>Med/Large schools meet by content (3)</td><td>Med/Large schools meet by department (4)</td></tr>
<tr><th colspan="5">Distribution of Teachers (PEIMS)</th></tr>
<tr><td>Distribution of Teachers</td><td>Predominantly 1 type (>67%) or mixed mid-career and veteran (1)</td><td>Mixed with novice and veteran (2)</td><td>Mixed with novice and mid-career (3)</td><td>Mixed w/3 types (4)</td></tr>
</table>

Fig. 4.3. School science professional culture rubric. Scores for elements not previously measured provided in parentheses.

Table 4.2

Correspondence of Established Characteristics Regarding Professional Culture and Proposed School Science Professional Culture Model

Corresponding Model Component	Corresponding Model Element	Corresponding Model Indicator(s)
Literature Characteristic (Kardos & Johnson, 2007)		
Formal mentoring system		
School	Mentoring Program	Mentoring Actors Components for Mentor Mentor Selection
Classroom observations with feedback		
Not included in rubric; Integrated into TPSTT and various rubric scores		
Official and informal meetings among teachers		
Program	Meetings Among Teachers	Holistic score
Program	Common Planning	Master Schedule
Interaction among teachers of various levels of experience		
Distribution of Teachers	Distribution of Teachers	Distributions of Teachers
Special status granted to novice teachers		
School	Special Activities for Novice Teachers	Mentoring Activities Induction Activities
Collective responsibility amongst all teachers regarding student expectations and success		
Program	Collective Responsibility for Student Achievement	Holistic score
Professional development		
Teacher	Professional Activity	Average mean-weighted score
Administrative support		
School	Administrative Support	Schools' PD Support score from Factor Analysis Campus Administrator's Direct Involvement
Additional characteristic		
Teacher	Job Satisfaction	Average teacher score

Identification of Components and Elements. Within the *School* component, I used rubrics (Ivey, 2009; Ruebush, 2012) to determine scores for the three elements (*Administrative support, Mentoring program,* and *Special activities for novice teachers*). *Administrative Support* scores were determined by summing scores related to schools' PD support (Ruebush, 2012) and administrators direct involvement in induction (Ivey, 2009). These scores were then quartile ranked and multiplied by 2 providing a weighted quartile rank score for *Administrative support*. *Mentoring program* scores were determined by summing scores related to the mentoring actors, components for mentor, and mentor selection subscales contained in the induction rubric (Ivey, 2009). These scores were then quartile ranked and multiplied by 2 providing a weighted quartile rank score for *Mentoring program*. *Special activities for novice teachers* scores were determined by summing scores related to the mentoring and induction activities subscales contained in the induction rubric (Ivey, 2009). These scores were then quartile ranked and multiplied by 2 providing a weighted quartile rank score for *Special activities for novice teachers*.

For the *Teachers* component, I used teachers' responses on the TPSST to determine measures of both *Job satisfaction* and *Professional activities*. *Job satisfaction* scores were determined by aggregating teacher responses to 14 job satisfaction questions contained in the TPSST for each school. These average satisfaction scores were then quartile ranked and multiplied by 3 providing a weighted quartile rank score for *Job satisfaction*. *Professional activity* scores were determined by aggregating teachers' participation in various PD activities using the results from a factor analysis of the

TPSST presented in Chapter III of this dissertation. These average participation scores were then quartile ranked and multiplied by 3 providing a weighted quartile rank score for *Professional activity*.

Within the *Program* component, I used science program interview data and holistic scoring methods to score the two elements of (1) *Meetings among teachers* and (2) *Collective responsibility for student achievement* (see Figure 4.3 for a description of scores). The scores for each element were determined based on literature descriptions identifying best practices (Kardos & Johnson, 2007; Kardos et al., 2001). I derived a score for the third element, *Common planning*, by examining each school's master schedule (see Figure 4.3 for a description of scores). Each of these scores (i.e., *Meetings among teachers*, *Collective responsibility for student achievement*, and *Common planning*) were multiplied by 2 to provide a weighted score associated with each element.

Finally, I determined the score for the *Distribution of science teachers* component by querying the state-maintained database on Texas teachers to identify teachers at three stages in the professional science teacher continuum: novice (in their first 3 years of teaching), mid-career (in their fourth through seventh years of teaching), and veteran (in their eighth and above years of teaching). The total number of each teacher type at a school was determined and scored via the scoring protocol identified in Figure 4.3 for *Distribution of science teachers*. This scoring scheme was determined based on the idea that novice teachers provide a rich addition (e.g., energy, innovative ideas) to the faculty (e,g, see Kardos & Johnson, 2007; Kardos et al., 2001) and the notion that we learn best from others who are closer in terms of experience and age, but slightly more advanced than ourselves (e.g., see Bransford, Derry, Berlinger, Hammerness, & Beckett, 2005; Vygotsky, 1978). This score was then multiplied by 6 to provide a weighted score for the *Distribution of science teachers*. A composite *School Science professional culture score* was then calculated for each of the 50 PRISE schools (see Equation 4.2).

$$\textit{School Science Professional Culture Score} = (2*\textit{Admin} + 2*\textit{Mentor} + 2*\textit{SpecNovice}) + (3*\textit{ProfAct} + 3*\textit{JS}) + (2*\textit{Meetings} + 2*\textit{CollResp} + 2*\textit{Plan}) + (6*\textit{DistribTchr}) \quad (4.2)$$

Factor Analysis. A factor analysis was used to understand how various elements within the school science professional culture rubric cluster to determine factors that are most likely to explain variance associated with school science professional culture scores. Principal axis factoring was used in this analysis to partition unique variance from both shared and error variance associated with elements thought to describe school science professional culture. The solution from principal axis factoring contains only unique variance that reveals the underlying structure associated with elements selected to define and quantify school science professional culture (Costello & Osborne, 2005). An oblique rotation was used to confirm that factors were uncorrelated. Therefore, an orthogonal rotation, Varimax with Kaiser Normalization, was used to maximize separation between factors by not accounting for correlation between factors. The factor analysis examined 9 elements that clustered into 3 factors that explained 52.95% of the variance. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO=0.65) indicated that there were not enough elements contained within each of the factors to achieve adequate clustering within each factor. However, Bartlett's Test of Sphericity was statistically significant indicating that the factors were independent of one another (χ^2=114.2, df=36, p=0.0001). A 3-factor solution was supported by the "leveling off" of the Eigenvalues apparent on the Scree plot (see Figure 4.4). For a description of the 3 factors and activities contained within each factor see Table 4.3.

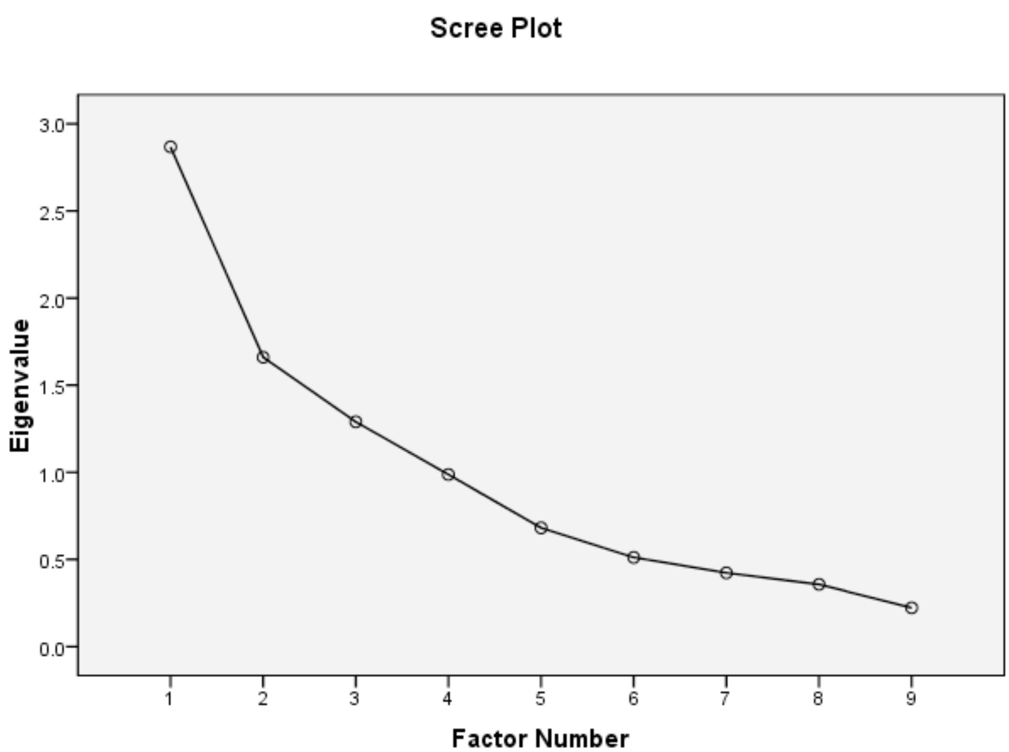

Fig. 4.4. Scree plot displaying "leveling off" of Eigenvalues after 3 factors.

Table 4.3

Factors within School Science Professional Culture

	Loadings		
	Factor 1: Program	Factor 2: School Support & Satisfaction	Factor 3: Activities & Interactions
Collective Responsibility for Student Achievement	.892	-.054	.282
Meetings Among Teachers	.751	.246	.223
Common Planning	.561	.090	-.095
Mentoring Program	.033	.852	-.057
Special Activities for Novice Teachers	.159	.723	.091
Administrative Support	.236	.367	.273
Teacher Job Satisfaction	-.011	-.318	-.119
Professional Activities	-.071	.308	.940
Distribution of Science Teachers	.170	.002	.451
Eigenvalues	1.79	1.65	1.33
% of Total Variance	19.88	18.33	14.74
Total Variance	19.88	38.22	52.95

Revised Three-component Model. Considering a low level of reliability (α=0.52) and clustering of elements into 3 factors, the original model appearing as Figure 4.1 was revised to reflect a 3-component model each containing 3 elements with equal weights (see Figure 4.5).

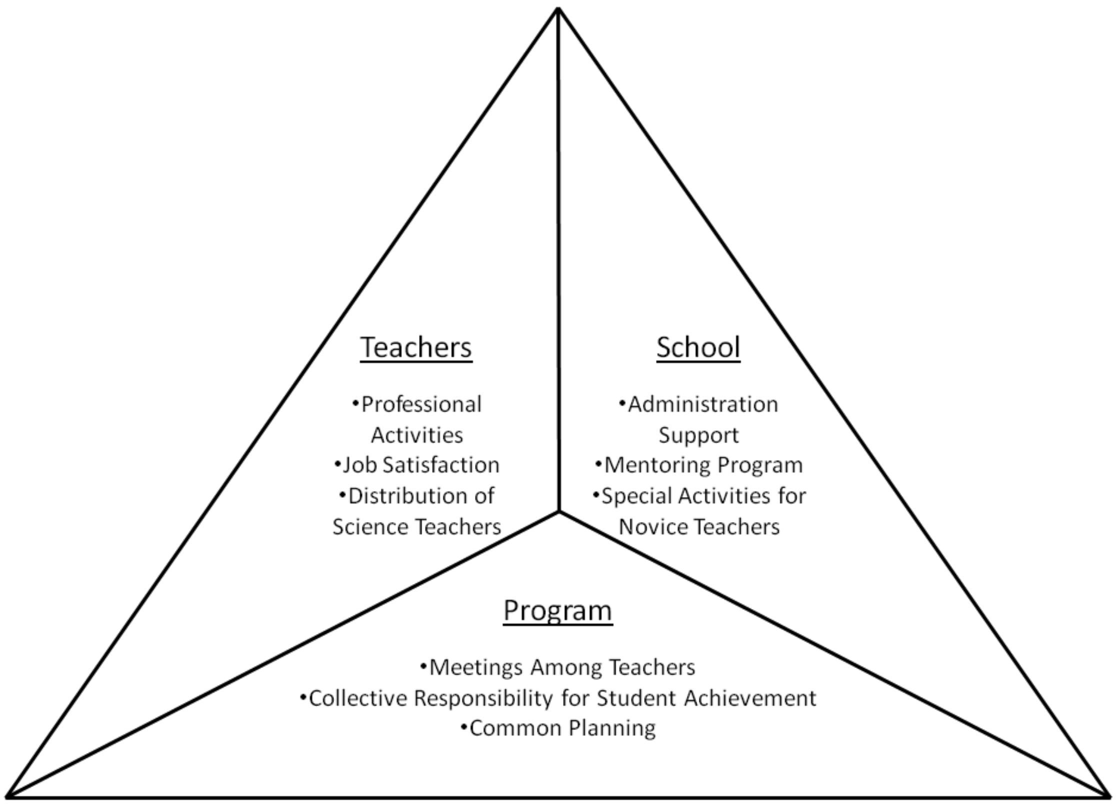

Fig. 4.5. Revised school science professional culture model containing 9 elements within 3 components.

The range of scores using the revised 3-component model was 9-36. The average school science professional culture score was 20.92 with a minimum score of 10.0 and a maximum score of 29.0. Skewness, which provides an estimate for the symmetry of a distribution with a normal distribution having a skewness of zero, was -0.25 indicating a nearly normal distribution. Kurtosis, which provides an estimate of the ratio of height of distribution to the width of the tails with a normal distribution having a kurtosis of zero, was -0.92 indicating a non-normal distribution. The value for kurtosis can most likely be attributed to the large number of schools scoring above and below the mean. Figure 4.6

provides the frequency distribution of school science professional culture scores obtained. Table 4.4 provides descriptive statistics for the school science professional culture scores for all schools and by school size and minority student enrollment proportion.

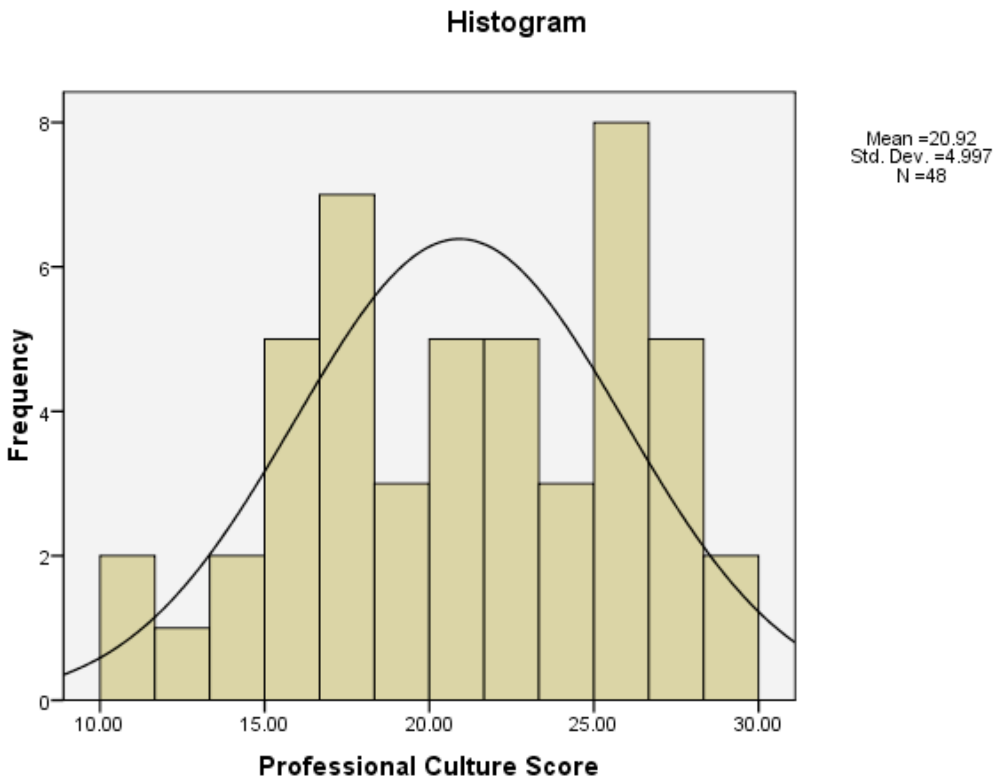

Fig. 4.6. Distribution of school science professional culture scores for all 50 PRISE schools.

Table 4.4

Distribution of School Science Professional Culture Scores[a] by School Size and Minority Student Enrollment Proportion (MSEP)

		School Size			MSEP	
	All (n=50)	Small (n=15)	Medium (n=18)	Large (n=18)	Low (n=29)	High (n=21)
Mean	20.92	16.67	20.75	24.82	20.41	21.68
Standard deviation	4.99	3.96	4.45	2.81	5.12	4.83
Standard error	0.72	1.02	1.11	0.68	0.95	1.11
Minimum	10.0	10.0	13.0	20.0	10.0	11.0
25th percentile	17.0	14.0	16.25	22.5	16.0	18.0
Median	21.0	17.0	21.5	25.0	21.0	22.0
75th percentile	25.0	19.0	24.75	27.0	24.5	26.0
Maximum	29.0	27.0	27.0	29.0	29.0	28.0

[a] Range of scores was 9.0-36.0.

Examination of the descriptive statistics indicated a difference in professional culture scores by school size but not by MSEP. Therefore, with respect to school size, I conducted a post hoc comparison using the nonparametric Kruskal-Wallis test to determine if there were differences between the three school sizes. The Kruskal-Wallis test confirmed that there was a difference with regard to school size (χ^2=20.18, *p*=0.0001). Consequently, I conducted three iterations of the post hoc comparison using the nonparametric Mann-Whitney *U* test to discern which school sizes were different from one another. The Mann-Whitney *U* test confirmed that there were significant differences between scores for all three school sizes (Small/Medium, U=66, *p*=0.03; Medium/Large, U=65, *p*=0.01; Small/Large, U=13, *p*=0.0001).

With respect to differences between schools' MSEP status, I conducted a post hoc comparison using the nonparametric Mann-Whitney *U* test to determine if there were differences between the two groups. The Mann-Whitney *U* test confirmed that there was no significant difference between the profession culture scores for low- and high-MSEP schools (U=229, *p*=0.33).

Reliability analysis was performed using the scores for the three component model, which resulted in an increase in Crohnbach's alpha to 0.63. This value approaches the value of 0.70 considered acceptable for social science research (Gliem & Gliem, 2003). A composite school science professional culture score, however, may not be a reliable measure for further analyses. Therefore, the remainder of the analyses presented in this paper focus on associations between the elements of the professional culture model and two additional outcome variables of interest (i.e., schools' science teacher retention rates and schools' scores for students' science proficiencies and college readiness).

Professional Culture Elements and Schools' Science Teacher Retention Rates

Teacher retention was determined by using a combination of schools' master schedules and the PEIMS database. Retention rates were calculated for each school depending on the number of teachers who remained at school to teach from the 2007-2008 school year to the 2008-2009 school year. Schools were ranked according to their retention rate then divided into quartiles. This analysis presents the relationship between each professional culture element as scored by schools whose retention rates were in the highest quartile (i.e., 4^{th} quartile=100%) and lowest quartile (i.e., 1^{st} quartile=0-59.8%). Scores for each professional culture element were also quartile ranks. To ease interpretability the mean rank was rounded to the nearest 0.5. The rounded mean rank score provides a measure that accounts for variability, while also maintaining the integrity of the original quartile rank scores. Table 4.5 provides both the mean rank and rounded mean rank scores for schools with both high and low retention. Figure 4.7 compares the relationships between each professional culture element in schools with both high- and low-retention rates.

Table 4.5

Mean Quartile Rank Scores for Professional Culture Elements for Schools with both High- and Low-Retention Rates

	High-Retention (n=14)		Low-Retention (n=11)	
Element	Mean Rank	Rounded to 0.5	Mean Rank	Rounded to 0.5
Administrative Support	2.29	2.5	2.27	2.5
Mentoring Program	2.00	2.0	2.09	2.0
Special Activities for Novice Teachers	2.07	2.0	2.00	2.0
Meetings Among Teachers	2.29	2.5	2.45	2.5
Collective Responsibility for Student Achievement	2.00	2.0	2.27	2.5
Common Planning	1.50	1.5	1.40	1.5
Distribution of Teachers	1.57	1.5	1.91	2.0
Job Satisfaction	3.14	3.0	2.91	3.0
Professional Activities	2.14	2.0	2.18	2.0

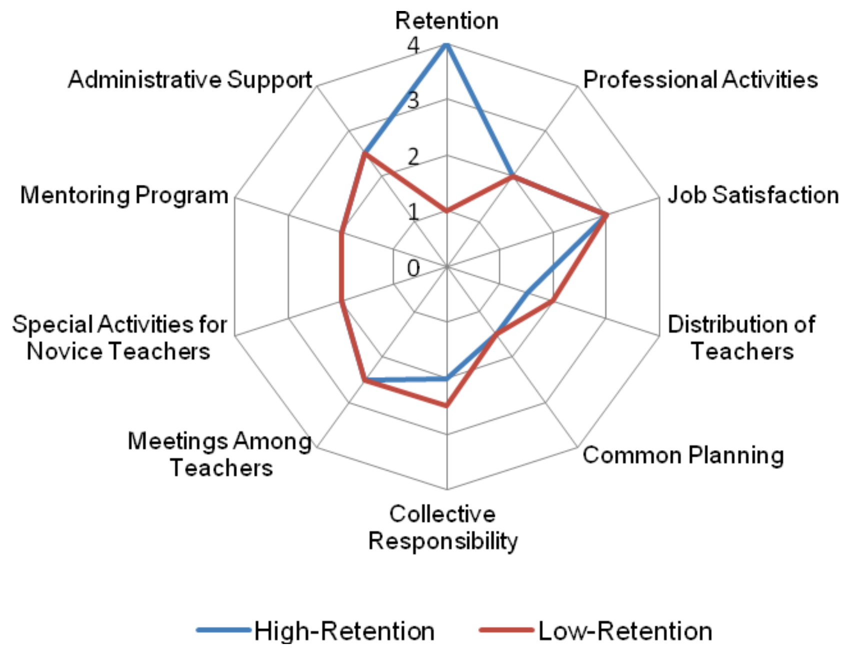

Fig. 4.7. Mean quartile rank scores for each professional culture element in schools with both high- (n=14) and low- (n=11) retention rates.

Figure 4.7 indicates that schools scored similarly on the school science professional culture elements regardless of retention status. Low-retention schools outperformed high retention schools with regard to *Collective responsibility* and *Distribution of teachers* represented within the science department. For most of the other professional culture elements, both high- and low-retention schools scored in the 2^{nd} quartile indicating “average” performance (i.e., *Administrative support, Mentoring program, Special activities for novice teachers, Meetings among teachers, Common planning*, and *Professional activities*). Teachers in schools with both high- and low-retention reported higher levels of *Job satisfaction* (i.e., 3^{rd} quartile). A Somer’s d statistic was calculated to determine the association between the composite school science professional culture score and quartile ranked scores for schools' science teacher retention rates (Gonzalez & Nelson, 1996). The correlation between schools' composite school science professional culture score and quartile ranked retention rates was found to be near neutral and non-significant

(d= -0.05, p=0.71).

Professional Culture Elements and Schools' Students' Science Proficiencies and College Readiness Scores

Scores for students' science proficiencies and college readiness were determined using an algorithm developed by members of the PRISE research team (see Equation 4.1). Schools were ranked according to their score then divided into quartiles. This analysis presents the relationship between each school science professional culture element as scored by schools whose scores for SPCR were in the highest quartile (i.e., 4^{th} quartile=15-21) and lowest quartile (i.e., 1^{st} quartile=3-9). Scores for each school science professional culture element were also quartile ranks. To ease interpretability the mean rank was rounded to the nearest 0.5. The rounded mean rank score provides a measure that accounts for variability, while also maintaining the integrity of the original quartile rank scores. Table 4.6 provides both the mean rank and rounded mean rank scores for schools with both high and low achievement. Figure 4.8 compares the relationships between each school science professional culture element in schools with both high and low achievement.

Table 4.6

Mean Quartile Rank Scores for School Science Professional Culture Elements in Schools with both High and Low Achievement

	High Achievement (n=9)		Low Achievement (n=13)	
Element	Mean Rank	Rounded to 0.5	Mean Rank	Rounded to 0.5
Administrative Support	2.67	3.0	2.08	2.0
Mentoring Program	2.11	2.0	2.77	3.0
Special Activities for Novice Teachers	2.00	2.0	2.54	2.5
Meetings Among Teachers	2.56	2.5	2.85	3.0
Collective Responsibility for Student Achievement	2.22	2.0	2.38	2.5
Common Planning	1.33	1.5	1.92	2.0
Distribution of Teachers	2.00	2.0	1.92	2.0
Job Satisfaction	3.11	3.0	2.08	2.0
Professional Activities	2.22	2.0	2.38	2.5

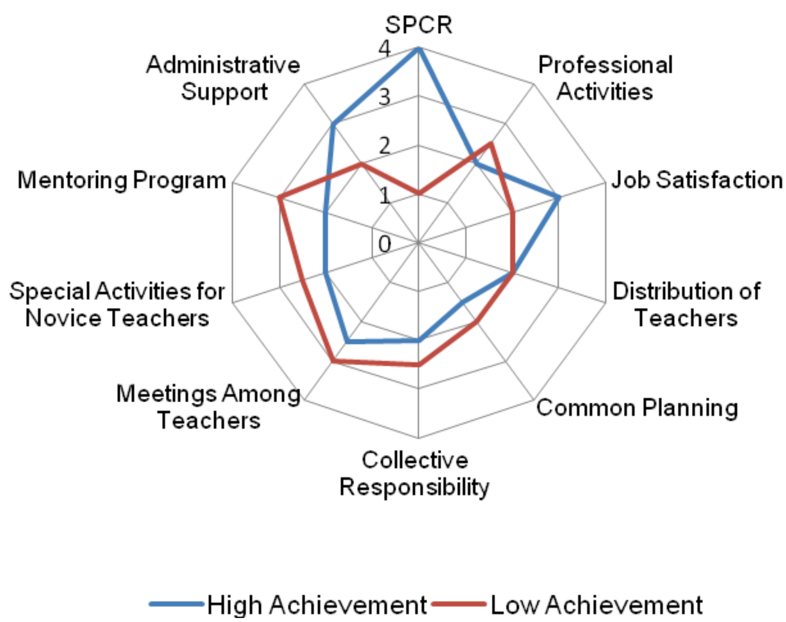

Fig. 4.8. Mean quartile rank scores for each school science professional culture elements in schools with both high (n=9) and low (n=13) achievement.

Figure 4.8 indicates that schools with low achievement outperformed high achieving schools on most of the elements associated with school science professional culture (i.e., *Mentoring program, Special activities for novice teachers, Meetings among teachers, Collective responsibility, Common planning*, and *Professional activities*). Elements for which schools with high achievement ranked higher were *Administrative support* and *Job satisfaction*. Both high- and low-achieving schools had similar distributions of teachers within the science department. A Somer's d statistic was calculated to determine the association between the composite school science professional culture score and quartile ranked scores for schools' science teacher retention rates. Somer's d was used because of the presences of ties associated with the data (Gonzalez & Nelson, 1996). The correlation between schools' composite school science professional culture score and quartile ranked scores for SPCR was found to be near neutral and non-significant (d=0.02, p=0.88).

School Science Professional Culture Elements and Relationships with Schools' Science Teacher Retention Rates and Students' Science Proficiencies and College Readiness Score

I examined associations between schools' science teacher retention rates and scores for students' science proficiencies and college readiness with each school science professional culture element using Cramer's V. Cramer's V, a nominal by nominal variation of chi-square, provides an estimate of the strength of an association between two categorical variables. Table 4.7 provides the Cramer's V value and associated *p*-value for each combination of school science professional culture elements with both outcome variables of interest (i.e., retention and SPCR). Values for Cramer's V can range from 0 (no association) to 1 (perfect association). Cramer's V is an analogous measure for categorical data as correlations are used for continuous data. Researchers often find it useful to define a range of values to classify the relative strength of associations between variables (Fletcher, Ramanathan, Dallaire, Saini, & Levine, 2005; Kotrlik, Williams, & Jabor, 2011). For purposes of this study associations measured with a Cramer's V value less than 0.25 was coded as very weak, values between 0.25 and 0.29 as weak, values between 0.30 and 0.34 as strong, and values greater than or equal to 0.35 as very strong. Figure 4.9 provides a visual representation of the associations between all variables using this categorization. Reading Figure 4.9 clockwise, both outcome variables are located at the top (i.e., SPCR and retention), three elements associated with *Teachers* component (i.e., *Professional activities, Job satisfaction*, and *Distribution of teachers*), three elements associated with *Program* component (i.e., *Common planning, Collective responsibility*, and *Meetings among teachers*), and three elements associated with *Schools* component (i.e., *Special activities for novice teachers, Mentoring program*, and *Administrative support*) can be identified.

Very Strong Associations. The only element associated very strongly with an outcome variable of interest was *Meetings among teachers* with retention. Associations between *School* (i.e., *Special activities for novice teachers* and *Mentoring program*) and *Program* (i.e., *Common planning, Collective responsibility*, and *Meetings among teachers*) characteristics were the strongest. *Administrative support* was found to be very strongly associated with science department's enabling of *Meetings among teachers* and fostering *Collective responsibility for student achievement*. Additional very strong associations were found between the following school and department school science professional culture elements: (1) *Mentoring program* with *Special activities for novice teachers*, (2) *Special activities* with *Meetings among teachers*, (3) *Meetings among teachers* with *Collective responsibility for student achievement*, and (4) *Collective responsibility for student achievement* with *Common planning*. Table 4.8 provides a summary of very strong associations between outcome variables and school science professional culture elements and components with associated Cramer's V value.

Table 4.7

Associations between School Science Professional Culture Elements, Schools' Teacher Retention Rates, and Scores for Students' Science Proficiencies and College Readiness (SPCR)

Variable	Administrative Support	Mentoring Program	Special Activities for Novices	Job Satisfaction	Professional Activities	Distribution of Teachers	Meetings Among Teachers	Collective Responsibility	Common Planning	Teacher Retention	SPCR
Administrative Support	1	0.28 (0.25)	0.28 (0.24)	0.26 (0.37)	0.24 (0.45)	0.24 (0.50)	0.36 (0.03)*	0.35 (0.03)*	0.20 (0.78)	0.29 (0.21)	0.32 (0.07)
Mentoring Program		1	0.39 (0.01)*	0.31 (0.12)	0.29 (0.20)	0.30 (0.15)	0.24 (0.48)	0.12 (0.99)	0.27 (0.32)	0.30 (0.15)	0.23 (0.53)
Special Activities for Novices			1	0.31 (0.12)	0.32 (0.10)	0.28 (0.23)	0.38 (0.01)*	0.28 (0.21)	0.28 (0.27)	0.29 (0.20)	0.24 (0.46)
Job Satisfaction				1	0.31 (0.11)	0.27 (0.30)	0.25 (0.39)	0.15 (0.96)	0.25 (0.45)	0.31 (0.12)	0.24 (0.47)
Professional Activities					1	0.33 (0.07)	0.32 (0.07)	0.34 (0.05)*	0.31 (0.13)	0.34 (0.04)*	0.22 (0.60)
Distribution of Teachers						1	0.24 (0.50)	0.27 (0.28)	0.20 (0.78)	0.23 (0.55)	0.24 (0.45)
Meetings Among Teachers							1	0.58 (0.001)*	0.33 (0.08)	0.36 (0.02)*	0.21 (0.69)
Collective Responsibility								1	0.38 (0.01)*	0.26 (0.31)	0.24 (0.47)
Common Planning									1	0.30 (0.15)	0.20 (0.77)
Teacher Retention										1	0.21 (0.68)
SPCR											1

*indicates $p \leq 0.05$

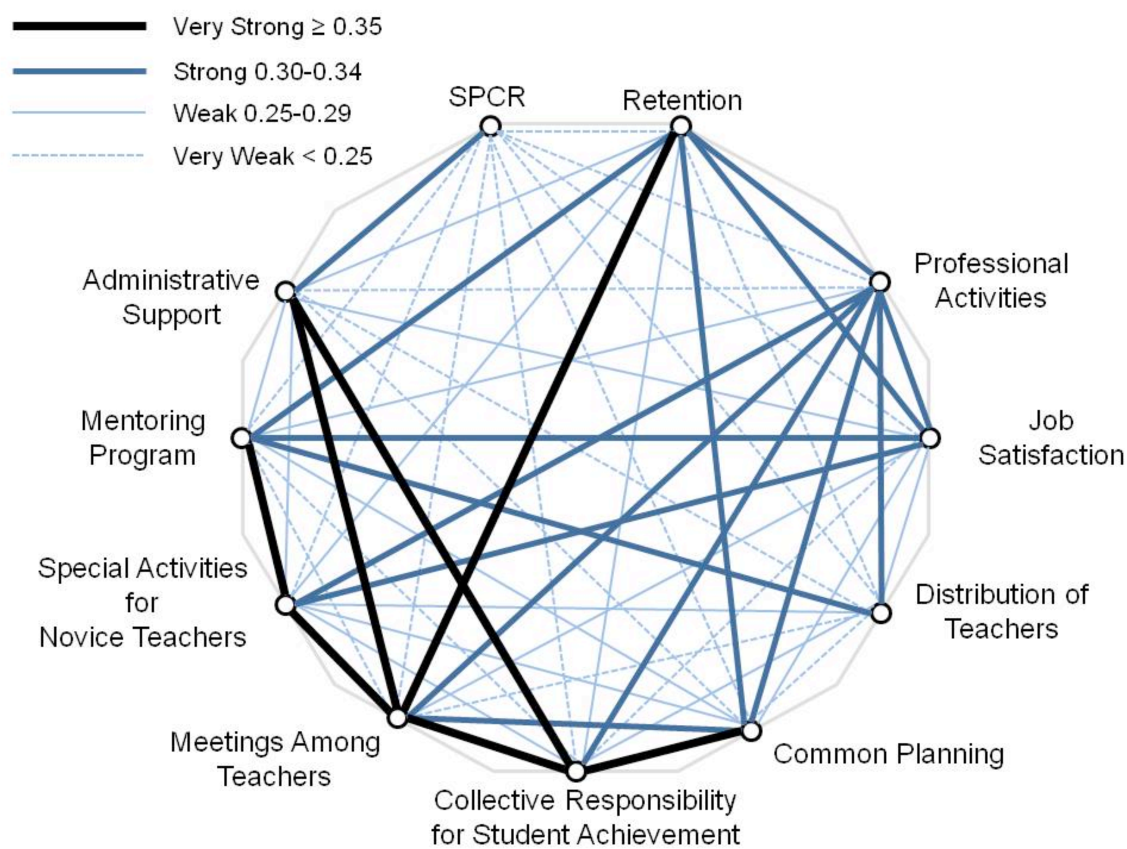

Fig. 4.9. Associations between school science professional culture elements. Associations among quartile rank scores for both students' science proficiencies and college readiness (SPCR) and schools' science teacher retention rates assessed using Cramer's V for all 50 PRISE schools.

Table 4.8

Very Strong Associations between Outcome Variables and School Science Professional Culture Elements

Component	Element	Component	Element	Cramer's V
Outcome	Retention	Program	Meetings[a]	0.36
School	Administrative Support	Program	Meetings	0.36
School	Administrative Support	Program	Collective Responsibility[b]	0.35
School	Mentoring Program	School	Special Activities[c]	0.39
School	Special Activities	Program	Meetings	0.38
Program	Meetings	Program	Collective Responsibility	0.58
Program	Collective Responsibility	Program	Common Planning	0.38

[a] Meetings among teachers. [b] Collective responsibility for student achievement. [c] Special activities for novice teachers.

Strong Associations. Five of the school science professional culture elements were strongly associated with one of the outcome variables of interest. The following school science professional culture elements were strongly associated with retention: (1) *Mentoring program*, (2) *Common planning*, (3) *Job satisfaction*, and (4) *Professional activities*. The only element strongly associated with SPCR was *Administrative support*. There were several strong associations between the elements of school science professional culture. These associations reveal the interaction of the *School, Program,* and *Teachers* components within the school science professional culture. Teachers' *Professional activities* was strongly associated with numerous other school science professional culture elements including (1) *Special activities for novice teachers*, (2) *Meetings among teachers*, (3) *Collective responsibility for student achievement*, (4) *Common planning*, (5) *Distribution of teachers*, and (6) *Job satisfaction*. *Job satisfaction* was also strongly associated with *Mentoring program* and *Special activities for novice teachers*. *Mentoring program* was also strongly associated with the *Distribution of teachers*. A final strong association to note is between *Meetings among teachers* and *Common planning*. Table 4.9 provides a summary of strong associations between outcome variables and school science professional culture elements and components with associated Cramer's V value.

Table 4.9

Strong Associations between Outcome Variables and School Science Professional Culture Elements

Component	Element	Component	Element	Cramer's V
Outcome	SPCR	School	Administrative Support	0.32
Outcome	Retention	School	Mentoring Program	0.30
Outcome	Retention	Program	Common Planning	0.30
Outcome	Retention	Teachers	Job Satisfaction	0.31
Outcome	Retention	Teachers	Professional Activities	0.34
Teachers	Professional Activities	School	Special Activities[a]	0.32
Teachers	Professional Activities	Program	Meetings[b]	0.32
Teachers	Professional Activities	Program	Collective Responsibility[c]	0.34
Teachers	Professional Activities	Program	Common Planning	0.31
Teachers	Professional Activities	Teachers	Distribution of Teachers	0.33
Teachers	Professional Activities	Teachers	Job Satisfaction	0.31
Teachers	Job Satisfaction	School	Mentoring Program	0.31
Teachers	Job Satisfaction	School	Special Activities	0.31
School	Mentoring Program	Teachers	Distribution of Teachers	0.30
Program	Meetings	Program	Common Planning	0.33

[a] Special activities for novice teachers. [b] Meetings among teachers. [c] Collective responsibility for student achievement.

Weak Associations. Weak associations were found between a number of elements with retention including: (1) *Administrative support*, (2) *Special activities for novice teachers*, and (3) *Collective responsibility for student achievement*. Several weak associations were also found between various elements. *Administrative support* was weakly associated with (1) *Mentoring program*, (2) *Special activities for novice teachers*, and (3) *Job satisfaction*. *Special activities for novice teachers* was weakly associated with (1) *Collective responsibility for student achievement*, (2) *Common planning*, and (3) *Distribution of teachers*. *Job satisfaction* was weakly associated with *Common planning* and *Distribution of teachers*. *Mentoring program* was weakly associated with *Professional activities* and *Common planning*. An additional weak association was found between *Meetings among teachers* and *Job satisfaction*. Table 4.10 provides a summary of weak associations between outcome variables and school science professional culture elements and components with associated Cramer's V value.

Very Weak Associations. Very weak associations were found with a number of elements and outcome variables of interest. The following elements were found to be very weakly associated with SPCR: (1) *Mentoring program*, (2) *Special activities for novice teachers*, (3) *Meetings among teachers*, (4) *Collective responsibility for student achievement*, (5) *Common planning*, (6) *Distribution of teachers*, (7) *Job satisfaction*, (8) *Professional activities*, and (9) Retention. Retention was also found to be very weakly associated with *Distribution of teachers*. A number of very weak associations were also found between school science professional culture elements. *Administrative support* was found to be very weakly associated with (1) *Common planning*, (2) *Distribution of* *teachers*, and (3) *Professional activities*. *Mentoring program* was found to be very weakly associated with *Meetings among teachers* and *Collective responsibility for student achievement*. Both *Meetings among teachers* and *Common planning* were found to be very weakly associated with *Distribution of teachers*. *Collective responsibility for student achievement* was found to be very weakly associated with *Job satisfaction*. Table 4.11 provides a summary of very weak associations between outcome variables and school science professional culture elements and components with associated Cramer's V value.

Table 4.10

Weak Associations between Outcome Variables and School Science Professional Culture Elements

Component	Element	Component	Element	Cramer's V
Outcome	Retention	School	Administrative Support	0.29
Outcome	Retention	School	Special Activities	0.29
Outcome	Retention	Program	Collective Responsibility[a]	0.26
School	Administrative Support	School	Mentoring Program	0.28
School	Administrative Support	School	Special Activities[b]	0.28
School	Administrative Support	Teachers	Job Satisfaction	0.26
School	Special Activities	Program	Collective Responsibility	0.28
School	Special Activities	Program	Common Planning	0.28
School	Special Activities	Teachers	Distribution of Teachers	0.28
Teachers	Job Satisfaction	Program	Common Planning	0.25
Teachers	Job Satisfaction	Teachers	Distribution of Teachers	0.27
School	Mentoring Program	Program	Common Planning	0.27
School	Mentoring Program	Teachers	Professional Activities	0.29
Program	Meetings[c]	Teachers	Job Satisfaction	0.25

[a] Collective responsibility for student achievement. [b] Special activities for novice teachers. [c] Meetings among teachers.

Table 4.11

Very Weak Associations between Outcome Variables and School Science Professional Culture Elements

Component	Element	Component	Element	Cramer's V
Outcome	SPCR	School	Mentoring Program	0.23
Outcome	SPCR	School	Special Activities[a]	0.24
Outcome	SPCR	Program	Meetings[b]	0.21
Outcome	SPCR	Program	Collective Responsibility[c]	0.24
Outcome	SPCR	Program	Common Planning	0.20
Outcome	SPCR	Teachers	Distribution of Teachers	0.24
Outcome	SPCR	Teachers	Job Satisfaction	0.24
Outcome	SPCR	Teachers	Professional Activities	0.22
Outcome	SPCR	Outcome	Retention	0.21
Outcome	Retention	Teachers	Distribution of Teachers	0.23
School	Administrative Support	Program	Common Planning	0.20
School	Administrative Support	Teachers	Distribution of Teachers	0.24
School	Administrative Support	Teachers	Professional Activities	0.24
School	Mentoring Program	Program	Meetings	0.24
School	Mentoring Program	Program	Collective Responsibility	0.12
Program	Meetings	Teachers	Distribution of Teachers	0.24
Program	Common Planning	Teachers	Distribution of Teachers	0.20
Program	Collective Responsibility	Teachers	Job Satisfaction	0.15

[a] Special activities for novice teachers. [b] Meetings among teachers. [c] Collective responsibility for student achievement.

Discussion and Implications

This study contributes to what we know by operationalizing the professional cultures experienced by high school science teachers. Relationships between elements of school science professional culture with both schools' science teacher retention rates and scores for students' science proficiencies and college readiness were also examined.

School Science Professional Culture Rubric

This paper outlined the development of a rubric to define and measure school science professional cultures in which high school science teachers teach science. The school science professional culture rubric combined information from five different PRISE data sources (i.e., TPSST; Stuessy & PRISE Research Group, 2007a; administrator interviews; Stuessy & PRISE Research Group, 2007b; science program interviews; Stuessy & PRISE Research Group, 2007c; master schedules, and PEIMS data) and two pre-existing instruments (i.e., schools' PD support rubric; Ruebush, 2012; and induction rubric; Ivey, 2009). The Cronbach's Alpha of 0.63 indicates low levels of internal reliability when applying the school science professional culture rubric to score schools. Low levels of reliability may be related to the various instruments used to obtain many of the indicators contained within the rubric. Refinement of the scales associated with measuring each of the indicators may also increase reliability. Prior to this study, no instrument was found that used data from school, program, and teacher levels to determine and measure professional cultures experienced by high school science teachers.

Descriptive statistics were used to examine trends associated with the composite school science professional culture score for all 50 PRISE schools, by school size (i.e., small, medium, and large), and MSEP status (i.e., low and high). With regard to school size, I found that there were significant differences in composite school science professional culture scores for all three sizes with large schools having highest scores and small schools having lowest. With regard to MSEP status, I found no significant differences in composite school science professional culture scores.

School Science Professional Culture Elements and Schools' Science Teacher Retention Rates

The relationship between school science professional culture elements and science teacher retention was examined through comparison of mean quartile rank scores of schools with high- (i.e., 4^{th} quartile) and low- (i.e., 1^{st} quartile) retention rates. Comparisons of mean quartile rank scores revealed little differences between schools based on retention status. This was confirmed using Somer's d as a measure of the association of composite school science professional culture scores and quartile rank retention rates for all 50 PRISE sample schools ($d= -0.05$, $p=0.71$).

Findings from this study indicate little differences among frequencies of practice associated with school science professional culture elements on schools' retention rates. This is in contrast to current literature that examines professional culture as it relates to retention. Johnson & Kardos (2005) report that teachers new to the profession often look for many opportunities associated with a strong, integrated professional cultures (i.e., collaborative partnerships, interactive classrooms, and increasing levels of responsibility for decision making as their careers progress). However, these new teachers are often disenchanted when they find that classrooms are often isolated from one another with little opportunity for collaboration and increased authority (Johnson & Kardos, 2005). This disenchantment is often one of the reasons identified by new teachers for leaving the classroom within their first years in the profession (Kardos & Johnson, 2007). Researchers suggest that the presence of professional culture elements (e.g., quality induction supports, mentoring, time for teachers to reflect on their own instruction professional development) within a school system should result in increases in retention (Feiman-Nemser, 2003; Kardos & Johnson, 2007).

School Science Professional Culture Elements and Scores for Students' Science Proficiencies and College Readiness

The relationship between school science professional culture elements and schools' scores for SPCR was examined through comparison of mean quartile rank scores of schools with high- (i.e., 4th quartile) and low- (i.e., 1st quartile) achievement. Comparisons of mean quartile rank scores revealed little differences between schools based on achievement status. This was confirmed using Somer's d as a measure of the association of composite school science professional culture scores and quartile ranks for SPCR for all 50 PRISE sample schools (d=0.02, p=0.88).

Findings from this study indicate little differences among frequencies of practice associated with school science professional culture elements on schools' scores for SPCR. This is in contrast to current literature indicating improvement in achievement when implementing elements of school science professional culture (e.g., common planning, mentoring interactions among teachers of various experience levels, and collective responsibility for student achievement; Kardos & Johnson 2007). However, there is little direct evidence available to understand the relationship between school science professional culture and student achievement. The findings presented in this study show that the current definitions and measures of school science professional culture elements have very weak associations with student achievement.

School Science Professional Culture Elements and Relationships with Schools' Science Teacher Retention Rates and Students' Science Proficiencies and College Readiness Scores

Associations between school science professional culture elements and quartile ranks for schools' science teacher retention rates and scores for SPCR were calculated using Cramer's V. Cramer's V provides a measure of association for nominal variables implying that there is no hierarchal order associated with the scores. The magnitude of the value indicates the likelihood of an association existing between the variables. However, Cramer's V does not account for the direction of the relationship. According to Cramer's V, few strong associations exist between school science professional culture elements and the outcome variables of interest. However, all of the very strong associations occurred between elements belonging to both the *School* and *Program* components within the school science professional culture rubric. Strong associations were also identified between many of the teachers and program elements. These strong associations are counter-acted by the large number of weak associations between the remaining elements and outcome variables.

Nearly all of the elements showed either strong associations with each other or the outcome variables indicating evidence for the inclusion of these elements in revised versions of the school science professional culture rubric (i.e., *Administrative support, Mentoring program, Special activities for novice teachers, Meetings among teachers, Collective responsibility for student achievement, Common planning, Job satisfaction,* and *Professional activities*).

The element that did not seem to contribute much to the understanding of school science professional culture was the *Distribution of teachers*. This may be due to the scale developed to quantify the element. The *Distribution of teachers* was intended to provide a quantitative approximation of the opportunities for interaction amongst colleagues of various years of experience. These interactions have been shown to be integral for the development of strong, school science professional cultures (e.g., Feiman-Nemser, 2003; Kardos & Johnson, 2007). As this element is currently defined, the *Distribution of teachers* implies an inverse relationship with retention due to the emphasis being placed on the role of novice teachers in the distribution of teachers. In future studies, the scale associated with the *Distribution of teachers* may need to have major revisions to capture the essence of interactions amongst colleagues of varying experience.

Limitations

The near neutral relationship found between the composite school science professional culture with both retention and achievement may be due to the nature of coding many of the elements. The current coding scheme did not provide a method for distinguishing if practices were in place because of administrator mandates or legitimate buy-in and development from the teacher level. Therefore, the driving force behind school science professional culture elements was hard to determine.

The TPSST was used to collect data on teachers' levels of professional activity and job satisfaction. Teachers' levels of *Professional activity* were determined based on self-reported data to pre-determined list of activities. There was an option of other that teachers could use to describe activities that were not provided on the list. *Job satisfaction* was also measured using self-reported data to pre-determined list of categories related to their work environment. These categories may not have captured the full extent of the work environments encountered within a school. However, results from the poll were found to be both valid and reliable.

Scales for *Administrative support*, *Mentoring program*, and *Special activities for novice teachers* were determined based on practices currently being used in Texas high schools. These practices may not be the "best" available practices for establishing strong, school science professional cultures. However, results from the rubrics used to determine these scales were found to be both valid and reliable.

Scales for *Meetings among teachers* and *Collective responsibility for student achievement* were determined based on holistic scoring of program transcripts. The 4-point scale developed to quantify these elements may not have provided adequate separation for the scores associated with high (i.e., 4) and mid-range (i.e., 3 or 2) performing programs. With respect to the third program element, *Common planning*, only 13 of the 50 schools scored above one. This implies that this practice is not readily used in Texas and the scale associated with it may need to be revised in future studies.

One of the strengths of this study is based on the PRISE research design that enables findings to be generalizable to all Texas high schools and science teachers. However, results from the study may not be generalizable beyond the state of Texas. Instruments designed to collect and analyze data may be used in other contexts.

Implications

As the school science professional culture model currently stands, I can make a case for the strong association of many of the elements with teacher retention, but not student achievement. The current school science professional culture model may be a good construct for increasing the likelihood of teachers to stay at their school. Since many of the elements have strong associations with retention, school administrators do not necessarily have to put resources into developing all of the elements, but may instead focus on elements suited to their school's specific needs. However, student achievement is the driving force behind many of the decisions made in the current accountability-driven system. Therefore, instilling administrator buy-in to implement these elements may require providing further evidence for increasing student achievement.

The current rubric, developed using definitions derived from literature of professional culture, does not include a measure of teachers' decisions and practices in the classroom. Considering that many of the elements contained in the rubric are centered on teachers' classroom decisions and practices, a scale to define and measure this element may provide additional insight into the establishment of strong, school science professional cultures in schools. As a result, I am suggesting that an additional program element be integrated into future versions of the professional rubric called *Autonomy and authority in the classroom*. I believe this element could provide a measure of teachers' abilities to individualize instruction in their classrooms based on their strengths and tailor instruction to specific student needs and interests. Teachers who have been given the freedom to adapt instructional styles in their classroom to their strengths have increased levels of commitment to the profession and higher levels of student achievement (Day, 2008). A meta-analysis of recent research indicates that providing teachers with the opportunity to enhance their instruction by responding to students' prior knowledge, interests, and providing real-world applications provides larger gains in student achievement as compared to more traditional teaching strategies (Schroeder et al., 2007).

CHAPTER V

CONCLUSIONS

American high school students are losing interest in and being outperformed in science (Augustine, 2007; Gonzales et al., 2008; Hilton, 2010; OECD, 2007). Students' science achievement has often been linked to the retention of highly-qualified teachers (Barnes et al., 2007; Guarino et al., 2006; Johnson et al., 2005). Alarming numbers of teachers are leaving the profession due to low levels of support and dissatisfaction with the profession (Ingersoll, 2003). Researchers suggest that professional development (PD) and professional culture may be a means for addressing concerns related to both teacher retention and student achievement (Barnes et al., 2007; Feiman-Nemser, 2003; Guarino et al., 2006; Johnson et al., 2005; Joyce & Showers, 2002; Kardos et al., 2001).

The purpose of my dissertation was to identify patterns of relationships with professional development, professional culture, teacher retention, and student achievement. Teachers' participation in PD and schools' PD support have been cited in the literature as a primary means for addressing issues of teacher retention and student achievement (e.g., Barnes et al., 2007; Guarino et al., 2006; Johnson et al., 2005; Joyce & Showers, 2002; Wei et al., 2010). The establishment of supportive professional cultures provides a means for integrating a cohesive PD program while also establishing a set of collegial norms that foster comfortable, encouraging, and meaningful opportunities for interaction between teachers (e.g., Kardos et al., 2001; Kardos & Johnson, 2007). Increases in both teacher retention and student achievement have also been linked to the presence of strong, supportive professional cultures within a school (Feiman-Nemser, 2003; Kardos & Johnson 2007).

The research presented in this dissertation was part of a larger study conducted by the Policy Research Initiative in Science Education (PRISE) research group. The PRISE research group sought to provide a comprehensive report of the state-of-the state of Texas regarding the teacher professional continuum (TPC; Stuessy, 2009). The project used a mixed methods approach to answer three questions: (1) Where are we? (2) Where do we want to go? and (3) How do we get there? Members of the PRISE research team developed a two-stage stratified sampling plan to select 50 high schools to be representative of all high schools (n=1,333) throughout the state of Texas (McNamara & Bozeman, 2007). My research contributed to the PRISE research agenda by identifying the participation of Texas teachers in various types of PD, identifying current policies and practices in place at the school level to support their participation, and defining and measuring the professional cultures currently experienced by science teachers in Texas high schools.

Summary of Findings

In Chapter III, an exploratory factor analysis of teachers' self-reported survey data revealed that Texas high school science teachers most frequently participate in six distinct types of PD (i.e., *Mentoring, Recruitment, Science Professional Organizations, Standards, Curriculum,* and *Non-Science Professional Organizations*). Examination of participation by teacher type (i.e., novice, mid-career, veteran) revealed that veteran teachers participated more frequently in a wider variety of PD than their less experienced colleagues. PD focused on standards was the most frequently attended PD regardless of teacher type.

An original rubric was designed using administrators' semi-structured interviews identifying current policies and practices in place to support PD. An exploratory factor analysis of the rubric revealed that schools most frequently provide six distinct types of PD support (i.e., *Partnerships & PCK, School Commitment to Science PD, Ease & Practicality, Structured PD Supports for All Teachers, School Based Non-Science PD,* and *School & Teacher Synergy*). This study found that small schools were better able to match support to their teachers' participation in PD. Additionally, a minimal relationship was found between science teachers' participation or schools' PD support on schools' science teacher retention rates. However, schools' PD support was found to be a significant predictor of schools' scores for students' science proficiencies and college readiness.

In Chapter IV, I provided the outline for the development of a rubric to operationalize professional culture as experienced by Texas high school science teachers. The model consisted of three components (i.e., school, program, and teacher). Each component consisted of three elements. These 9 elements were used to define and measure the professional culture for each of the 50 PRISE schools. A minimal relationship was found between professional culture elements and schools' scores for SPCR. Only one element (i.e., administrative support) had a strong association with scores for students' science proficiencies and college readiness. However, several elements showed strong associations with schools' science teacher retention rates (i.e., M*eetings among teachers, Mentoring program, Common planning, Job satisfaction,* and *Professional activities*). Therefore, as currently defined and measured, professional culture provides a good working model for addressing issues of teacher retention. Also, all of the elements associated strongly with at least one other element. These strong associations provide evidence to include these elements in future studies of professional culture, but perhaps using revised scales of measure.

Inclusion of additional elements in future versions of the professional culture rubric may also provide added insight into the dynamics affecting the professional cultures experienced by high school science teachers. The first consideration for a future version of the professional culture rubric would be to include a measure of the direction of the driving force behind the elements (i.e., administrator mandates or teacher-led initiatives). Furthermore, a measure of teachers' levels of autonomy and authority in the classroom should be explored. The *Autonomy and authority in the classroom* element may provide a measure for teachers' abilities to individualize instruction in their classroom based on personal strengths, integrate a variety of instructional methods, and address issues of student interest and real-world applications.

Findings from this dissertation suggest that schools' PD support and other administrative supports (i.e., induction supports) provide a mechanism for increasing student achievement. In addition, several elements from the professional culture rubric suggest means (i.e., *Meetings among teachers, Mentoring program, Common planning, Job satisfaction,* and *Professional activities*) for improving teacher retention. This resonates with other literature suggesting that school administrators and high school science teachers need to support and work with each other to improve issues related to both retention and student achievement.

Many combinations of both professional development and professional culture strategies exist to support positive impacts on both retention and achievement. In an effort to answer the question “Where are we?” with regard to professional development and professional culture, I found that Texas currently has a disjointed, non-cohesive system. Patterns of teachers’ participation in PD, schools’ PD support, and professional culture revealed weak relationships with dissimilar effects on teacher retention and student achievement (see Figure 5.1).

Examination of national and state policy (e.g., NRC, 1996; 2005; 2007; TEA, 1995, USDE, 2002) and current research (e.g., Desimone et al., 2007; Garet et al., 2001; Joyce & Showers, 2002; Loucks-Horsley et al., 2003; Penuel et al., 2007) reveal that cohesive PD programs providing support and enabling teachers to participate in and implement high-quality PD in their classrooms impact both teacher retention and student achievement.

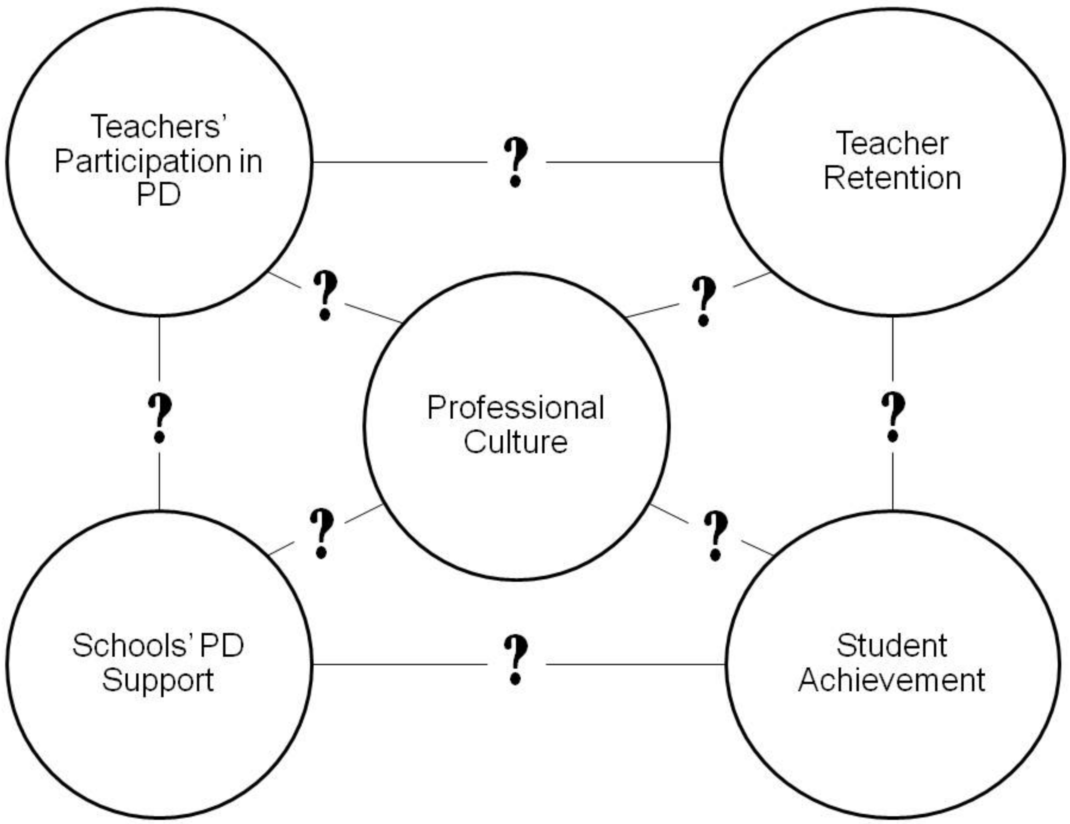

Fig. 5.1. Where are we? Currently, Texas has a disjointed, non-cohesive system with regards to professional development and professional culture and their relationships with teacher retention and student achievement.

A strong, supportive professional culture that integrates other types of supports (e.g., meetings among teachers, mentoring programs, and special activities for novice teachers) provides a mechanism for developing and implementing a cohesive PD program (Kardos et al., 2001; Kardos & Johnson, 2007; Johnson & Kardos, 2005). The presence of a strong, supportive professional culture has also been shown to increase teacher retention and student achievement (e.g., Guarino et al., 2006; Johnson et al., 2005). Therefore, to answer the question of “Where do we want to go?” I present the ideal: an integrated, cohesive framework situating teachers' participation in PD within schools' PD support with both contributing to the professional culture (see Figure 5.2). The ideal model does not exclude teachers' ventures outside the school environment to pursue their own interests and/or shortcomings. The model implies, however, that even autonomous decisions to participate in PD are supported by enabling teachers to implement additional training upon return to their classrooms and inform their colleagues about the trainings attended to encourage implementation in multiple classrooms.

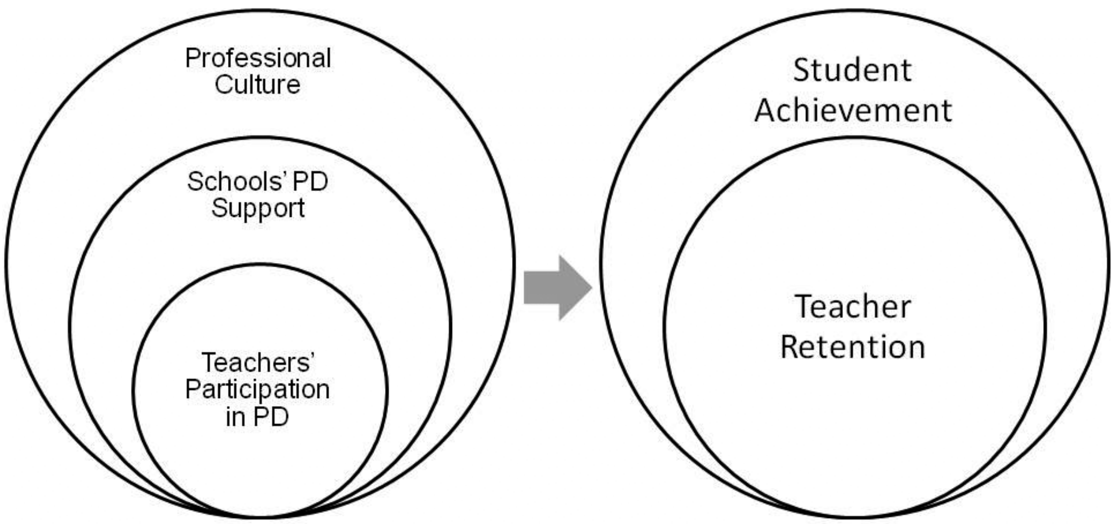

Fig. 5.2. Where do we want to go? An integrated, cohesive framework for understanding the relationship between teachers' participation in PD, schools' PD support, and professional culture and their relationships with teacher retention and student achievement.

Policy Recommendations and Implications

To address the question of “How do we get there?” I present the following recommendations for school administrators and high school science teachers:

(1) *Develop data-driven systems for identifying strengths and weakness associated with student achievement.* Use results from a variety of student assessments (e.g., formative and summative) to determine both strong and weak areas of understanding. Currently, a strong relationship does not exist between professional development and science assessment support in Texas high schools. While the factor analyses revealed that teachers are most frequently attending PD regarding standards, schools support of PD aimed at addressing areas related to science standards was removed from the practices under consideration due to low levels of factorability with other practices. Areas in which students are struggling may be due to the type and level of instruction they have received. Weak areas of student understanding should be addressed in future discussions with teachers and perhaps additional training should be sought to increase teachers’ proficiencies with either their content and/or pedagogical content knowledge.

(2) *Include teachers in the planning and selection of professional development programs.* By including teachers in the planning and selection of professional development, a cohesive PD program can be developed addressing both what teachers want to learn to improve their professional practice as well as areas that administration feel are important. This combination may improve willingness to participate in a cohesive PD program and greater gains may be seen in both

teacher retention and student achievement. Currently, Texas teachers and schools have very little match between participation in and support for PD.

(3) *Increase coherence of professional development program through careful consideration of the characteristics associated with opportunities selected.* Given that there is such a wide range of teachers' participation and schools' support practices in place in Texas, the full impact of many of the practices examined within the context of these studies has been hard to determine. In fact, some of the supports that have been cited as the most effective means for increasing the quality of implementation and changes in classroom practice were dropped from the analysis due to low frequency of occurrence amongst PRISE sample schools. Therefore, I propose increasing the frequency of implementation of the following supports associated with high-quality PD:

  (a) *Increase financial supports for teachers to obtain continuing education (e.g., attending university classes) or additional certifications.* Provide financial support for teachers to attend PD on their own time if the PD is related to increasing their content and/or pedagogical content knowledge. So few Texas schools currently provide financial incentives for teachers to obtain university graduate credit or additional state or national certifications that this type of PD support was eliminated as a current practice. Enabling teachers to obtain continuing education or additional certifications ensures that they are keeping abreast of their content area and increasing their pedagogical content knowledge.

(b) *Enable participation of scientists as content experts in professional development.* The involvement of scientists in PD will enable teachers to get relevant, new information related to the increasing body of scientific knowledge. So few Texas schools currently participate in PD that directly engages scientists as trainers that this type of PD support was also eliminated as a current practice. Scientists provide a mechanism for exposing both teachers and students to research currently underway. Exposure to scientists and their research provides a direct link to science beyond the textbook and a possible mechanism for improving both interest and knowledge related to science.

(c) *Select professional development opportunities that provide multiple follow-up sessions.* Receiving follow-up support after attending PD training is one way to improve the rate and quality of implementation of the PD in the classroom. So few Texas schools currently participate in PD that provides multiple follow-up sessions that this type of PD support as well was eliminated as a current practice. Follow-up sessions should include discussion regarding what parts of the PD training were implemented successfully as well as what may have gone wrong. Use the follow-up sessions to reflect, revise and update content of the PD to suit the needs of the school's student demographics and local context.

(4) *Allocate time for discussions among teachers regarding teaching, learning, and assessment of students.* Teachers need to be given regular opportunities to meet

and discuss issues relevant to their daily classroom experiences. Meetings focusing on reflection and revision of current classroom practices enable teachers to become active agents in shaping their work environment. Currently, Texas does not have a standard in place providing for this type of structured, supportive, and relevant discussion to occur. By allocating time for teachers dedicated to discussing issues relevant to teaching, learning, and assessment, a cohesive set of standards for these issues will emerge. A cohesive set of standards that are generated from collegial interactions should be more meaningful than when standards are dictated from outside authorities.

(5) *Provide programs that acknowledge the special needs of novice teachers and enable meaningful, supportive interactions with their more experienced colleagues.* New teachers are entering and leaving the profession at alarming rates. Therefore, implementing programs (e.g., induction and mentoring) that acknowledge the special needs of novice teachers may go a long way in keeping them in the profession. What currently exists, more often than not, are superficial interactions designed to support daily operations of the school rather than improving the professional practice of novice teachers. Programs should be structured in such a way that novice teachers are regularly engaged in communicating with more experienced colleagues (i.e., mid-career and veteran teachers) about issues relevant to their daily classroom practice and student interactions.

Implications

A review of national and state policies and current research laid the framework for what I knew at the onset of my dissertation work. This framework supported that notion that both professional development and professional culture provided effective means for improving teacher retention and student achievement. However, there were no studies indentifying the current range of practices associated with schools' PD support and corresponding ranges of teachers' participation in PD for Texas high school science teachers. Additionally, there were no instruments available to assess the professional culture experienced by high school science teachers.

My dissertation provided a current assessment of PD and professional culture currently experienced by Texas high school science teachers. What I found was that Texas teachers at this time experience a disjointed, non-cohesive system with regard to both PD and professional culture. Teachers are either participating in PD on their own or with little support from their schools. Many Texas schools have not established strong school science professional cultures. Schools providing higher levels of support for teachers' participation in PD are seeing increases in student achievement.

Now that a current assessment of "where are we" regarding professional development and professional culture has been completed, future studies can begin to ask more pointed questions regarding current policies and practices. These questions should address the communication, structure, and coherence of professional development programs and elements of professional culture in place at schools. The following questions are suggested to guide future research:

(1) What is the process for determining high school science teachers' professional development needs?

(2) What characteristics of professional development are considered necessary for meeting science teachers' professional development needs?

(3) What structures are in place to monitor and assure the quality of implementation of the professional development program for science teachers?

(4) What programs are in place to address the special needs of novice science teachers and provide meaningful interactions with their colleagues?

Addressing the above questions will provide insight into how schools and teachers work together to increase teacher retention and student achievement. Further research will enable us to understand the complex and interconnected nature of professional development and professional culture as it relates to high school science teachers and students.

The PRISE research group has recently completed data collection for 10 high achieving, high-minority high schools in Texas. Data collection and analyses in these schools was analogous to the original PRISE study. Preliminary analyses indicate that both schools' PD support and school science professional culture scores are higher and more cohesive than the original 50 PRISE schools. These results provide unique insight into the strong relationships that may exist between professional development and professional culture with Texas high school science teachers and students.

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APPENDIX A

TEXAS POLL OF SECONDARY SCIENCE TEACHERS

1. (a) Have you formally participated in **recruiting new science teachers** since the fall of 2006? (*Please enter a check on just one line below.)*

_____ Yes (*If yes, go to question #1b)*

_____ No (*If no, go to question #2)*

(b) Please indicate all of the ways that you have formally participated in the recruitment of new science teachers. (*Please check all that apply).*

_____a. F**ormal interviews** at the school site

_____b. **Informal visits** with perspective science teachers

_____c. **Recruitment trips** outside school walls

_____d. Policy meetings **specific** to science

_____e. **Review job applications** for prospective science teachers

_____f. Other (*Please briefly explain)*

2. (a) Have you participated in the **induction/mentoring of new science teachers** since the fall of 2006? (*Please enter a check on just one line below.)*

_____ Yes (*If yes, go to question #2b)*

_____ No (*If no, go to question #3)*

(b) Please indicate all of the ways that you have participated in the induction/mentoring of new science teachers. (*Please check all that apply)*.

_____a. Assisted with orientation to school policies

_____b. Assisted with classroom management

_____c. Observed a new science teacher teaching a science class

_____d. Modeled teaching for a new science teacher

_____e. Provided a new science teacher with a science lesson

_____f. Developed a science lesson with a new science teacher

_____g. Performed formal mentoring duties with a new science teacher

_____h. Other (*Please briefly explain)*

3. (a) Since the fall of 2006, have you **served in a leadership role**? (*Please enter a check on just one line below.)*

_____ Yes (*If yes, go to question #3b)*

_____ No (*If no, go to question #4)*

(b) Please indicate the leadership roles you have held since the fall of 2006. (*Please check all that apply).*

_____a. **Science** department chair

_____b. **Science** curriculum writer

_____c. **Science** club/organization sponsor

_____d. Mentor to a science teacher

_____e. Member of a science teacher professional organization

_____f. Presenter at a science workshop, conference, or training session

_____g. Mentor to a teacher who is not a science teacher

_____h. Subject team leader in a subject other than science

_____i. Member of a teacher professional organization that is not specifically science- related

_____j. Member of a district-level decision-making committee

_____k. Other leadership role (*Please specify below)*

4. Since the fall of 2006, in which of the following types of **professional development opportunities** have you participated? (*Please enter a check in all lines below that apply to you.)*

_____a. Strategies for teaching science content

_____b. Strategies for teaching science using technology

_____c. Strategies for teaching science using the Texas Essential Knowledge and Skills (TEKS)

_____d. Strategies for preparing students to master the Texas Assessment of Knowledge and Skills (TAKS) objectives

_____e. Strategies for teaching science to students with special needs

_____f. Strategies for the use of laboratory in teaching science

_____g. Strategies for teaching science by inquiry

_____h. None of the above

_____i. Other (*Please specify below)*

5. (a) Since the fall of 2006, in which of the following activities have you engaged that were **specific to science or science education**? (*Please enter a check in all lines below that apply to you.)*

_____a. Teacher research on innovative practice in science

_____b. Peer observations of other science teachers

_____c. Graduate studies in a science-related field

_____d. Educator study groups in science

_____e. Professional science teacher associations

_____f. Curriculum writing in science

_____g. Mentoring of science student teachers

_____h. Other (*Please specify below)*

(b) Since the fall of 2006, in which of the following **professional activities** have you engaged that were **not specific** to science? (*Please enter a check in all lines below that apply to you.)*

_____a. Teacher research on innovative practice in a content area other than science

_____b. Peer observations of teachers other than science teachers

_____c. Graduate studies in an area that is not science-related

_____d. Educator study groups in an area other than science

_____e. Teaching professional associations that are not science specific

_____f. Curriculum writing in a content other than science

_____g. Mentoring of student teachers in content areas other than science

_____h. Other (*Please specify below)*

6. In a typical semester, **how often** do **you informally meet** (that is, not during a scheduled science department meeting) **with other science teachers** at your school about issues related to classroom science teaching? *(Please enter a check on just one line below.)*

_____a. Daily

_____b. Once a week

_____c. Twice a week

_____d. Once a month

_____e. Twice a month

_____f. Once a semester

_____g. Twice a semester

_____h. Almost never

7. Overall, how satisfied are you with **your decision** to become a high school science teacher? *(Please enter a check on just one line below)*.

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

8. How much do you agree with this statement: Improving student achievement in science is a **team effort** at this school? *(Please enter a check on just one line below)*.

_____a. Strongly agree

_____b. Agree

_____c. Disagree

_____d. Strongly disagree

9. How satisfied are you with the **level of cooperation and collegiality** among all the teachers at this school? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

10. How satisfied are you with the way your science program contributes to the **career development of students** at this school? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

11. How satisfied are you with the **decisions you can make** about the **instructional methods** you use in your own science classroom? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

12. How satisfied are you with the support you receive from the school to have your students attend informal science activities, such as field trips, visits to museums, and off-campus activities at informal science institutions? *(Please enter a check on just one line below)*.

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

13. How satisfied are you with the **options that you have** at your school for participating in science-specific professional development? *(Please enter a check on just one line below)*.

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

14. How satisfied are you with the **support provided by your school** for you to participate in professional development? *(Please enter a check on just one line below)*.

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

15. How satisfied are you with your **science laboratory facilities?** *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

16. How satisfied are you with your **science laboratory equipment**? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

17. How satisfied are you regarding the **recognition you receive** for your science teaching efforts at this school? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

18. How satisfied are you with your current teaching assignment? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

19. How would you rate your personal level of safety at this school? *(Please enter a check on just one line below).*

_____a. Excellent personal safety

_____b. Good personal safety

_____c. Fair personal safety

_____d. Poor personal safety

20. How satisfied are you with the administrative communication you receive about expectations for your teaching in this school? *(Please enter a check on just one line below).*

_____a. Very satisfied

_____b. Satisfied

_____c. Dissatisfied

_____d. Very dissatisfied

21. Please provide your full name.

____

First *Middle* *Last* *Maiden (if applicable)*

22. Including this year (2007-2008) as one year, how long have you taught science **at this school?** *(Please enter the number of years in the box below.)*

# of years

Stuessy, C. & PRISE Research Group. (2007a). *Texas poll of secondary science teachers.* Unpublished.

APPENDIX B

INTERVIEW PROTOCOL FOR PRINCIPALS: INDUCTION AND RENEWAL

Starter Question (Robust):
How does teacher induction work in your school?

Probing Questions:

- **Explain** your school's current teacher induction procedures.
- **Identify** "what works best" in your school's current teacher induction procedures.
- Do you see teacher induction issues or concerns that are likely to emerge in the immediate future at your school? (***Elaborate these issues and concerns.***)
- Do you have plans to change your school's current teacher induction process? (***Elaborate these changes and how they might affect your induction efforts.***)
- How might our network help you with teacher induction at your school? (***Elaborate.***)
- Is there anything else that you would like to tell us about induction at your school?
- Is there anything else that you would like to tell us about induction that you think would be helpful to share with the network and/or with the population of schools that teach high school science?

Reminder: Be sure to address in the interview both

- **General perspective** (responding in terms of all fields of study) and
- **Specific perspective** (responding in terms of just high school science)

Probing Question One: Explain your school's current teacher induction procedures.

- **Explain** what induction procedures you have in place for **beginning teachers** entering your school this year?
- **Explain** what induction procedures you have in place for **teachers transferring** into your school this year?
- **Explain** what procedures you have in place for selecting and training **mentor teachers** who will participate in your school's induction program?

Starter Question (Robust):
How does teacher professional growth work in your school?

Probing Questions:

1. **Explain** your school's current teacher professional growth procedures.
    - What about **science teacher** professional growth?

2. **Identify** "what works best" in your school's current professional growth procedures.
    - What works best in your school's current professional growth procedures **for science teachers**?

3. Do you see teacher professional growth issues or concerns that are likely to emerge in the immediate future at your school? ***(Elaborate these issues and concerns.)***
    - Are there professional growth issues or concerns **for science teachers in particular?**
    - What about the **projected 4 x 4 plan in science?** How do you foresee that affecting your school's plan for teacher professional growth?
    - What about the **removal of Integrated Physics & Chemistry (IPC**)? How do you foresee that affecting your school's plan for teacher professional growth?

4. Do you have plans to change your school's current teacher professional growth process? ***(Elaborate these changes and how they might affect your renewal efforts.)***
    - What **about science in particular?**

5. How might our network help you with teacher professional growth at your school***? (Elaborate.)***
    - Are there **things particular to science** that the network might help you with?

6. Is **there anything else** that you would like to tell us about teacher professional growth at your school?

7. Is there anything else that you would like to tell us about your professional growth practices that you think would be helpful to share with the network and/or with other schools that teach high school science?

Stuessy, C. & PRISE Research Group. (2007b). *Interview protocol for principals: Induction and renewal.* Unpublished.

APPENDIX C

INTERVIEW PROTOCOL FOR SCIENCE PROGRAM

In the first few questions, I would like talk with you about the policies and practices that your SP program has in regard to the ways its members communicate, collaborate and make decisions. So if may we may begin…

1. What can you tell me about the general organization of your school's SP?

- What is the general organizing structure of the SP?
- Who are the participating members in the SP? That is, who is attending meetings and performing essential tasks for SP?
- How many members are there total?

2. Can you describe the way in which the SP conducts its meetings?

- Does the SP typically meet as a whole group or in small subgroups? How so?
- Generally, what purpose(s) do those meetings serve?
- How often do SP meetings occur? Are these meetings regularly scheduled or do they occur more intermittently?
- Who leads these meetings?
- Do school administrators ever participate in the SP meetings? How so?

3. What can you tell me about the leaders in your school's SP? [players]

- What are the formal leadership positions in your school's SP?
- Are there others in the SP who have more informal leadership roles?
- Are the people in these positions and/or roles compensated in some way?

4. What can you tell me about the way administrators and SP members communicate and make decisions about program management issues (such as staffing and training, facility use, and budgetary concerns)?

- How do administrators and SP members discuss and make decisions about staffing and training issues?
- How do administrators and SP members make decisions about the facility needs of science teachers, e.g. classroom and laboratory space?
- How do administrators and SP members make decisions about the SP budget?
- Generally speaking, can you say whether the decision-making process in the SP is a top-down, bottom-up, or more balanced process? How so?

5. What can you tell me about the ways the SP supports science teachers' needs for professional development?

- Does your SP actively support professional development though collaborative relationships **within the school**? How?
- Does your SP support professional development through collaborative partnerships **outside the school**? How?
- Does your SP recognize or compensate science teachers who seek professional development in any particular way?
- How does your SP document CPE hours? What categories of CPE hours do you document?
- Does the SP provide or manage a budget to support science teachers' continued professional development? If so, how does that work?

6. In general, how are decisions made about what is taught in your science curriculum?

- To what extent do individual science teachers "actively" shape the policies about curriculum in the school's science program? How so?
- Would you say that the SP is "actively" involved in the textbook selection and adoption process? How so?
- What role does the SP at your campus have, if any, in the vertical alignment of the district's K-12 science curriculum? Explain.

7. What role does the SP have in implementing the school's science curriculum?

- Does the SP provide a specific forum where science teachers can reflect on their "teaching experiments" with others as they discover and refine new ways of teaching?
- Does the SP have a process for selecting and acquiring science-related resources for students?

8. Does the SP have a process by which extra science-related resources for teachers are chosen and purchased?

- If so, how does this process work?
- Does the SP encourage science teachers to use national reform documents as well?
- Does the SP support a lesson sharing system? If so, what do teachers use the system for in your school? Can you describe how it works?

9. To what extent does your SP encourage teachers to use inquiry-based instructional methods?

- How does your SP generally approach science teaching by inquiry?
- Do you have specific courses that emphasize inquiry, or is inquiry emphasized in all courses?
- How does the SP encourage science teachers to include the history and the nature of science in their lessons?
- Does the SP seek out and support the professional development of science teachers in inquiry-based instruction?

10. To what extent does the SP encourage science teachers to integrate laboratory experiences into their curricula?

- Does the state's recommendation for 40% laboratory instruction create difficulties in your school?
- If so, is the SP working with the administration to overcome those barriers?

11. Can you tell me about the ways that your SP encourages students to think about science in relation to their developing career plans after high school?

- Are there specific ways the SP encourages teachers to develop career-related science learning experiences for their students **outside the school's walls**?
- Are there specific ways that the SP encourages teachers to develop career-related science learning experiences for their students **within their classrooms**?

12. Can you tell me about the ways that your SP encourages students to think about science in relation to their personal interests?

- Are there specific ways that the SP encourages science teachers to provide students with personally relevant learning experiences outside the school's walls?
- Are there specific ways the SP encourages teachers to provide students with personally relevant learning experiences within the school's walls?

13. Can you tell me about the ways that your SP encourages students to think about science in relation to their developing social interests?

- What particular social issues are emphasized by the SP?
- How are these issues integrated within the school's science curriculum?
- How are these issues taught to students in personally meaningful ways?

14. How does the SP assist students in matching their academic interests to the different types of science courses offered by the school?

- What options are available for different students in terms of types of courses?
- Who makes decisions about the assignments of students into those types of courses?
- With whom do students talk about the science courses they may be interested in taking?

15. How does your SP assess its students' overall achievement in science?

- Do your science teachers use benchmark-type tests? If so, for what purpose?
- How does your SP emphasize strategies for all science teachers to prepare students for state-mandated tests?
- How are these achievement-oriented assessments used to inform future decisions about student learning?

16. Does the SP encourage teachers to use other forms of assessments?

- Are there particular alternative assessment strategies that the SP encourages science teachers to use?
- Does the SP emphasize the use of formative assessment strategies? How so?
- If yes, what reasons does the SP have for wanting teachers to use these alternative methods for assessing students?

17. Finally, is there anything special or unique that you would like share with us about your school's SP?

- How is this related to your SP's common, shared vision of science education?

Stuessy, C. & PRISE Research Group. (2007c). *Science program interview questions for the science liaison.* Unpublished.

APPENDIX D

EXAMPLE SCHOOL SCIENCE MASTER SCHEDULE

	1st	2nd	3rd	4th	5th	6th	7th	8th
Boggs	Pre-AP English 9	English 9	Coll. English	Lunch	English 10	LDC - UIL ELA	Pre-AP English 10	*conference*
J. Moore	Speech/Yearbook	English 11	English 12	Yearbook/Speech	AP English 11	LDC - UIL ELA	English 12	*conference*
D. Moore	Coll. USH	World History	Govt / Eco	*conference*	Lunch	W. Geography	Coll. Govt / Eco	World History
Robison	7/8 B Athletics	W. Geography	US History	US History	*conference*	LDC - UIL Soc.Stud.	6 B Pre-Athletics	HS B Athletics
Kana	Physics	Physics	Chemistry	Chemistry	Anat & Phys	LDC - UIL Science	*conference*	TAKS Science
McCasland	7/8 G Athletics	6 G Pre-Athletics	Biology	Int. Phy/Chem	Biology	Int. Phy/Chem	*conference*	HS G Athletics
Hoots	Geometry	Pre-Calculus	Geometry	Band Assistant	Pre-Calculus	LDC - UIL Math	TAKS Math	*conference*
Burke	Algebra II	Coll. Alg/Trig	Algebra I	*conference*	Math Models	LDC - UIL Tech App	Algebra II	Algebra I
Yanker	Basic English	*CMC / AEP*	*conference*	System 44	System 44	LDC - UIL ELA	Read 180	*CMC / AEP*
Haney	Agri. Alg. Ext. Expl.	Basic Math	*Bio / AEP / CMC*	*IPC / AEP / CMC*	*conference*	LDC - UIL Math	*TAKS Math*	*TAKS Science*
McCullar	Art	Library	Library	Art	Library	Library	Read 180	Library
McLendon	7/8 B/G Ath	Human Services	Dol&Sen / IntDes	*conference*	Human Services	Dol&Sen / IntDes	Human Services	HS G Athletics
Cooper	Agri. Alg. Ext. Expl. AgMech&MetTech AgFacDes & Fab I	*CMC/AEP*	*conference*	Principles of Ag.	WF&E Mgmt (F) ProStrd AgBus (S)	AgMech&MetTech AgFacDes & Fab I	WF&E Mgmt (F) ProStrd AgBus (S)	PrinArch&Const
Albus	Bus. Info. Mgmt. I	Bus. Info. Mgmt. I	Bus. Info. Mgmt. I	Print&ImageTech	Bus. Info. Mgmt. II	LDC - UIL Tech App	*conference*	Audio/Video Prod.
Hodges						LDC - UIL Tech App		
Caudle	Spanish 3 Spanish 1 (Comp.)	*conference*	Spanish 2	Spanish 1	Spanish 1 Spanish 2 (Comp.)	ESL	Spanish 1	Spanish 3
Miller	*conference*	Head Band Dir.	Head Band Dir.	HS Band (+8th)	Lunch	6th Gr. Band	Head Band Dir.	7th Grade Band
Cavazuela	Office	Office	Office	Mail	Lunch	Office	Office	Office

APPENDIX E

WEIGHTED INDUCTION RUBRIC

Section	Subsection	Weight	Item
Campus Administrator's Direct Involvement in Teacher Induction		1	Mentor matching
Campus Administrator's Direct Involvement in Teacher Induction		1	Mentor selection
Campus Administrator's Direct Involvement in Teacher Induction		1	Involves novices in school activities
Campus Administrator's Direct Involvement in Teacher Induction		4	Provide substitutes for mentor/mentee observations
Campus Administrator's Direct Involvement in Teacher Induction		1	Formal observations
Campus Administrator's Direct Involvement in Teacher Induction		2	Informal observations
Campus Administrator's Direct Involvement in Teacher Induction		4	Meets with novices throughout school year
Campus Administrator's Direct Involvement in Teacher Induction		4	Help novice improve science instruction
Campus Administrator's Direct Involvement in Teacher Induction		1	Open-door policy
Campus Administrator's Direct Involvement in Teacher Induction		0	Tries not to hire new teachers
Campus Administrator's Direct Involvement in Teacher Induction		2	Communicates expectations to novices
Campus Administrator's Direct Involvement in Teacher Induction		2	Communicates expectations to mentors
Campus Administrator's Direct Involvement in Teacher Induction		1	Policies and procedures
Campus Administrator's Direct Involvement in Teacher Induction		4	Gets feedback on induction
What works best for induction?		0	Mentoring
What works best for induction?		0	Building relationships
What works best for induction?		0	Policies and procedures
What works best for induction?		0	New teacher orientation
What works best for induction?		0	Team planning
What works best for induction?		0	Other
Mentor Selection		1	"experienced" teacher
Mentor Selection		1	Mentor "understands" school
Mentor Selection		1	Model teacher
Mentor Selection		2	Subject match
Mentor Selection		1	Proximity match
Mentor Selection		1	Work ethic and attitude
Mentor Selection		0	Mentor not selected by principal
Mentoring Activities		1	Policies and procedures
Mentoring Activities		2	Lesson planning
Mentoring Activities		2	Help improve instruction
Mentoring Activities		3	Mandatory observations of novice
Mentoring Activities		3	Being observed by novice
Mentoring Activities		1	Classroom management and general pedagogy
Mentoring Activities		1	Informally take novice "under their wing"
Induction Concerns		0	Current induction program at school is "poor"
Induction Concerns		0	New teacher training needs
Induction Concerns		0	Lack of guidelines
Induction Concerns		0	Not enough mentors
Induction Concerns		0	Scheduling difficulties
Induction Concerns		0	Monitor mentoring
Induction Concerns		0	Other
Plans to Change		0	Yes
Induction Activities	Before School Starts	2	New Teacher Orientation
Induction Activities	Before School Starts	1	School/District policies and procedures
Induction Activities	Before School Starts	2	Meet science faculty
Induction Activities	Before School Starts	2	Familiarized with school community
Induction Activities	Before School Starts	2	Familiarized with science curriculum
Induction Activities	Before School Starts	1	Familiarized with school-wide technologies
Induction Activities	After School Starts	4	Scheduled mentoring during school day
Induction Activities	After School Starts	4	Training specific for new teachers
Induction Activities	After School Starts	4	Science training for novices
Induction Activities	After School Starts	4	Reduced course load
Induction Activities	After School Starts	4	Support beyond one year
Induction Activities	After School Starts	3	Meetings with other new teachers
Induction Activities	After School Starts	3	Common planning period for science teachers
Induction Activities	After School Starts	3	Lesson plan in teams
Induction Activities	After School Starts	2	Mandatory observations by teacher(s) other than mentor
Induction Activities	After School Starts	2	Mandatory observations of non-science teachers
Induction Activities	After School Starts	3	Mandatory observations of science teachers
Mentoring Actors	Formally Assigned	1	School administrator
Mentoring Actors	Formally Assigned	1	District mentor
Mentoring Actors	Formally Assigned	2	Science teacher
Mentoring Actors	Formally Assigned	1	Non-science teacher
Mentoring Actors	Formally Assigned	1	Other
Mentoring Actors		1	Informal mentor or "buddy"
Mentoring Actors		0	No mentor
Components for mentors		2	Training (initial)
Components for mentors		3	Training (updates)
Components for mentors		2	Compensated by school/district
Components for mentors		3	Guidelines/goals for mentoring
Components for mentors		4	Meetings for mentor teachers
Components for mentors		4	Reduced course load

Ivey, T. *High school science teacher induction in Texas: Implications for policy*. (Unpublished doctoral dissertation). Texas A&M University, College Station, TX.

VITA

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